Appendix

m

Surface Water Impact Assessment

Continuation of Boggabri Coal Mine Project - Surface Water Assessment

October 2010

Hansen Bailey Pty Ltd

Parsons Brinckerhoff Australia Pty Limited
ABN 80 078 004 798

Level 3
51–55 Bolton Street
NEWCASTLE NSW 2300
PO Box 1162
NEWCASTLE NSW 2300
Australia
Telephone +61 2 4929 8300
Facsimile +61 2 4929 8382
Email newcastle@pb.com.au

2123173A PR_1675 RevF.doc

Certified to ISO 9001, ISO 14001, AS/NZS 4801

Revision	Details	Date	Amended By
0	Advanced Draft	18 December 2009	
A	Draft	26 February 2010	
B	Final Draft	6 May 2010	
C	Final	13 May 2010	
D	Final	4 June 2010	
E	Final	8 October 2010	
F	Final	11 October 2010	

Author: Leigh Tickle ....

Signed: ....

Reviewer: Eric Lam / Rob Leslie ....

Signed: ....

Approved by: Leigh Tickle ....

Signed: ....

Date: 11 October 2010..

Distribution: Hansen Bailey (x 1), PB file (x 1) ....

Parsons Brinckerhoff Australia Pty Limited
ABN 80 078 004 798

Level 3
51–55 Bolton Street
NEWCASTLE NSW 2300
PO Box 1162
NEWCASTLE NSW 2300
Australia
Telephone +61 2 4929 8300
Facsimile +61 2 4929 8382
Email newcastle@pb.com.au

Our Reference 2123173A / PR_1675 RevF

11 October 2010

Ben Eastwood
Senior Environmental Scientist
Hansen Bailey Pty Ltd
PO Box 473
Singleton NSW 2330

Dear Ben

Continuation of Boggabri Coal Mine Project - Surface Water Assessment

Please find enclosed a FINAL copy of the Surface Water Assessment report for the Boggabri Coal Mine Continuation of Mining Project.

If you have any queries, please do not hesitate to contact the undersigned on (02) 49 29 8300.

Yours sincerely

Leigh Tickle
Senior Environmental Engineer
Parsons Brinckerhoff Australia Pty Limited

Contents

Page number

List of tables

List of figures

Page number

Appendices

1. Introduction

1.1 Purpose

Parsons Brinckerhoff Australia Pty Limited (PB) was engaged by Hansen Bailey Pty Limited (Hansen Bailey) to undertake a surface water assessment for the Continuation of Boggabri Coal Mine Project. It is understood that the surface water assessment will support the Environmental Assessment for the Project. The Environmental Assessment is being prepared by Hansen Bailey on behalf of Boggabri Coal Pty Limited (Boggabri Coal).

Boggabri Coal Mine is located in the Gunnedah Basin, approximately 15 km north-east of the town of Boggabri in north-west New South Wales. A locality plan is provided in Figure 1-1.

1.2 Background

In August 1989 the NSW Minister for Planning granted development consent Departmental File Number (DFN) 79/1443(z)2 (Development Consent) to the Boggabri Coal Joint Venture enabling the construction and operation of the Boggabri Coal Project, which included a surface coal mine and associated infrastructure.

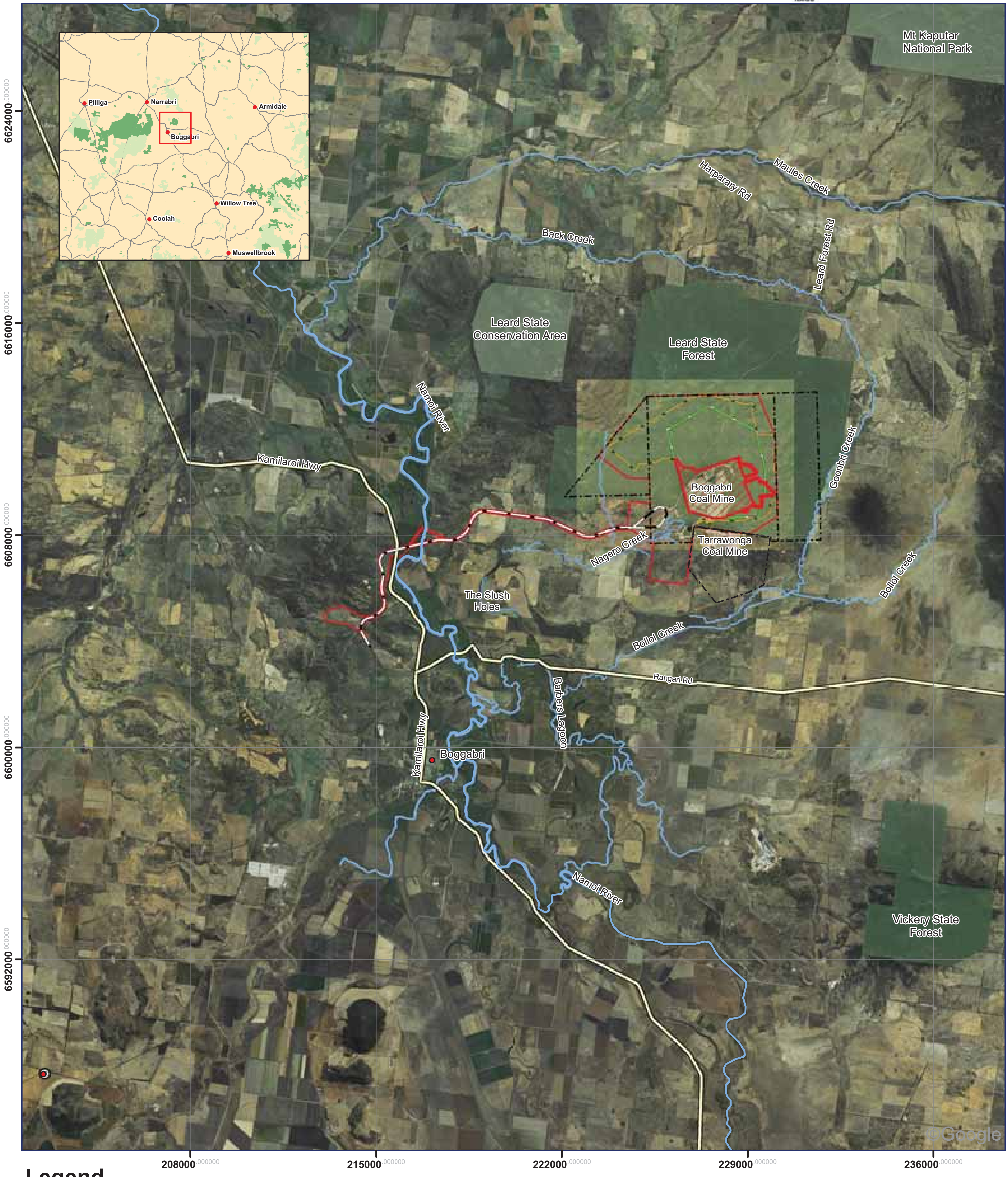
The Development Consent was supported by the Environmental Impact Statement Joint Venture Boggabri Coal Project (Boggabri Coal Joint Venture, 1987) (Boggabri EIS). The Development Consent allowed the open cut coal mining of up to 5 Million tonnes per annum (Mtpa) of product coal for a period of 21 years from the date of the granting of a mining lease. CL 368 was granted in November 1990 and consequently the Development Consent expires in November 2011. Mining under this Development Consent did not commence until 2006.

Boggabri Coal seeks a Project Approval under Part 3A of the Environmental Planning & Assessment Act 1979 for a single, contemporary planning approval for the continuation of its mining operations within its current mining tenements for a further 21 years (the Project).

Disturbance limits for the current Development Consent and the proposed Part 3A Project Approval are illustrated on the locality plan provided in Figure 1-1.

CLIENT: HANSEN BAILEY PTY LTD
PROJECT: CONTINUATION OF BOGGABRI COAL MINE, SURFACE WATER ASSESSMENT

PARSONS BRINCKERHOFF



Legend

- Town Location
- River / Creek
- Mine Tenement Boundary
- Mine Disturbance to Nov 2011
- Project Boundary
- Proposed Disturbed Limit (Boggabri Extension)
- EIS Mine Disturbance (Boggabri Existing)

0 2.5 5
Kilometers

GDA 1994 MGA Zone 56

FIGURE 1-1 LOCALITY PLAN

1.2.1 Approved operations

A summary of the key features of the existing approved operations for the Boggabri Coal Mine is provided below:

Mine plan

- Open cut mining operations, utilising a combination of dragline and truck / shovel methods, to strip and extract all coal seams to the Merriown seam up to a maximum of 5 Mtpa product coal.
- Out-of-pit emplacement in limited areas where overburden is required to merge the rehabilitated surface and existing topography.
- A provisional void to remain at the end of mine life.

Infrastructure

- Mine facilities (including offices, coal preparation facilities, workshops and bathhouse), access roads, mine water storage and irrigation system, and 45,000 tonne raw coal stockpile.
- Coal crushing and sizing plant that conveys coal to the truck product stockpile prior to being loaded into coal haulage trucks with initial coal processing to generate coarse reject only to be co-disposed in-pit.
- Coal handling and preparation facility including raw coal handling, coal bypass, coal preparation and product coal handling facilities (for rail) with a capacity to process 5 Mtpa.
- A 3,000ML capacity tailings dam located to the south of the mining area.

Product coal transport

- Initial production of coal to be hauled by trucks from the mine site to the existing train loading facilities via a 17km private sealed haul road.
- At full production, construction of a new 17km rail spur and mine site rail loop.
- Washed coal to be stacked on a 60,000 tonne product coal stockpile, reclaimed and conveyed to a single 1,500 tonne rail loading bin, with capacity to load at 5,000 tonnes per hour.

1.2.2 Current operations

Since the commencement of mining in 2006, Boggabri Coal has constructed some but not all of the infrastructure described within its Development Consent. The washery, tailings dam, mine site rail spur and loop described within the Development Consent have not yet been constructed. The dragline described within the Development Consent is also yet to be introduced.

A summary of the current operations, as at the beginning of 2010, is provided below:

Mine plan

- Open cut mining operations utilising hydraulic excavators. Approximately 1.5 Mtpa product coal was mined to the Merriown seam during 2009.
- Coal from the mining void is loaded onto rear dump trucks and transported to the run of mine (ROM) crusher pad. Coal is recovered from the ROM pad by front end loader and trammed to a crusher. Crushed coal is conveyed to a product bin where it is loaded into B-double haul trucks.

Infrastructure

- Coal crushing and handling plant with a throughput rate of 500 tonne per hour.
- Coal receival hopper of 60 tonne capacity fitted with a grizzly designed to accommodate a front end loader.
- Crushing system comprising a feeder breaker and a sizer of 500 tonne per hour capacity with a capacity in excess of 2.5 Mtpa.
- 500 tonne per hour loadout bin conveyor.
- Truck Loading Bin System comprising a 380 tonne capacity bin with a bypass chute for emergency stockpiling. The truck loadout system is automated and has an instantaneous loadout rate of 2,000 tonne per hour.
- Product stockpile adjacent to rail loadout of approximately 70,000 tonne capacity.
- Train Loadout System comprising:
  - reclaim system
  - loadout conveyor of up to 5,000 tonne per hour (tph) capacity
  - automatic 3,500 tph train loadout system incorporating a Precision Loading System with surge bin and weigh bin capable of loading at up to 5,000 tph.

Product coal transport

- Coal haulage from the mine site to the product stockpile is achieved using a fleet of B-double haul trucks. The private haul road facilitates the transport of coal to the train load out facility.

1.3 Project description

Boggabri Coal is seeking approval for the continuation of its mining operations within its current mining tenements for a further 21 years from November 2011. The Project generally comprises the following:

- Continuation of mining operations via open cut methods up to 7 Mtpa product coal to the Merriown seam with a maximum overburden emplacement height of approximately RL 395.

- Open cut mining fleet including excavators and fleet of haul trucks, dozers, graders, water carts and other equipment, with the flexibility to introduce a dragline as required, utilising up to 500 employees.

- Modifications to existing and continuation of approved (but not yet constructed) infrastructure including:

  - coal handling and preparation plant
  - modifications to existing site infrastructure capacities including: ROM coal hopper, second crusher, stockpile area, coal loading facilities, water management and irrigation system
  - rail loop and 17km rail line across the Namoi River and floodplain including overpasses across the Kamilaroi Highway, Therribri Road and Namoi River
  - minor widening of the existing coal haul road
  - upgrading and relocating site facilities including offices, car parking and maintenance sheds.

- Closing a section of Leard State Forest Road.

- Upgrading the power supply capacity to 132 kilovolt (kV) high voltage lines suitable for dragline operations.

The Project will be implemented in stages, as can be justified by economic drivers. It is understood that the proposed upgrades and relocation of the site facilities including offices, car parking and maintenance sheds will be implemented by Year 1. The proposed coal handling and preparation facility (incorporating the new product stockpile pad) and rail loop and spur (incorporating the train load out area) will be implemented between Years 1 and 5.

Anticipated production rates for the Project are provided in Table 1-1 for Years 1, 5, 10 and 21. The washery feed varies over the life of the Project, and is dependent on the ash content of ROM coal as well as the tonnage of ROM coal mined.

Table 1-1 Summary of production rates and washery feed requirement for the Project

Description	Year 1	Year 5	Year 10	Year 21
ROM coal mined (Mtpa)	2.5	8.6	7.9	7.2
Direct feed to plant (Mtpa)	1.8	6.9	6.3	5.8
To ROM stockpile (Mtpa)	0.8	1.7	1.6	1.4
Reclaim from ROM stockpile (Mtpa)	0.8	1.7	1.6	1.4
ROM stock level (Mtpa)	0.1	0.2	0.2	0.2
Feed to process (Mtpa)	2.5	8.6	7.9	7.2
Bypass / crushing (Mtpa)	2.5	5.6	5.4	4.7
Washery feed (Mtpa) ^	0.0	3.0	2.5	2.5
Product coal (Mtpa)	2.5	7.0	7.0	7.0

Note. ^ Washery will not be operational for Year 1.

1.4 Scope of work

The scope of the surface water assessment in this report includes:

- Review available data, including previous surface water studies and management plans for Boggabri Coal Mine.
- Undertake a desktop assessment of existing water quality at the site, and identify potential impacts and mitigation measures.
- Undertake a desktop assessment of existing water usage downstream of the site, and identify potential impacts and mitigation measures.
- Undertake an assessment of existing surface water hydrology for the local catchment, and identify potential impacts and propose mitigation measures for the Year 1, 5, 10 and 21 landforms.
- Undertake a site water balance to estimate annual runoff volumes and identify potential water deficits and surpluses for the Year 1, 5, 10 and 21 landforms.
- Develop surface water management system concepts for the Year 1, 5, 10 and 21 landforms.
- Outline a surface water monitoring program for the site.

A site walkover of Boggabri Coal Mine was undertaken by PB staff in July 2009 for familiarisation purposes and to identify critical features of the existing water management system and local catchment.

Separate groundwater and flooding assessments for the Project have been undertaken by others and are discussed further in Sections 2.5, 2.6 and 7.

1.5 Environmental Assessment Requirements

The Director General's requirements for the Environmental Assessment for the Project that relate specifically to surface water include:

- *"Detailed modelling of the potential surface water impacts of the Project.*
- *A detailed site water balance, including a description of the measures to be implemented to minimise water use on site.*
- *A detailed assessment of the potential impacts of the Project on:*
  - *the quality and quality of surface water resources*
  - *water users both in the vicinity of and downstream of the Project*
  - *the riparian and ecological values of watercourses both on site and downstream of the Project*
  - *environmental flows.*
- *A detailed description of the proposed water management system for the Project and water monitoring program".*

2. Existing surface water environment

2.1 Regional hydrology

Boggabri Coal Mine is contained within the catchments of Nagero Creek and Bollol Creek. Nagero Creek and Bollol Creek are both small tributaries of the Namoi River, which is part of the Barwon-Darling River system.

The Namoi River catchment is bounded by the Great Dividing Range in the east, the Liverpool Ranges and Warrumbungle Ranges in the south, and the Nandewar Ranges and Mount Kaputar to the north. Major tributaries of the Namoi River include Coxs Creek, Mooki River, Peel River, Cockburn River, Manilla River and Macdonald River, which all join the Namoi River upstream of Boggabri.

The Namoi River catchment has an area of approximately 42,000km^2. The catchment extends over 350km in an east-west direction between the Great Dividing Range and the Barwon River. The Namoi River catchment area to Boggabri is approximately 22,600km^2, contributing to a mean annual streamflow of 906,470ML/yr at the Boggabri gauging station (ID 419012).

Split Rock Dam on the Manilla River and Keepit Dam on the Namoi River are the two main water storages in the Namoi River catchment. These structures allow the delivery of flows to meet the needs of water users downstream.

Annual rainfall in the Namoi River catchment is highly variable, and decreases across the catchment from around 1,000mm along the Great Dividing Range in the east, to around 470mm in the western extent of the catchment.

The Namoi Valley is subject to regular flooding. The largest recently recorded flood events in the Namoi Valley occurred in February 1955, January 1971, February 1984 and November 2000. The existing mining area and Mine Infrastructure Area (MIA) are not located within the floodplain, however, the existing product coal haul road and proposed rail line cross the floodplain.

2.2 Local hydrology

2.2.1 Nagero Creek

The existing mining area and MIA are entirely contained within the Nagero Creek catchment. The northern portion of the Boggabri Coal Mine irrigation area (used to dispose of surplus mine water) is also contained within the Nagero Creek catchment.

The Nagero Creek catchment is bounded by the Willowtree range to the north-east and falls generally to the south-west. The catchment area is approximately 4,250ha to the point where Nagero Creek meets the Namoi River floodplain. The current mining area to November 2011 disturbs approximately 350ha of this catchment (equivalent to 8% of the 4,250ha catchment). The Project mining area (including that which will be disturbed as at November 2011) will disturb approximately 1,830ha of this catchment (equivalent to 43% of the 4,250ha catchment).

The majority of the Nagero Creek catchment upstream of the site is contained within the Leard State Forest. Leard State Forest has been selectively logged in the past, but is generally forested with the exception of Boggabri Coal Mine, Tarrawonga Coal Mine and Leard Forest Road. The majority of the catchment downstream of the site comprises cleared farm land.

From the south-western corner of the mining area, Nagero Creek flows approximately 5km westward to the Namoi River.

Nagero Creek is an ephemeral stream. The cross-section comprises a well defined incised channel up to approximately 15 m wide bank to bank and 3 m deep. The banks are well vegetated, and the bed comprises sand and/or rock.

The bed slope varies between approximately 2% at the top of the catchment to 0.8% at the downstream edge of the Boggabri Coal Mine.

Downstream of the site, Nagero Creek becomes indistinct as it flows across the Namoi River floodplain. These alluvial flats become swampy following rainfall, and natural ponds and farm dams store water for long periods.

2.2.2 Bollol Creek

The southern portion of the Boggabri Coal Mine irrigation area is contained within the Bollol Creek catchment.

Bollol Creek is an ephemeral stream with a total catchment area of approximately 85,000ha. The catchment is predominately cleared and utilised for cropping, grazing and other agricultural land uses.

The area of the Boggabri Coal Mine irrigation area that is within the Bollol Creek catchment is approximately 130ha. This is less than 0.2% of the 85,000ha catchment.

2.3 Surface water quality

Concentration limits for surface water emissions specified under Boggabri Coal's current Environmental Protection License (EPL) No. 12407 are provided in Table 2-1.

Table 2-1 Concentration limits for emissions to water (as per EPL No. 12407)

	Concentration limit		
Pollutant	**50th percentile**	**90th percentile**	**100th percentile**
Oil & grease (mg/L)	-	-	10
pH	-	-	6.5-8.5
Total suspended solids (mg/L)	20	35	50

Surface water quality in the local catchment is monitored by Boggabri Coal as per the conditions of EPL No. 12407.

Surface water monitoring is undertaken at seven sites, including Nagero Creek upstream and downstream of existing mining operations, and within existing sediment dams SD2, SD3 and SD6. Monitoring is undertaken for pH, electrical conductivity, total suspended solids, oil and grease, nitrate, nitrogen (total), phosphorus (total) and reactive phosphorus.

A plan showing existing surface water monitoring sites is provided in Figure 2-1. Descriptions of existing sediment dams and mine water storages are provided in Section 3.

A summary of surface water quality monitoring data collected by Boggabri Coal between July 2008 and February 2009 is provided in Table 2-2. Full analytical reports for the seven monitoring sites listed in Table 2-2 are provided in Appendix A. The analytical reports also include additional monitoring data for metals, cations, hydrocarbons and volatile organic compounds at selected monitoring sites.

Table 2-2 Summary of surface water quality monitoring data

		Compound					
Monitoring Site	**Sample date**	**pH**	**Electrical conductivity (µS/cm)**	**Suspended solids (mg/L)**	**Total Nitrogen as N (mg/L)**	**Total Phosphorus as P (mg/L)**	**Oil & grease (mg/L)**
SW1	23/9/08	6.7	231	2,070	3.8	0.38	-
SW1	6/10/08	7.4	127	169	3.1	0.29	-
SW1	13/12/08	7.7	174	158	1.2	-	-
SW1	17/2/09	7.3	59	160	1.9	0.12	<5
SW2	23/9/08	5.9	56	99	0.7	0.19	-
SW2	6/10/08	7.0	72	32	0.6	0.13	-
SW2	13/12/08	7.8	86	66	0.8	-	-
SW2	17/2//09	7.1	33	110	0.5	0.11	<5
SD2	17/7/08	8.1	310	44	33.3	13	-
SD2	23/9/08	6.8	337	273	3.4	<0.01	-
SD2	6/10/08	7.3	247	382	1.3	0.1	-
SD3	17/7/08	8.1	818	46	0.9	0.15	-
SD3	6/10/08	7.2	295	656	6	1.72	-
SD6	6/10/08	7.1	355	60	1.5	0.23	-
SD6	16/10/08	7.8	394	-	1	0.31	<5
SD6	17/7/08	8.1	507	165	1.7	0.26	-
MW2	17/7/08	8.8	1300	38	7.8	<0.01	-
MW2	16/10/08	8.6	1300	-	9.1	0.13	<5
Tarrawonga Discharge	6/10//08	7.0	750	12	1	0.07	-
Detection limit		*0.01*	*1*	*1*	*0.1*	*0.01*	*5*
Minimum		*5.9*	*33*	*12*	*0.5*	*<0.01*	*<5*
Maximum		*8.8*	*1300*	*2070*	*33.3*	*13*	*<5*

Notes: Monitoring at the ‘Tarrawonga Discharge’ site is undertaken for internal purposes, and is not a requirement of EPL No. 12407

CLIENT: HANSEN BAILEY PTY LTD
PROJECT: CONTINUATION OF BOGGABRI COAL MINE, SURFACE WATER ASSESSMENT

PARSONS BRINCKERHOFF

Legend

- Existing surface water monitoring sites
- Existing storages
- Namoi River Floodplain from EIS
- Project Boundary
- Boggabri Coal Mining Tenements
- Mine Disturbance to Nov 2011
- Proposed Disturbed Limit (Boggabri Extension)
- EIS Mine Disturbance (Boggabri Existing)

0 0.5 1
Kilometers

GDA 1994 MGA Zone 56

\\AUNCLF\proj\H\Hansen_Bailey\2123173_EMA_BOGGABRI_COAL_EA\05_WrkPapers\GIS\Output\Maps LT

FIGURE 2-1 EXISTING SURFACE WATER MONITORING SITES

Monitoring site ‘SW2’ is located upstream of mining operations. Monitoring has been undertaken at SW2 on four occasions. A summary of the results is provided below:

- pH ranged from 5.9 to 7.8
- electrical conductivity ranged from 33 to 86 µS/cm
- suspended solids concentrations ranged from 32 to 110 mg/L
- oil and grease was only sampled on one occasion, and was not detected.

Background suspended solids concentrations at the upstream monitoring site SW2 exceeded the limits specified under EPL No. 12407 (100^{th} percentile limit of 50 mg/L, refer to Table 2-1). The background pH was lower than the range specified under the EPL No. 12407 on one occasion (100^{th} percentile range of 6.5 to 8.5, refer to Table 2-1).

Monitoring site ‘SW1’ is located downstream of Boggabri Coal Mine, at the Nagero Creek crossing of Leard Forest Road. Monitoring has been undertaken at SW1 on four occasions. A summary of the results is provided below:

- pH ranged from 6.7 to 7.7
- electrical conductivity ranged from 59 to 231 µS/cm
- the suspended solids concentration was 2070 mg/L on one monitoring occasion, but was between 158 and 169 mg/L on the other three monitoring occasions
- oil and grease was only sampled on one occasion, and was not detected.

Suspended solids concentrations at the downstream monitoring site SW1 exceeded the limits specified under EPL No. 12407 (100^{th} percentile limit of 50 mg/L, refer to Table 2-1).

Monitoring site ‘MW2’ is located at Mine Water Dam 2. This is the ‘turkey’s nest’ dam that stores contaminated mine water pumped from the mining void. Monitoring at this site has been undertaken on two occasions and indicates that mine water is mildly saline (electrical conductivity of 1,300 µS/cm) and alkaline (pH of 8.6 to 8.8). The additional monitoring data from site ’MW2’ that is provided in Appendix A indicates that mine water also has high levels of sodium (sodium concentration of 282mg/L) and high levels of carbonates (bicarbonate alkalinity as $CaCO_3$ of 451mg/L).

2.4 Downstream surface water users

2.4.1 Namoi Water Management Area

Boggabri Coal Mine is located within the Namoi Water Management Area, which includes two water sources. The Upper Namoi Regulated River Water Source includes the regulated river sections between Split Rock Dam and Keepit Dam. The Lower Namoi Regulated River Water Source includes the regulated river sections downstream of Keepit Dam to the Barwon River, including the regulated sections of the Gunidgera/Pian system. Boggabri Coal Mine drains to the Lower Namoi Regulated River Water Source.

The main landuse in the Namoi Water Management Area is agriculture, accounting for approximately 96% of water consumption from the Namoi River. Mining, manufacturing and households account for approximately 2% of consumption, and 'other' users account for the remaining 2% of consumption (Australian Government National Water Commission, 2005). The majority of agricultural water consumption is for irrigation of cotton.

Water sharing in the Namoi Water Management Area is regulated by the Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated River Water Sources 2003, made under the Water Management Act 2000. The Water Sharing Plan sets out rules for how water is shared between the environment and water users and different categories of water access licences. Water is shared amongst different categories of water access licences by means of Available Water Determinations.

For the Lower Namoi, Available Water Determinations provide allocations of water equal to 100% of the share component of domestic and stock, and local water utility access licences and 1ML per unit share for high security access licences, in all but the most exceptional drought years. However, the water made available to general security access licences is reviewed monthly and depends upon the amount of water held in Split Rock and Keepit Dams. The water made available to supplementary water access licences is set at the start of each water year.

A summary of the Available Water Determinations at the start of the 2009 / 2010 water year under the Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated River Water Sources 2003 is provided in Table 2-3.

Table 2-3 Available Water Determinations 2009 / 2010 under the Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated River Water Sources

Source	Water Access License category	No. of Water Access Licenses	Total share component	Available Water Determination
Lower Namoi	Domestic and Stock	128	2,022ML	100%
	Local Water Utility	1	2,271ML	100%
	General Security	217	246,056 unit shares	0ML/share
	High Security	11	3,418 unit shares	1ML/share
	High Security (Research)	1	486ML	1ML/share
	Supplementary Water	209	115,486 unit shares	1ML/share
Upper Namoi	Domestic and Stock	20	92ML	100%
	Local Water Utility	1	150ML	100%
	General Security	82	9,724 unit shares	0.5ML/share
	High Security	5	80 unit shares	1ML/share

Source: NSW Department of Water and Energy, Water Access License Statistics (www.wma.dwe.nsw.gov.au)

Long term extraction factors for the Namoi Regulated River are given in the document Water Availability in New South Wales Murray-Darling Basin Regulated Rivers (NSW Department of Water and Energy, 2009). The estimated long term extraction factors under the 'ultimate development scenario' for high security, general security and supplementary license categories are 0.95, 0.76 and 0.18, respectively.

However, Available Water Determinations for general security licenses in the Lower Namoi have been much lower in recent years than the long term extraction factor. A summary of Available Water Determination announcements for the four year period from 2004 to 2008 is provided in the Water Sharing in the Upper and Lower Namoi Regulated Rivers: Progress Report 2004 to 2008 (NSW Department of Water and Energy, 2009). Due to extended low flows, Available Water Determination announcements for general security licences in the Lower Namoi were set at zero for a period of 17 months between February 2006 and July 2007. When water was made available for general security licences, Available Water Determinations announcements for this category of licence in the Lower Namoi ranged from zero to a maximum of 0.117 ML per share in September 2005.

Boggabri Coal currently holds general security and supplementary water access licenses for the Lower Namoi Regulated River Water Source. Details of water access licenses, along with groundwater access licenses held by Boggabri Coal Mine, are provided in Sections 5.3.3 and 5.3.4.

Boggabri Coal currently only utilises groundwater allocations to supplement an onsite water deficit. This groundwater is pumped to site from Lovton Bore and Daisymede Bore. Boggabri Coal does not currently utilise surface water allocations to supplement an onsite water deficit. As such, there is currently no infrastructure to transfer water from the Namoi River to the site (e.g. raw water dam, pump and pipeline).

2.4.2 Nagero Creek

Water from the Nagero Creek catchment is currently used by properties located along Therribri Road, Manilla Road and Leard Forest Road. This water is mainly used to fill small farm dams and for stock watering.

2.5 Soil characteristics

Soil characteristics have been assessed in the Boggabri Coal Continuation of Mining Project Environmental Assessment – Soil Survey and Land Resource Impact Assessment (GSS, 2009).

The soil assessment identified the following soil units within the Project Boundary:

- **Grey Brown Gradational Loam**. These moderately drained soils range from slightly acidic to neutral in the upper layers to strongly acidic to moderately alkaline at depth. The soils are generally non saline with poor to moderate fertility characteristics. The topsoil is non-sodic tending to moderately sodic in the subsoil. These soils are found on the waning mid to lower slopes within the Leard State Forest.

- **Light Brown Uniform Gravelly Sand**. These well drained soils range from moderately acidic to strongly acidic at depth. The soils are generally non saline with poor fertility characteristics. The topsoil and subsoil are non-sodic. These soils are found on the upper slopes, crests and ridgelines within the Leard State Forest.

- **Light Brown Duplex Loam**. These moderately drained soils range from moderately acidic in the upper layers to strongly alkaline at depth. The soils are generally non saline with poor fertility characteristics. The topsoil is non-sodic whilst the subsoil is sodic to very sodic. These soils are found on the waning lower slopes within the Leard State Forest and nearby grazing land.

- **Brown Gradational Clay**. These poorly drained soils range from neutral to strong alkaline in the upper layers to moderate to strong alkaline at depth. The soils are generally non saline with good fertility characteristics. The topsoil is non-sodic tending to highly sodic in the subsoil. These soils are found on the lower slope, flats and flood plain of the higher quality grazing and cropping soil.

The Grey Brown Gradational Loams, Light Brown Duplex Loams and Brown Gradational Clay showed a similar pattern, with the upper layers being non dispersive and non sodic, and the subsoils tending to be highly dispersive and highly sodic with depth. The Light Brown Uniform Gravelly Sands were found to be non dispersive and non saline throughout the soil profile (GSS, 2009).

The potential for acid generation from regolith material (i.e. topsoil and subsoil) was found to be low. This does not include acid potential within the overburden material, or the current level of acidity within the soil (GSS, 2009).

Acid Sulphate Soils, which are the main cause of acid generation within the soil mantle, are commonly found less than 5m above sea level, particularly in low-lying coastal areas. There has been little history of acid generation from regolith material in the Boggabri area, which is located approximately 250km from the coast (GSS, 2009).

2.6 Overburden and potential coal reject characteristics

The geochemical characteristics of overburden and potential reject materials from the coal washery have been assessed in The Boggabri Continuation of Mining Project Geochemical Assessment of Overburden and Potential Reject Materials (RGS, 2009). The geochemical assessment concluded that:

Overburden

- Most overburden is likely to have negligible total sulphur content and is therefore classified as Non Acid Forming (NAF) barren. Overburden also appears to have excess acid buffering capacity typical of a moderate Acid Neutralising Capacity (ANC) value, which should more than compensate for any acid that could potentially be generated from the small amount of overburden materials with uncertain acid generating classification.

- Most overburden materials generated at the Project are likely to be NAF and have a high factor of safety with respect to potential acid generation. The overburden can therefore be regarded as a NAF unit.

- The concentration of total metals in overburden solids is well below applied guideline criteria for soils and is unlikely to present any environmental issues associated with revegetation and rehabilitation.

- Most overburden materials will generate slightly alkaline and relatively low salinity runoff and seepage following surface exposure. The major ion chemistry of initial surface runoff and seepage from overburden materials is likely to be dominated by sodium, bicarbonate, chloride and sulphate.

- The concentration of dissolved metals in initial runoff and seepage from overburden materials is unlikely to present any significant environmental issues associated with surface and ground water quality as a result of the Project.

- Most overburden materials are sodic and likely to have structural stability problems related to potential dispersion. Some near surface and conglomerate overburden materials are likely to be less sodic and may be the most suitable materials for revegetation and rehabilitation activities (as a growth medium). For all other sodic overburden materials, it is likely that treatment would be required if these were to be considered for use as vegetation growth medium.

Potential coal reject

- Most potential coal reject materials are likely to have negligible total sulphur content and are therefore classified as NAF barren. These materials have a high factor of safety with respect to potential acid generation.

- A small proportion of the potential coal reject materials located near the Braymont Seam have a relatively high total sulphur content and negligible buffering capacity and are classified as Potentially Acid Forming - High Capacity (PAF-HC).

- The concentration of total metals in potential coal reject solids is well below applied guideline criteria for soils and is unlikely to present any environmental issues associated with revegetation and rehabilitation.

- Most potential coal reject materials will generate slightly alkaline and relatively low salinity runoff and seepage following surface exposure. The exception is potential coal reject material from the Braymont seam (and potentially the Jeralong seam) where PAF materials may generate acidic and more saline runoff and seepage.

- The major ion chemistry of initial surface runoff and seepage from potential coal reject materials is likely to be dominated by sodium, bicarbonate, chloride and sulphate, although for PAF materials, calcium and sulphate may become more dominant. For PAF materials, the initial concentration of soluble sulphate in runoff and seepage is expected to remain within the applied water quality guideline criterion (1,000mg/L), although further exposure to oxidising conditions could lead to increased soluble sulphate concentrations.

- The concentration of dissolved metals in initial runoff and seepage from potential coal reject materials is unlikely to present any significant environmental issues associated with surface and ground water quality as a result of the Project.

- Most potential coal reject materials are sodic and likely to have structural stability problems related to potential dispersion. These materials are unlikely to be suitable for use as a vegetation growth medium.

3. Existing surface water management system

This section provides an overview of the existing water management system at Boggabri Coal Mine, as at the beginning of 2010.

3.1 Existing clean water system

Clean water diversion drains are currently located around the upslope perimeters of the mine working area to divert runoff from undisturbed catchments. Details of existing diversion drains are provided below.

Clean Water Diversion Drain 1 (CW1)

CW1 (commonly referred to as the Northern Clean Water Diversion Drain) is an existing drain that begins to the north-east of the mining void. The drain flows west along the northern perimeter of the mining void, then turns south and runs along the western perimeter of the spoil dump. The drain outlets to a location west of the spoil dump. Surface water ponds behind a bund before spilling to the west of Sediment Dam 3 (SD3) and discharging to Nagero Creek.

Clean Water Diversion Drain 2 (CW2)

CW2 (commonly referred to as the Southern Clean Water Diversion Drain) is an existing drain that begins at an existing depression to the east of the mining void, which fills and then spills to a constructed trapezoidal shaped channel. The drain flows along the southern perimeter of the mining void, to a location east of the Ammonia Nitrate Fuel Oil (ANFO) storage facility where ponding occurs. The drain then flows west to a culvert crossing the mine haul road.

3.2 Existing dirty water system

Dirty water runoff from disturbed areas of the mine site is currently captured in sediment dams. These sediment dams are generally ‘wet basins’, comprising a ‘settling zone’ for temporary treatment storage and a ‘sediment zone’ for storage of sediment.

EPL No. 12407 requires that water quality monitoring of dirty water sediment dams be undertaken as soon as practicable after a discharge.

Details of existing dirty water sediment dams and diversion drains are provided below.

Sediment Dam 1 (SD1)

SD1 is an existing sediment dam located north of the MIA. SD1 receives localised dirty water runoff from the MIA. Fuel storage and workshop areas within the MIA are bunded to prevent the discharge of oils and grease into the drainage system. SD1 does not currently have a low flow outlet, and overflows via a spillway to SD6.

Sediment Dam 3 (SD3)

SD3 is an existing sediment dam located south-west of the spoil dump. SD3 receives dirty water runoff from the western spoil dump. SD3 currently has a low flow outlet pipe, which discharges to Nagero Creek. The low flow outlet has a manually operated valve to allow the outlet to be closed.

Sediment Dam 5 (SD5)

SD5 is an existing sediment dam located east of the MIA. SD5 receives dirty water runoff from the MIA and part of the haul road. SD5 does not currently have a low flow outlet, and overflows via a spillway to SD6.

Sediment Dam 6 (SD6)

SD6 (commonly referred to as Nagero Dam) is an existing dam located downstream of SD1 and SD5. SD6 receives localised runoff from grassed areas, as well as overflows from SD1 and SD5. SD6 currently has a low flow outlet pipe, which discharges to Nagero Creek. The low flow outlet has a manually operated valve to allow it to be closed.

The capacity of SD6 was increased to approximately 55ML in early 2010.

Dirty Water Diversion Drain 1 (DW1)

DW1 is an existing drain running along the western perimeter of the spoil dump. The drain conveys runoff from the spoil dump to SD3.

Dirty Water Diversion Drain 2 (DW2)

DW2 is an existing drain running along the southern perimeter of the spoil dump. The drain conveys runoff from the spoil dump to SD3.

Discharge from Tarrawonga Coal Mine

The adjacent Tarrawonga Coal Mine has its northern spoil dump and coal processing area situated east of Boggabri Coal Mine's MIA. Dirty runoff from these areas is currently captured in a series of dams at Tarrawonga Coal Mine. However, during prolonged wet periods, overflows from these dams discharge to SD1 and SD6 at Boggabri Coal Mine.

3.3 Existing contaminated water system

Contaminated water is water originating from direct surface runoff on coal stockpiles and the mining void, as well as groundwater inflows to the mining void.

Contaminated mine water is currently reused onsite for dust suppression. Surplus contaminated water is currently stored in onsite contaminated water storages or in-pit. Details of existing contaminated water storages are provided below.

Sediment Dam 2 (SD2)

SD2 is an existing sediment dam located west of the ROM pad. SD2 receives contaminated water runoff from the ROM stockpile pad, part of the haul road and truck loading facility.

Water stored in SD2 is currently reused onsite for dust suppression. Surplus contaminated water from SD2 is pumped to MD2 for storage.

Sediment Dam 4 (SD4)

SD4 is an existing sediment dam located at the rail loading facility approximately 15km west of the mine working area. SD4 captures contaminated runoff from the product coal stockpile pad. Water stored in SD4 is currently reused for dust suppression at the rail loading facility.

Mine Water Dam 2 (MD2)

MD2 is an existing ‘turkey’s nest’ dam located north-east of the mining void. MD2 receives contaminated water pumped from the mining void and SD2. Overflows from MD2 are directed back to the mining void.

Mining voids

Runoff from rainfall on mine working areas and groundwater inflows are collected within the mining void. Stored water within the void is currently pumped to MD2 where it is reused onsite for dust suppression.

3.4 Summary of existing storages

A summary of existing storages and capacities is provided in Table 3-1. Information on existing storage capacities has been obtained from the report entitled Boggabri Coal Mine 2008 Site Water Balance (PB, 2009).

Table 3-1 Summary of existing storages

Storage	Description	Capacity (ML)
SD1	Dirty water sediment dam capturing runoff from MIA	1
SD2	Contaminated water sediment dam capturing runoff from ROM stockpile pad	20
SD3	Dirty water sediment dam capturing runoff from spoil dump	35
SD4	Contaminated water sediment dam capturing runoff from rail loading facility (west of site)	8.1
SD5	Dirty water sediment dam capturing runoff from MIA	1.4
SD6	Dirty water sediment dam downstream of MIA	55
MD2	Mine water dam receiving water pumped from mining void and SD2	175

4. Project surface water management system

This section describes the proposed water management system for the Project for the Year 1, 5, 10 and 21 landforms.

A water balance analysis and local catchment hydrological analysis for the proposed water management system is provided in subsequent sections.

The water management system for the Year 1 landform has been adopted as the baseline for assessing potential impacts of the water management system for the subsequent Year 5, 10 and 21 landforms.

4.1 Erosion and sediment controls

An Erosion and Sediment Control Plan should be prepared and implemented during the construction, operation and rehabilitation phases of the Project. The plan should be in accordance with appropriate statutory requirements, including conditions of the Development Consent, Mining Lease, Mining Operations Plan and EPL. Controls should be established to a standard consistent with Managing Urban Stormwater - Soils and Construction - Volume 1 (Landcom, 2004), Managing Urban Stormwater - Soils and Construction - Volume 2E Mines and Quarries (DECC, 2008) and Guidelines for Establishing Drainage Lines on Rehabilitated Minesites (Draft) (DLWC, 1999).

Erosion and sediment controls recommended to be adopted include:

- Minimising forward clearing, particularly areas around flow lines, drainage lines and watercourses.
- Minimising site disturbance by containing machinery access to areas required for approved construction works, access tracks or materials stockpiles.
- Staging construction activities where practical, so that land disturbance is confined to the minimum possible area.
- Completing work and rehabilitating disturbed areas quickly and progressively.
- Minimising erosion from drainage lines which can be very vulnerable to the erosive effects of concentrated flow.
- Intercepting and diverting clean water runoff from undisturbed areas so that it does not flow onto disturbed areas.
- Passing clean water through the site without mixing it with dirty runoff from disturbed areas.
- Treating highly dispersive soils with gypsum to reduce the potential for tunnel erosion and surface rilling of disturbed areas.
- Limiting erosion potential within earthworks areas by managing runoff fetches and velocities, with measures such as diversion banks.

- Locating sediment traps such as silt fences and check dams downstream of disturbed areas.
- Treating runoff from large areas of construction (greater than 2,500 m^2) in sediment basins, prior to discharge to watercourses.
- Providing shaker ramps and rock pads at the construction exit to remove excess mud from truck tyres / under-bodies.

Management strategies for topsoil stripping and handling, topsoil respreading, post disturbance regrading, and seedbed preparation are outlined in the soil assessment (GSS, 2009). These measures should also be implemented during the construction, operation and rehabilitation phases of the Project.

4.2 Objectives of Project surface water management system

The objectives for the Project surface water management system are similar to those for the existing system at Boggabri Coal Mine.

The proposed water management system has been designed to segregate clean runoff, dirty runoff and contaminated water generated from rainfall events and mining operations. The following definitions have been adopted for the various runoff types:

- **Clean water** is defined as runoff from undisturbed bushland catchments located upslope of the mine site.
- **Dirty water** is defined as runoff from disturbed areas within the mine site and includes runoff from the MIA, spoil dumps and haul roads. This water contains high levels of suspended solids.
- **Contaminated water** is defined as runoff generated from coal stockpiles and the mining void, as well as groundwater inflows to the mining void. This water contains high levels of suspended solids and is mildly saline.

Clean water runoff from undisturbed catchments will be diverted around the mine working area and into Nagero Creek as much as practical.

Clean water runoff from the rehabilitated spoil dump will be progressively released back into Nagero Creek. Water from rehabilitated areas will be released once successful rehabilitation has been achieved on disturbed areas.

Dirty water runoff will be captured in sediment dams to encourage the settling of suspended solids. Runoff from large storm events will overtop sediment dams and discharge to Nagero Creek. Captured water will either be released to Nagero Creek or pumped to mine water dams for storage and reuse. This will depend on water quality and the site water balance.

Contaminated water will be captured in sediment dams. Contaminated water will be pumped to mine water dams for storage and reuse and will not be released to Nagero Creek. Surplus contaminated water will be stored in-pit or disposed of via irrigation.

The water management system will aim to reuse as much contaminated water as possible onsite. Contaminated water will be used as a priority to supply dust suppression and washery make-up water demands. Water from offsite sources will only be used to meet dust suppression and washery make-up water demands when there is an onsite contaminated water deficit.

4.3 Design criteria for water management system

4.3.1 Diversion drains

Clean and dirty water diversion drains at Boggabri Coal Mine have previously been designed to convey the peak flow rate from a 100 year ARI time of concentration storm event. This criteria has been adopted for the proposed Project water management systems. Peak flow rates have been estimated by XPSWMM modelling (refer to Section 6).

Key design features of diversion drains are as follows:

- trapezoidal in section
- 3H:1V side slopes
- base and sides of drains may require gypsum stabilisation where constructed in dispersive clay
- scour protection will be required where velocities exceed 2m/s or diversion drains are constructed in highly erosive soil.

A typical section for a diversion drain is provided in Figure 4-1. Sizing calculations for diversion drains are provided in Appendix B.

4.3.2 Dirty water sediment dams

Dirty water sediment basins at Boggabri Coal Mine have previously been designed to store runoff from a 20 year ARI time of concentration storm event, with a 20% allowance for sediment storage. However, for the proposed Project water management system, dirty water sediment dams have been sized based on the criteria recommended in the recently published guidelines Managing Urban Stormwater - Soils and Construction - Volume 2E Mines and Quarries (DECC, 2008).

The DECC guidelines recommend that Type F/D sediment basins be provided for catchments with fine or dispersible soils. These are ‘wet basins’, comprising a ‘settling zone’ for temporary treatment storage and a ‘sediment zone’ for storage of sediment.

The DECC guidelines recommend that the ‘settling zone’ be sized to capture the 90th percentile 5 day duration storm event, and the ‘sediment zone’ be sized at 50% of the ‘settling zone’ volume. This sizing is based on a site disturbance duration of more than 3 years, and results in an average sediment basin overflow frequency of 2 to 4 overflows per year. For sizing purposes, runoff coefficients of 0.75 and 0.4 have been adopted for disturbed and undisturbed areas, respectively.

Key design features of proposed dirty water sediment basins are as follows:

- basins configured as Type F/D basins, as described in the guidelines Managing Urban Stormwater - Soils and Construction - Volume 1 (Landcom, 2004)
- ‘settling zone’ for temporary treatment storage
- ‘sediment zone’ for sediment storage
- slotted riser and discharge pipe with valve arrangement to allow manual operation of pipe
- slotted riser sized to drawdown ‘settling zone’ over 3 days
- select clay fill embankment with 3H:1V slopes
- 4m wide embankment crest with gravel capping and 3% cross fall
- spillway at top-water-level to safely convey the 100 year ARI peak flow
- freeboard of 1,000 mm between top-water-level and top-of-bank
- scour protection will be required at the discharge pipe outlet.

A typical section for a proposed dirty water sediment basin is provided in Figure 4-1.

Where it is proposed to capture dirty water runoff for onsite reuse, an additional ‘reuse zone’ will be required in sediment dams for the storage of this water. The ‘reuse zone’ would be located above the ‘sediment zone’ (i.e. above the obvert of the low flow outlet structure). The ‘reuse zone’ and ‘settlement zone’ would not be physically separated. A pump and pipeline system will be required to transfer water from the ‘settling zone’ to mine water dams.

It has been assumed that sediment dams will be constructed to their maximum volume when they are first commissioned.

Operation of dirty water sediment dams

Dirty water sediment dams are to be maintained in a drawn down state as much as practical, thus ensuring that sufficient capacity is available to capture water from subsequent storm events.

The following strategy is to be adopted for the operation of dirty water sediment dams:

- leave dirty water sediment basin outlets in an open position (i.e. drawn down)
- regularly monitor basins via visual inspection and in situ measurement (turbidity, pH and electrical conductivity)
- close basin outlet where the visual inspection or in situ measurement indicates a likely non-conformance, or there is an emergency spill event
- take corrective action, such as repair of infrastructure, extended retention time, flocculation, review of upstream erosion and sediment controls, or evacuation (for a spill event)

- reopen outlet upon completion of corrective action and suitable inspection
- complete quarterly testing unless a corrective action event occurs, in which case sampling would be undertaken prior to discharge
- regular removal of sediment to maintain the capacity of the ‘sediment zone’.

The exception to the above is when dirty water is to be captured in sediment dams to supplement an onsite water deficit. In this case, the following strategy is to be adopted for the operation of dirty water sediment dams:

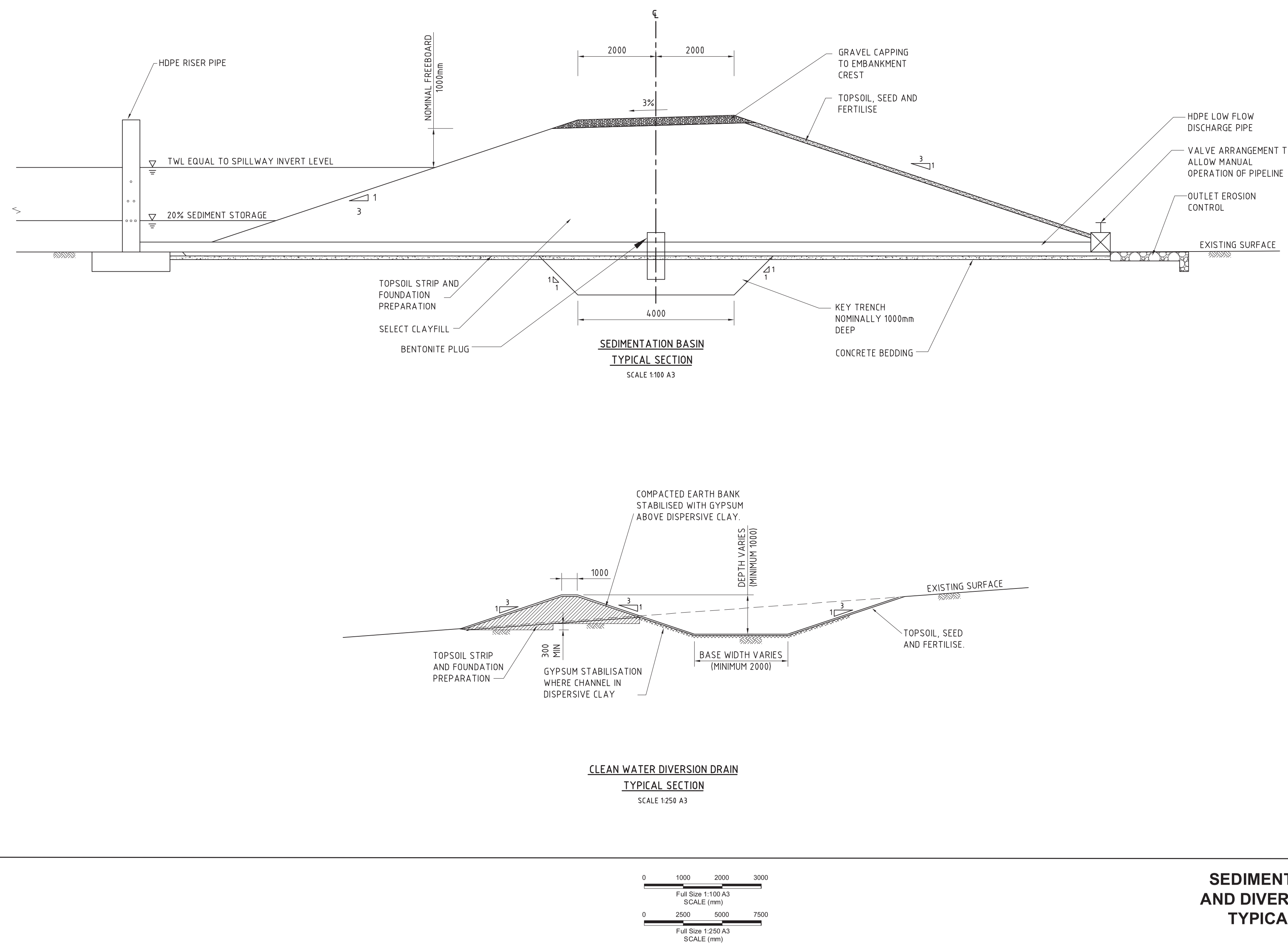
- leave dirty water sediment basin outlets in a closed position
- following a rainfall event, pump water captured in the ‘settling zone’ to mine water dams for long term storage.

Water can be stored in the ‘reuse zone’ of dirty water sediment dams on a long term basis. However, it is intended that water will only be stored in the ‘settling zone’ of dirty water sediment dams temporarily, and that the ‘settling zone’ will be maintained in a drawn down state as much as practical so that sufficient capacity is available to capture water from subsequent storm events. Water captured in the ‘settling zone’ will be pumped to the much larger mine water dams for long term storage for onsite reuse.

It is not necessary to allow dirty water to settle prior to pumping to the mine water dams, as the mine water dams store contaminated water. However, allowing sediment to settle prior to pumping would ease the wear on the pump and pipeline system.

Details of the monitoring strategy for discharges from dirty water sediment basins are provided in Section 9.

Client: HANSEN BAILEY PTY LTD
Project: CONTINUATION OF BOGGABRI COAL MINE, SURFACE WATER ASSESSMENT



SEDIMENTATION DAM AND DIVERSION DRAIN TYPICAL SECTIONS

Figure 4-1

Plot Date: 14/12/09 - 16:07 Cad File: \\Aunclf\PROJ\H\Hansen_Bailey\2123173_EMA_BOGGABRI_COAL_EA\09_CADD\Drawings\Figures\FIGURE 3-2.dwg

4.3.3 Contaminated water sediment basins

Contaminated water sediment basins will capture runoff from the coal stockpile pads, coal handling and preparation area, and rail load out area. Water stored in contaminated water sediment dams will be reused onsite for dust suppression and washery make-up water, or will be pumped to mine water dams for storage or utilised for irrigation.

Contaminated water sediment basins at Boggabri Coal Mine have previously been designed to store runoff from a 100 year ARI 72 hour duration storm event, with a 20% allowance for sediment storage. A runoff coefficient of 0.75 has previously been adopted for disturbed areas. This criteria has also been adopted for the proposed water management systems.

Key design features of contaminated water sediment basins are as follows:

- ‘sediment zone’ for storage of sediment
- ‘settling zone’ for treatment storage
- pump and pipeline system to draw down the ‘settling zone’ and transfer water to mine water dams
- no low flow discharge pipe
- freeboard of 1,000 mm between top-water-level and top-of-bank.

Operation of contaminated water sediment dams

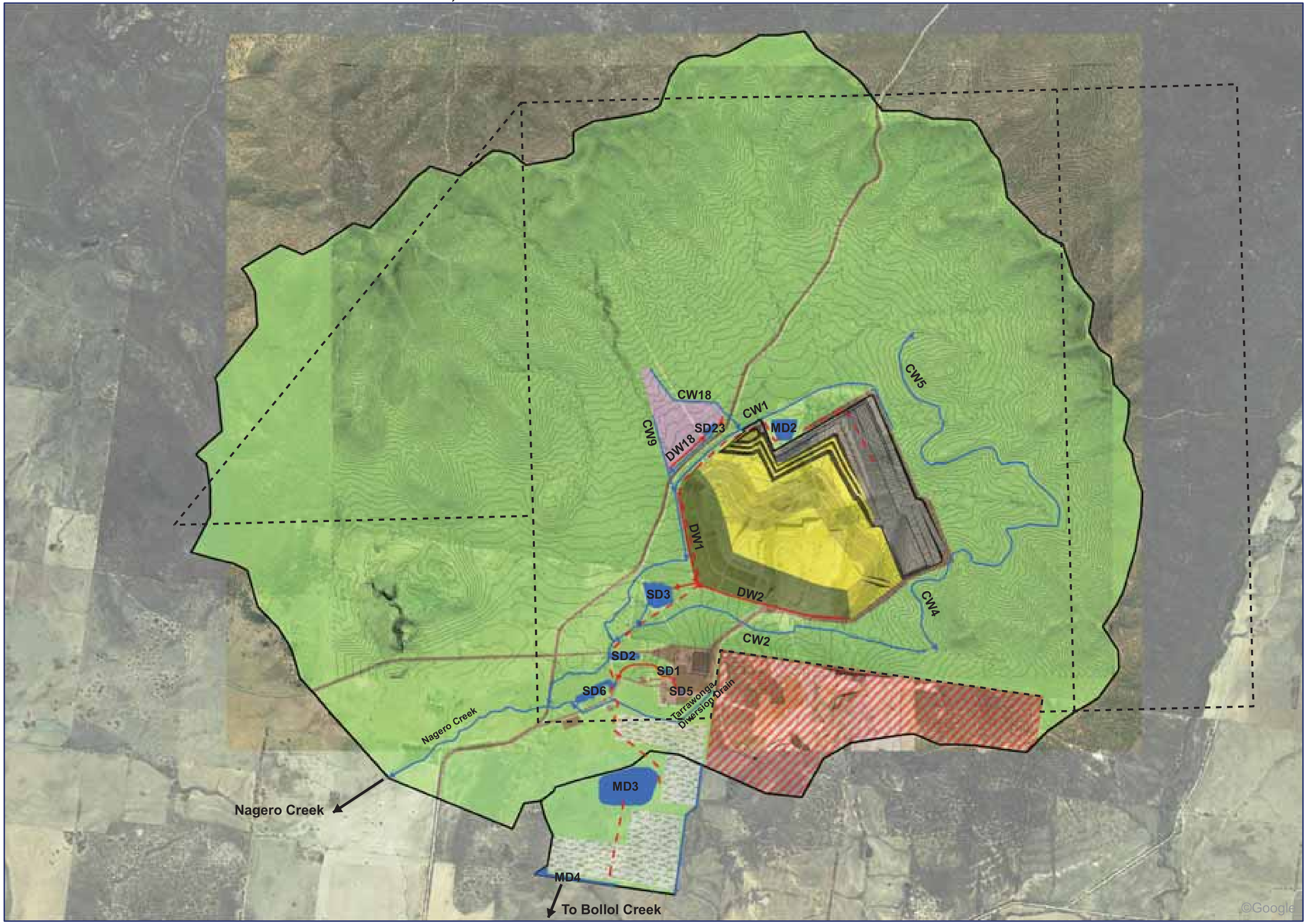
Contaminated water sediment dams are to be maintained in a drawn down state as much as practical. Following settling of sediment, water will be pumped to the much larger mine water dams, thus ensuring that sufficient capacity is available to capture water from subsequent storm events.

4.4 Year 1 water management system

It has been assumed that Year 1 will include the proposed upgrades and relocation of the site facilities including offices, car parking and maintenance sheds. However, the proposed coal handling and preparation facility (incorporating the new product stockpile pad) and rail loop and spur (incorporating the train load out area) will not be included until later years.

A layout plan of the Year 1 water management system is provided in Figure 4-2.

CLIENT: HANSEN BAILEY PTY LTD
PROJECT: CONTINUATION OF BOGGABRI COAL MINE, SURFACE WATER ASSESSMENT



PARSONS BRINCKERHOFF

Legend

Boggabri Coal Mining Tenements

Year 1 Topography

2m contours

Year 1 Water Management

Clean water

Dirty water

Pump / Pipeline

Water storages

Study catchment

Year 1 Landuses

Undisturbed

Irrigation

Mining void

Rehabilitated spoil dump

Road / Industrial

Unshaped spoil dump

Topsoil stockpile

Tarrawonga Coal Mine

0 0.5 1
Kilometers

GDA 1994 MGA Zone 56

\\AUNCLF\proj\H\Hansen_Bailey\2123173_EMA_BOGGABRI_COAL_EA\05_WrkPapers\GIS\Output\Maps LT

FIGURE 4-2 WATER MANAGEMENT SYSTEM CONCEPT - YEAR 1

4.4.1 Preliminary sizing

Preliminary sizing for storages is summarised in Table 4-1 for the Year 1 landform. Sizing calculations are provided in Appendix B.

Table 4-1 Preliminary storage sizes for Year 1 landform

Storage	Description	Adopted design event	Runoff coefficient	Catchment area (ha)	Capacity (ML)
SD1^	Dirty water sediment dam capturing runoff from MIA	90th %ile 5 day	0.75	9.3	1
SD2	Contaminated water sediment dam capturing runoff from ROM stockpile pad	100yr ARI 72hr	0.75	14.5	32.8
SD3	Dirty water sediment dam capturing runoff from spoil	90th %ile 5 day	0.4	103.7	100
SD4	Contaminated water sediment dam capturing runoff from rail loading facility (west of site)	100yr ARI 72hr	0.75	2.3	8.1
SD5	Dirty water sediment dam capturing runoff from MIA	90th %ile 5 day	0.75	2.8	1.4
SD6	Dirty water sediment dam downstream of MIA	90th %ile 5 day	0.75	20.1	55
SD23	Dirty water sediment dam capturing runoff from soil stockpile	90th %ile 5 day	0.75	29.4	12.7
MD2	Mine water dam receiving water pumped from mining void				175
MD3	Mine water dam receiving surplus contaminated water				600
MD4^^	Irrigation area recirculation dam				30

Notes: ^ Shortfall of storage in SD1 is provided in SD6. ^^ MD4 has been previously sized as part of the irrigation system design.

4.4.2 Clean water system

Clean water diversion drains will be located around the upslope perimeters of the mine working area to divert runoff from undisturbed catchments. Details of these diversion drains are provided below.

Clean Water Diversion Drains 1 and 2 (CW1 and CW2)

CW1 and CW2 will remain as per the existing situation.

Clean Water Diversion Drain 4 (CW4)

CW4 is an approved drain capturing clean runoff from the bushland catchment east of the mining void. The drain flows south to a natural drainage line that flows to existing CW2. CW4 will form part of the Year 1 water management system.

Clean Water Diversion Drain 5 (CW5)

CW5 is an approved drain capturing clean runoff from the bushland catchment east of the mining void. The drain flows north to a natural drainage line that flows to CW1. CW5 will form part of the Year 1 water management system.

4.4.3 Dirty water system

Dirty water runoff will be captured in sediment dams to attenuate flows and to encourage the settling of suspended solids. It is expected that the site will experience an annual water surplus for median rainfall years during Year 1 of the Project. It is therefore proposed to release water captured in sediment dams to Nagero Creek, rather than reusing it onsite. Details of dirty water sediment dams are provided below.

Sediment Dam 1 (SD1)

SD1 is an existing sediment dam located north of the MIA. SD1 receives localised dirty water runoff from the MIA. SD1 does not have a low flow outlet and overflows to SD6. This existing configuration will be maintained for Year 1 of the Project.

The existing volume of SD1 has been estimated as 1ML. SD1 does not have capacity to contain the 90th percentile 5 day duration storm event from the contributing catchment area with a 50% allowance for sediment storage. However, this shortfall in storage is provided in SD6.

Sediment Dam 3 (SD3)

SD3 is an existing sediment dam located south-west of the spoil dump. SD3 receives dirty water runoff from the western rehabilitated spoil dump.

SD3 will be upgraded in Year 1 of the Project. The capacity of the dam will be increased to 100ML, which is the maximum capacity of the dam over the life of the Project. A manually operated valve will be installed on the low flow outlet to allow the ‘settling zone’ to be drawn down.

Sediment Dam 5 (SD5)

SD5 is an existing sediment dam located east of the MIA. SD5 receives dirty water runoff from the MIA and part of the haul road.

The existing volume of SD5 has been estimated as 1.4ML. SD5 does not have a low flow outlet, and overflows to SD6. The existing configuration will be maintained for Year 1 of the Project.

Sediment Dam 6 (SD6)

SD6 is an existing dam located downstream of SD1 and SD5. SD6 receives localised runoff from grassed areas, as well as overflows from SD1 and SD5.

The existing volume of SD6 has been estimated as 55ML. The dam has a low flow outlet with a manually operated valve to allow the ‘settling zone’ to be drawn down. This existing configuration will be maintained for Year 1 of the Project.

Sediment Dam 23 (SD23)

SD23 is a proposed dam to capture dirty water runoff from the topsoil stockpile. The dam has a capacity of 12.7ML. The dam will be provided with a low flow outlet with a manually operated valve to allow the 'settling zone' to be drawn down.

Dirty Water Diversion Drains 1 and 2 (DW1 and DW2)

DW1 and DW2 will remain as per the existing situation.

4.4.4 Contaminated water system

During Year 1 of the Project, contaminated water will be reused onsite for dust suppression. Surplus contaminated water will be stored in-pit or in out-of-pit storages for reuse, or disposed of via irrigation.

Details of contaminated water sediment dams and mine water dams are provided below.

Sediment Dam 2 (SD2)

SD2 is an existing sediment dam located west of the ROM pad stockpile. SD2 receives contaminated water runoff from the ROM pad stockpiles, part of the haul road and truck loading facility.

SD2 will be upgraded in Year 1 of the Project. The capacity of the dam will be increased to 32.8ML.

Water stored in SD2 will be pumped to MD3 for storage for reuse or disposal via irrigation.

Sediment Dam 4 (SD4)

SD4 is an existing sediment dam located at the rail loading facility approximately 15km west of the existing mine working area. SD4 captures contaminated runoff from the product coal stockpile pad. Water stored in SD4 is reused for dust suppression at the rail loading facility.

SD4 has an existing volume of 8.1ML.The existing configuration of SD4 will be maintained for Year 1 of the Project.

Mining voids

Runoff from rainfall on mine working areas and groundwater inflows are collected within the mining void. Stored water within the mining void will be pumped to MD2 for storage for reuse and dust suppression.

During prolonged wet periods, runoff and groundwater inflows will be stored in the mining voids.

Mine Water Dam 2 (MD2)

MD2 is an existing 'turkey's nest' dam located north-west of the mining void. MD2 receives contaminated water pumped from the mining void. Overflows from MD2 are directed to the mining void.

MD2 has an existing volume of 175ML. The existing configuration of MD2 will be maintained for Year 1 of the Project.

Water stored in MD2 will be reused onsite for dust suppression. Surplus contaminated water from MD2 will be pumped to MD3 for storage or disposal by irrigation.

Mine Water Dam 3 (MD3)

MD3 is a proposed dam located south of the MIA. It has been assumed that MD3 will form part of the Year 1 water management system.

MD3 will receive surplus contaminated water pumped from MD2 and SD2, as well as runoff from a local grassed catchment.

Water stored in MD3 will be reused for dust suppression. Surplus contaminated water will be disposed of via irrigation. Details of the irrigation system are provided in Section 4.4.5.

MD3 will have a capacity of 600ML for Year 1 of the Project. The pumping policy to MD3 will be managed so that adequate freeboard is maintained in MD3 to prevent overtopping. During prolonged wet periods, pumping to MD3 from MD2 will cease, and runoff and groundwater inflows will be stored in the mining void until MD3 has capacity to accept flows.

4.4.5 Irrigation of surplus contaminated water

The Project will include an irrigation system to provide for the management of surplus contaminated water. Details of the irrigation system have been obtained from the existing Irrigation Management Plan for Boggabri Coal Mine (Aquatech Consulting, 2009).

The total area of the approved irrigation system is 95ha, which is divided into four discrete irrigation areas. It is initially proposed to utilise 53ha of the irrigation area (up to 2011), which allows for ‘spelling’ of the discrete irrigation areas. The primary crop to be cultivated in the irrigation area is salt tolerant lucerne. Cover crops such as barley or wheat will be considered if soil conditions are very dry.

Contaminated water stored in MD3 will be irrigated using spray and drip irrigation techniques (using a hose fed lateral move irrigator). The timing of irrigation and application rates will be determined using soil moisture monitoring devices. It is estimated that the irrigated lucerne crop will require around 6 to 7ML/ha/yr, with the bulk of this being required over the summer months. It is likely that this rate would be reduced during a wet year, when irrigation is not possible due to wet weather.

The disposal rate for the approved irrigation system is estimated to be 318ML/yr for an average year. This is based on an average irrigation rate of 6 ML/ha/yr and utilisation of 53ha, which allows for ‘spelling’ of the discrete irrigation areas. It may be possible to temporarily increase the irrigation rate to a maximum of 570ML/yr by utilising the full 95ha irrigation area. However, this maximum rate could not be maintained from the approved irrigation system on a long term basis, as it does not allow for ‘spelling’ of the discrete irrigation areas.

Contaminated mine water is expected to be alkaline and have elevated levels of salinity, sodium and carbonates (refer to Section 2.3). Water stored in MD3 will therefore be treated with acidifying agents, such as sulphuric acid, to lower the pH and carbonate levels prior to irrigation.

Diversion bunds will be located up gradient of the irrigation area to divert clean runoff around the irrigation area and into natural drainage lines.

Recirculation dams will be located down gradient of irrigation areas to capture the first flush rainfall runoff (20 year ARI rainfall event) from the irrigation area. Captured water will be pumped back to MD3 for irrigation. In larger storm events, the recirculation dams will overflow offsite to natural drainage lines.

4.4.6 Discharge from Tarrawonga Coal Mine

The adjacent Tarrawonga Coal Mine has its northern spoil dump and coal processing area situated east of Boggabri Coal Mine's MIA.

Details of the water management system at Tarrawonga Coal Mine were obtained from the Proposed East Boggabri Coal Mine Surface Water Assessment (Department of Lands – Soil Services, 2005). This assessment accompanied the EIS for the mine.

Runoff from the northern spoil dump and coal processing area at Tarrawonga Coal Mine drains towards Boggabri Coal Mine. It is understood that runoff from these areas will be captured in a series of 9 sediment basins (Sediment Basins 1 to 9), which have a combined catchment area of 160ha and a combined storage capacity of 15ML. These basins discharge to 3 storage dams (Storage Dams 1 to 3), which have a combined storage capacity of 21.8ML. It is understood that water in these storage dams will be pumped for reuse onsite for dust suppression. However, it is expected that overflows from Storage Dams 1 and 2 will discharge to the Boggabri Coal Mine site during wet rainfall years.

In order to keep overflows from Tarrawonga Coal Mine separate to Boggabri Coal Mine's water management system, a new drain will be provided to divert overflows to the south of the Boggabri Coal Mine MIA. The diversion drain bypasses SD6 before discharging to Nagero Creek.

The Tarrawonga Diversion Drain was approved as part of the modifications to Development Consent. It has therefore been assumed that the Tarrawonga Diversion Drain will form part of the Year 1 water management system.

4.5 Year 5 water management system

It has been assumed that by Year 5 the proposed coal handling and preparation facility, product stockpile pad and rail loop and spur (including the train load out area) will all be operational.

A layout plan for the Year 5 water management system is provided in Figure 4-3.

CLIENT: HANSEN BAILEY PTY LTD
PROJECT: CONTINUATION OF BOGGABRI COAL MINE, SURFACE WATER ASSESSMENT

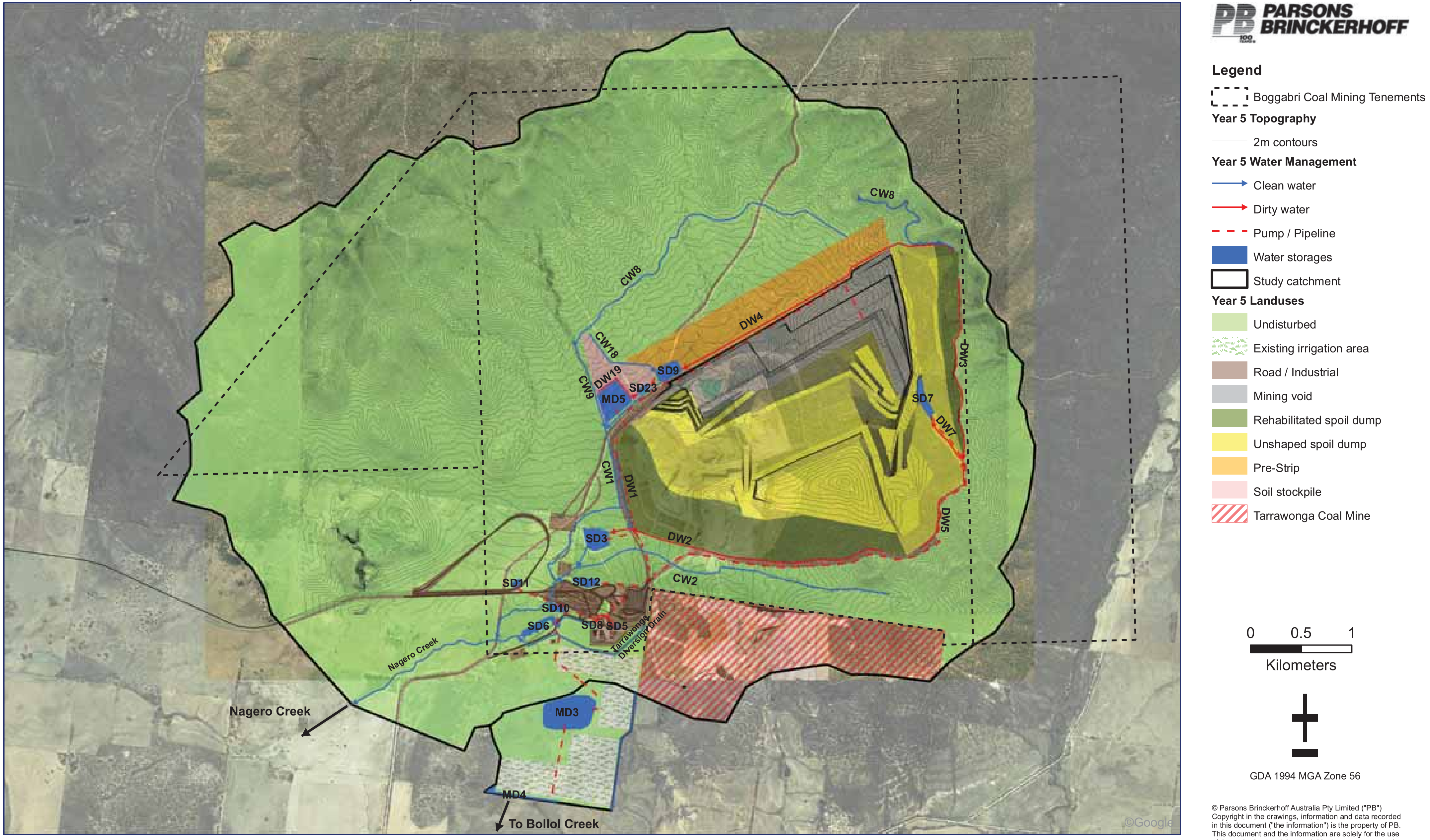


FIGURE 4-3 WATER MANAGEMENT SYSTEM CONCEPT - YEAR 5

\\AUNCLF\proj\H\Hansen_Bailey\2123173_EMA_BOGGABRI_COAL_EA\05_WrkPapers\GIS\Output\Maps LT

4.5.1 Preliminary sizing

Preliminary sizing for storages is summarised in Table 4-2 for the Year 5 landform. Sizing calculations are provided in Appendix B.

Table 4-2 Preliminary storage sizes for Year 5 landform

Storage	Description	Adopted design event	Runoff coefficient	Catchment area (ha)	Capacity (ML)
SD3	Dirty water sediment dam capturing runoff from spoil	90th %ile 5 day	0.4 to 0.75	212.6	100
SD5	Dirty water sediment dam capturing runoff from MIA	90th %ile 5 day	0.75	4.9	2.1
SD6	Dirty water sediment dam downstream of MIA	90th %ile 5 day	0.75	9.9	55
SD7	Dam capturing dirty water runoff from spoil and clean runoff from undisturbed catchment	90th %ile 5 day	0.4 to 0.75	275	100
SD8	Dirty water sediment dam capturing runoff from MIA	90th %ile 5 day	0.75	5	2.2
SD9	Dirty water sediment dam capturing runoff from pre-strip	90th %ile 5 day	0.4	291.4	67.1
SD10	Contaminated water sediment dam capturing runoff from product stockpile	100yr ARI 72hr	0.75	10.7	24.2
SD23	Dirty water sediment dam capturing runoff from soil stockpile	90th %ile 5 day	0.75	20.4	12.7
SD11^	Contaminated water sediment dam capturing runoff from rail load out	100yr ARI 72hr	0.75	5	11.3
SD12	Contaminated water sediment dam capturing runoff from ROM stockpile	100yr ARI 72hr	0.75	23.2	52.5
MD5	Mine water dam receiving water pumped from mining void				300
MD3	Mine water dam receiving surplus contaminated water				600
MD4^^	Irrigation area recirculation dam				30

Notes: ^A nominal catchment of 5ha has been assumed for SD11. ^^ MD4 has been previously sized as part of the irrigation system design.

4.5.2 Clean water system

Clean water diversion drains are proposed around the northern and southern perimeters of the mine working area to divert runoff from undisturbed catchments. Details of these diversion drains are provided below.

Clean runoff from the undisturbed bushland catchment to the east of the mine working area will be directed through the spoil dump and captured in a sediment dam along with dirty runoff from the spoil dump.

Clean Water Diversion Drain 1 (CW1)

The section of CW1 that runs along the western perimeter of the rehabilitated spoil dump will remain as per Year 1. However, the section of CW1 that runs along the northern perimeter of the Year 1 unshaped spoil dump and mining void will be mined through by Year 5.

Clean Water Diversion Drain 2 (CW2)

CW2 will remain as per Year 1.

Clean Water Diversion Drain 8, 9 and 18 (CW8, CW9 and CW18)

CW8 is a proposed new diversion drain capturing clean runoff from the undisturbed bushland catchment north of the mining void. The drain has been designed to run across the contour to minimise grade and earthworks.

CW9 is a proposed new drain that connects CW8 with existing CW1.

CW18 is a proposed new drain to divert clean runoff around the topsoil stockpile.

4.5.3 Dirty water system

Dirty water runoff will be captured in sediment dams to attenuate flows and to encourage the settling of suspended solids. Details of dirty water sediment dams are provided below.

It is expected that the site will experience an annual water deficit for median rainfall years during Year 5 of the Project. It is therefore proposed to reuse water from SD3 and SD7 during Year 5 of the Project.

Sediment Dam 3 (SD3)

SD3 will remain as per Year 1. However, the dam will be operated differently for Year 5 to allow the capture and reuse of dirty water. The valve on the low flow outlet will be maintained in a closed position, and captured water will be pumped to MD3 for storage and reuse.

Sediment Dam 5 (SD5)

SD5 will remain as per Year 1 to capture dirty runoff from the MIA and part of the haul road. However, as SD5 does not have a low flow outlet, a pump will be provided to allow the 'settling zone' to be drawn down.

Sediment Dam 6 (SD6)

SD6 will remain as per Year 1.

Sediment Dam 7 (SD7)

SD7 is a proposed new sediment basin capturing dirty runoff from the eastern spoil dump, as well as clean runoff from the undisturbed bushland catchment to the east of the mine working area. This dam will be operated to allow the capture and reuse of dirty water. The valve on the low flow outlet will be maintained in a closed position, and captured water will be pumped to MD3 for storage for reuse.

During periods of wet weather, SD7 will overflow to the mining void.

It may be possible to construct a series of smaller dams along the drainage line in order to reduce the volume of SD7.

Sediment Dam 8 (SD8)

SD8 is a proposed new sediment basin capturing dirty runoff from the MIA. Fuel storage and workshop areas within the MIA will be bunded to prevent the discharge of oils and grease into the drainage system.

Sediment Dam 9 (SD9)

SD9 is a proposed new sediment basin capturing dirty water runoff from the pre-strip area ahead of the progressing mining void. SD9 will also capture clean water runoff from the undisturbed catchment down slope of CW8.

Sediment Dam 23 (SD23)

SD23 will remain as per Year 1.

Dirty Water Diversion Drains 1 and 2 (DW1 and DW2)

DW1 and DW2 will remain as per Year 1, but will be extended to capture runoff from the expanding spoil dump.

Dirty Water Diversion Drains 3, 4, 5, 7 and 19 (DW3, DW4, DW5, DW7 and DW19)

DW3, DW4, DW5, DW7 and DW19 are proposed diversion drains. These drains convey runoff from disturbed areas to dirty water sediment dams.

4.5.4 Contaminated water system

For Year 5, contaminated mine water will be reused onsite for dust suppression and washery make-up water. During dry and median rainfall years, there will be a contaminated water deficit and make-up water will be required from offsite sources to meet demands. During a wet rainfall year, there will be a small contaminated water surplus. However, this surplus occurs because dirty water will be captured in sediment dams and pumped to mine water dams for reuse in future years. The irrigation system would therefore not be required during dry, median or wet rainfall years for disposal of surplus contaminated water.

Details of the site water balance are provided in Section 5.

Sediment Dam 10 (SD10)

SD10 is a proposed new sediment basin located south of the proposed product stockpile pad. SD10 will receive contaminated runoff from the southern portion of the product stockpile pad. Water stored in SD10 will be pumped to MD3 for storage for reuse.

Sediment Dam 11 (SD11)

SD11 is a proposed new sediment basin that will receive contaminated runoff from the proposed train load out area. Water stored in SD11 will be pumped to MD3 for storage for reuse.

A nominal catchment area of 5ha has been assumed for SD11 for the purposes of sediment dam sizing. The actual catchment area will depend on the design of the train load out area.

Sediment Dam 12 (SD12)

SD12 is a proposed new sediment basin located north of the proposed product stockpile pad. SD12 will receive contaminated runoff from the northern portion of the product stockpile pad, the ROM stockpile pad and the coal handing and preparation plant. Water stored in SD12 will be pumped to MD3 for storage for reuse.

Mining voids

Runoff from rainfall on mine working areas and groundwater inflows are collected within the mining void. Stored water within the mining void will be pumped to MD5 for reuse.

During prolonged wet periods, runoff and groundwater inflows will be stored in the mining voids.

Mine Water Dam 3 (MD3)

MD3 will remain as per Year 1.

Similar to Year 1, the pumping policy to MD3 will be managed so that adequate freeboard is maintained in MD3 to prevent overtopping. During prolonged wet periods, pumping to MD3 from MD5, SD3 and SD7 will cease.

Mine Water Dam 5 (MD5)

MD5 is a proposed new dam to store contaminated water pumped from the mining void. MD5 will replace MD2, and will have a minimum volume of 300ML. Water stored in MD5 will be reused for dust suppression or washery make-up water. Surplus contaminated water stored in MD5 will be pumped to the larger MD3 for storage for reuse.

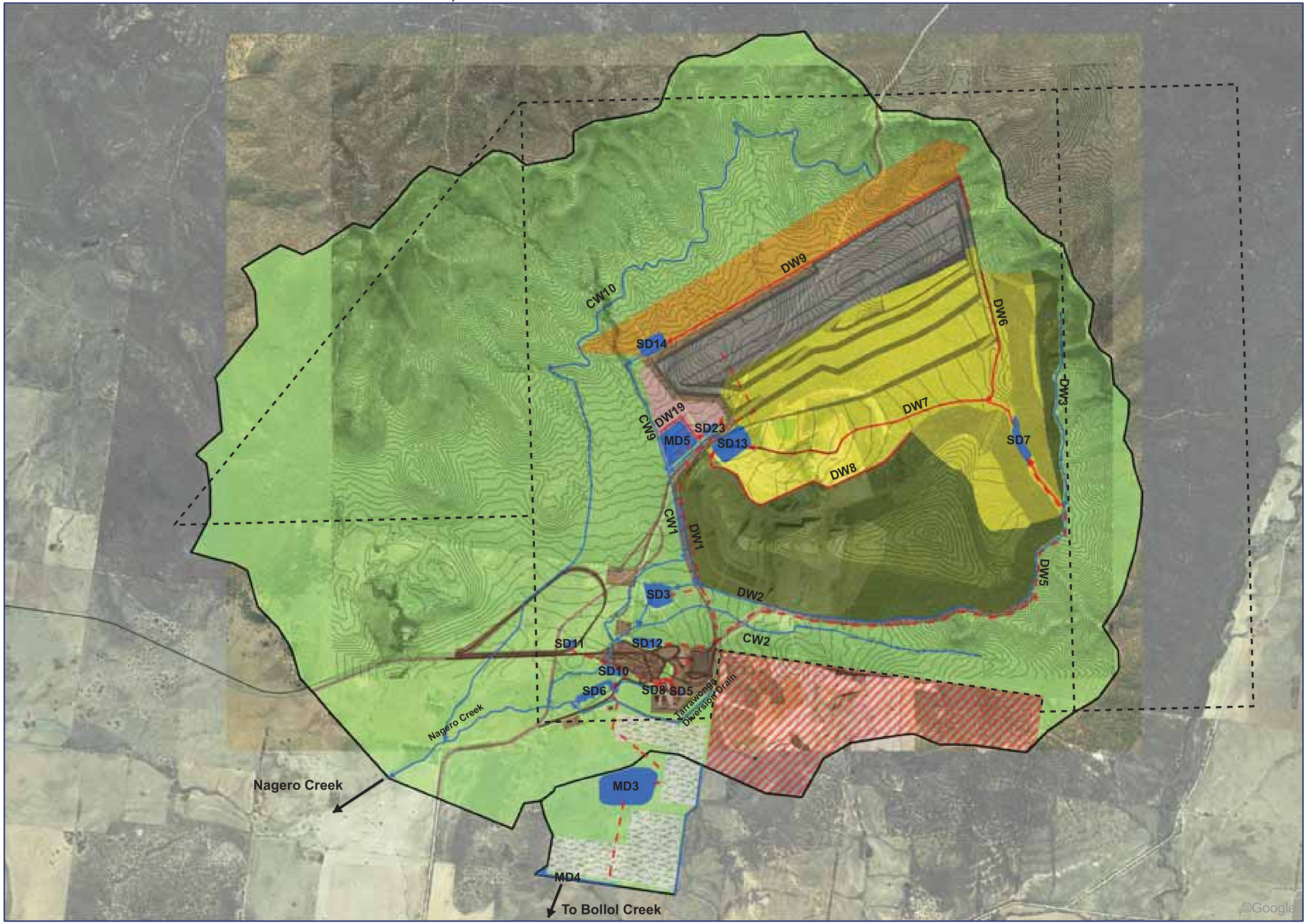
The pumping policy to MD5 will be managed so that adequate freeboard is maintained in MD5 to prevent overtopping. During prolonged wet periods, pumping to MD5 from the mining void will cease and runoff and groundwater inflows will be stored in the mining void.

Irrigation of surplus contaminated water

The irrigation system will not be required for the disposal of surplus contaminated water during Year 5.

4.6 Year 10 water management system

A layout plan for the Year 10 water management system is provided in Figure 4-4.



Legend

- Boggabri Coal Mining Tenements

Year 10 Topography

- 2m contours

Year 10 Water Management

- Pump / Pipeline
- Dirty water
- Clean water
- Water storages
- Study catchment

Year 10 Landuses

- Undisturbed
- Existing irrigation area
- Road / Industrial
- Mining void
- Rehabilitated spoil dump
- Unshaped spoil dump
- Pre-Strip
- Soil stockpile
- Tarrawonga Coal Mine

0 0.5 1
Kilometers

GDA 1994 MGA Zone 56

FIGURE 4-4 WATER MANAGEMENT SYSTEM CONCEPT - YEAR 10

4.6.1 Preliminary sizing

Preliminary sizing for storages is summarised in Table 4-3 for the Year 10 landform. Sizing calculations are provided in Appendix B.

Table 4-3 Preliminary storage sizes for Year 10 landform

Storage	Description	Adopted design event	Runoff coefficient	Catchment area (ha)	Capacity (ML)
SD3	Dirty water sediment dam capturing runoff from spoil	90^{th} %ile 5 day	0.4	211.6	100
SD5	Dirty water sediment dam capturing runoff from MIA	90^{th} %ile 5 day	0.75	4.9	2.1
SD6	Dirty water sediment dam downstream of MIA	90^{th} %ile 5 day	0.75	9.9	55
SD8	Dirty water sediment dam capturing runoff from MIA	90^{th} %ile 5 day	0.75	5	2.2
SD7	Dam capturing dirty water runoff from spoil and clean runoff from undisturbed catchment	90^{th} %ile 5 day	0.4 to 0.75	323.6	100
SD10	Contaminated water sediment dam capturing runoff from product stockpile	100yr ARI 72hr	0.75	10.7	24.2
SD11^	Contaminated water sediment dam capturing runoff from rail load out	100yr ARI 72hr	0.75	5	11.3
SD12	Contaminated water sediment dam capturing runoff from ROM stockpile	100yr ARI 72hr	0.75	23.2	52.5
SD13	Dirty water sediment dam capturing runoff from spoil and clean runoff from undisturbed catchment	90^{th} %ile 5 day	0.75	367.7	200
SD14	Dirty water sediment dam capturing runoff from pre-strip	90^{th} %ile 5 day	0.4	313.6	72.3
SD23	Dirty water sediment dam capturing runoff from soil stockpile	90^{th} %ile 5 day	0.75	20.4	12.7
MD5	Mine water dam receiving water pumped from mining void				300
MD3	Mine water dam receiving surplus contaminated water				600
MD4^^	Irrigation area recirculation dam				30

Notes: ^A nominal catchment of 5ha has been assumed for SD11. ^^ MD4 has been previously sized as part of the irrigation system design.

4.6.2 Clean water system

Similar to Year 5, clean water diversion drains are proposed around the northern and southern perimeters of the mine working area to divert runoff from undisturbed catchments. Details of these diversion drains are provided below.

Clean runoff from the undisturbed bushland catchment to the east of the mine working area will be directed through the spoil dump and captured in a sediment dam along with dirty runoff from the spoil dump.

Clean Water Diversion Drain 1 (CW1)

CW1 will remain as per Years 1 and 5.

Clean Water Diversion Drain 2 (CW2)

CW2 will remain as per Years 1 and 5.

Clean Water Diversion Drain 9 and 10 (CW9 and CW10)

CW9 will remain as per Year 5.

CW10 is a proposed new diversion drain capturing clean runoff from the undisturbed bushland catchment north of the mining void. The drain directs runoff to a natural drainage line, and has been designed to run across the contour to minimise grade and earthworks.

4.6.3 Dirty water system

Dirty water runoff will be captured in sediment dams to attenuate flows and to encourage the settling of suspended solids. Details of dirty water sediment dams are provided below.

It is expected that the site will experience an annual water deficit for median rainfall years during Year 10 of the Project. It is therefore proposed to reuse water from SD3, SD7 and SD13 during Year 10 of the Project.

Sediment Dam 3, 5, 6, 7, 8 and 23 (SD3, SD5, SD6, SD7, SD8 and SD23)

SD3, SD5, SD6, SD7, SD8 and SD23 will remain as per Year 5.

Sediment Dam 13 (SD13)

SD13 is a proposed new sediment basin capturing dirty water runoff from the spoil dump. This dam will be the operated to allow the capture and reuse of dirty water. The valve on the low flow outlet will be maintained in a closed position, and captured water will be pumped to MD3 for storage for reuse.

During periods of wet weather, SD7 will overflow to SD13.

It may be possible to construct a series of smaller dams along the drainage line in order to reduce the volume of SD13.

Sediment Dam 14 (SD14)

SD14 is a proposed new sediment basin capturing dirty runoff from the pre-strip area ahead of the progressing mining void. SD14 will also capture clean water runoff from the undisturbed catchment down slope of CW10.

Dirty Water Diversion Drains 1 and 2 (DW1 and DW2)

DW1 and DW2 will remain as per Years 1 and 5, but will be extended to capture runoff from the expanding spoil dump.

Dirty Water Diversion Drains 3 and 5 (DW3 and DW5)

DW3 and DW5 will remain as per Year 5.

Dirty Water Diversion Drains 6, 7, 8, 9 and 19 (DW6, DW7, DW8, DW9 and DW19)

DW6, DW7, DW8, DW9 and DW19 are proposed diversion drains. These drains convey runoff from disturbed areas to dirty water sediment dams.

4.6.4 Contaminated water system

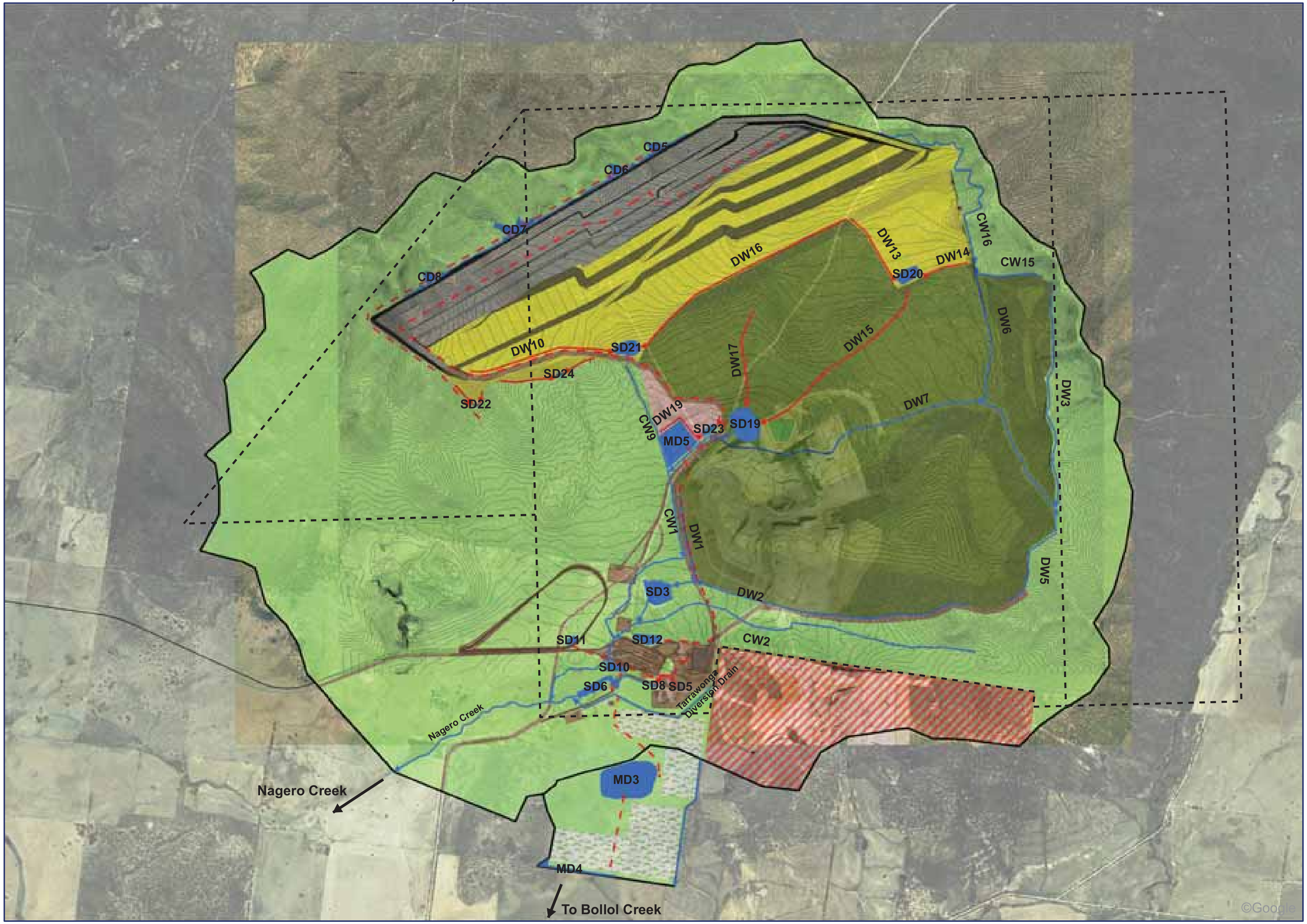
The key infrastructure associated with the contaminated water management system will remain as per Year 5. During dry and median rainfall years, there will be a contaminated water deficit and make-up water will be required from offsite sources to meet demands. During a wet rainfall year, there will be a contaminated water surplus. However, this surplus occurs because dirty water will be captured in sediment dams and pumped to mine water dams for reuse in future years. The irrigation system would therefore not be required during dry, median or wet rainfall years for disposal of surplus contaminated water.

Details of the site water balance are provided in Section 5.

4.7 Year 21 water management system

A layout plan for the Year 21 water management system is provided in Figure 4-5.

CLIENT: HANSEN BAILEY PTY LTD
PROJECT: CONTINUATION OF BOGGABRI COAL MINE, SURFACE WATER ASSESSMENT



PARSONS BRINCKERHOFF

Legend

- Boggabri Coal Mining Tenements

Year 21 Topography

- 2m contours

Year 21 Water Management

- Pump / Pipeline
- Dirty water
- Clean water
- Water storages
- Study catchment

Year 21 Landuses

- Undisturbed
- Existing irrigation area
- Road / Industrial
- Mining void
- Rehabilitated spoil dump
- Spoil dump
- Soil stockpile
- Tarrawonga Coal Mine

0 0.5 1
Kilometers

GDA 1994 MGA Zone 56

\\AUNCLF\proj\H\Hansen_Bailey\2123173_EMA_BOGGABRI_COAL_EA\05_WrkPapers\GIS\Output\Maps LT

FIGURE 4-5 WATER MANAGEMENT SYSTEM CONCEPT - YEAR 21

4.7.1 Preliminary sizing

Preliminary sizing for storages is summarised in Table 4-4 for the Year 21 landform. Sizing calculations are provided in Appendix B.

Table 4-4 Preliminary storage sizes for Year 21 landform

Storage	Description	Adopted design event	Runoff coefficient	Catchment area (ha)	Capacity (ML)
SD3	Dirty water sediment dam capturing runoff from spoil	90th %ile 5 day	0.4	211.6	100
SD5	Dirty water sediment dam capturing runoff from MIA	90th %ile 5 day	0.75	4.9	2.1
SD6	Dirty water sediment dam downstream of MIA	90th %ile 5 day	0.75	9.9	55
SD8	Dirty water sediment dam capturing runoff from MIA	90th %ile 5 day	0.75	5	2.2
SD10	Contaminated water sediment dam capturing runoff from product stockpile	100yr ARI 72hr	0.75	10.7	24.2
SD11^	Contaminated water sediment dam capturing runoff from rail load out	100yr ARI 72hr	0.75	5	11.3
SD12	Contaminated water sediment dam capturing runoff from ROM stockpile	100yr ARI 72hr	0.75	23.2	52.5
SD19	Dirty water sediment dam capturing runoff from spoil	90th %ile 5 day	0.75	434.2	187.6
SD20	Dirty water sediment dam capturing runoff from spoil	90th %ile 5 day	0.75	100	43.2
SD21	Dirty water sediment dam capturing runoff from spoil	90th %ile 5 day	0.75	121.1	52.3
SD22	Dirty water sediment dam capturing runoff from spoil	90th %ile 5 day	0.75	5.1	2.2
SD23	Dirty water sediment dam capturing runoff from topsoil stockpile	90th %ile 5 day	0.4	20.4	12.7
SD24	Dirty water sediment dam capturing runoff from spoil	90th %ile 5 day	0.75	10.9	4.7
CD5	Clean water dam	100yr ARI 72hr	0.4	19.9	20.0
CD6	Clean water dam	100yr ARI 72hr	0.4	20.7	20.8
CD7	Clean water dam	100yr ARI 72hr	0.4	102.9	103.4
CD8	Clean water dam	100yr ARI 72hr	0.4	18.3	18.4
MD5	Mine water dam receiving water pumped from mining void				300
MD3	Mine water dam receiving surplus contaminated water				600
MD4^^	Irrigation area recirculation dam				30

Notes: ^A nominal catchment of 5ha has been assumed for SD11. ^^ MD4 has been previously sized as part of the irrigation system design.

4.7.2 Clean water system

The undisturbed catchment to the north of the mining void does not drain freely to Nagero Creek for Year 21. Clean runoff from this catchment will therefore be captured in clean water dams, and then pumped to a natural drainage line discharging to Nagero Creek. Clean water diversion drains will be constructed adjacent to the remaining mine void post mining to direct flow into Nagero Creek from this catchment where practical.

Runoff from the rehabilitated spoil dump and the undisturbed catchment to the east of the mine working area will be released to Nagero Creek for Year 21, as it is expected that rehabilitation will be well established.

Clean Water Dams 5, 6, 7 and 8 (CD5, CD6, CD7 and CD8)

CD5, CD6, CD7 and CD8 are proposed new dams to capture clean runoff from the undisturbed catchment to the north of the mining void. Clean water will be pumped south-west to a natural drainage line that discharges to Nagero Creek.

To minimise overflows to the mining void during wet weather, these dams have been sized to capture the 100 year ARI 72 hour duration storm event.

Clean Water Diversion Drain 1 (CW1)

CW1 will remain as per Years 1, 5 and 10.

Clean Water Diversion Drain 2 (CW2)

CW2 will remain as per Years 1, 5 and 10.

Clean Water Diversion Drains 15 and 16 (CW15 and CW16)

CW15 and CW16 are proposed new drains to divert clean water from the undisturbed catchment through the rehabilitated spoil dump to Nagero Creek.

4.7.3 Dirty water system

Dirty water runoff will be captured in sediment dams to attenuate flows and to encourage the settling of suspended solids. It is expected that the site will experience an annual water surplus for median rainfall years during Year 21 of the Project. It is therefore proposed to release water captured in sediment dams to Nagero Creek, rather than reusing it onsite. Details of dirty water sediment dams are provided below.

Sediment Dam 3, 5, 6, 8 and 23 (SD3, SD5, SD6, SD8 and SD23)

SD3, SD5, SD6, SD8 and SD23 will remain as per Years 5 and 10.

Sediment Dam 19 (SD19)

SD19 is a proposed new sediment basin capturing dirty runoff from establishing rehabilitation in the spoil dump area.

It may be possible to construct a series of smaller dams along the drainage line in order to reduce the volume of SD19.

Sediment Dam 20 (SD20)

SD20 is a proposed new sediment basin capturing dirty water runoff from the spoil dump. SD20 overflows to SD19.

Sediment Dam 21 (SD21)

SD21 is a proposed new sediment basin capturing dirty water runoff from the spoil dump. SD21 overflows to Nagero Creek.

Sediment Dam 22 (SD22)

SD22 is a proposed new sediment basin capturing dirty water runoff from a small area of spoil dump that is south of the haul road. SD22 overflows to Nagero Creek.

Sediment Dam 24 (SD24)

SD24 is a proposed new sediment basin capturing dirty water runoff from a small area of spoil dump that is south of the haul road. SD24 overflows to Nagero Creek.

Dirty Water Diversion Drains 1 and 2 (DW1 and DW2)

DW1 and DW2 will remain as per Year 10.

Dirty Water Diversion Drains 3, 5, 6 and 7 (DW3, DW5, DW6 and DW7)

DW3, DW5, DW6 and DW7 will remain as per Year 10. However, these drains will discharge directly to Nagero Creek, as runoff will be from rehabilitated areas.

Dirty Water Diversion Drains 10, 13, 14, 15, 16, 17, 19 (DW10, DW13, DW14, DW15, DW16, DW17 and DW19)

DW10, DW13, DW14, DW15, DW16, DW17 and DW19 are proposed diversion drains. These drains convey runoff from disturbed areas to dirty water sediment dams.

4.7.4 Contaminated water system

The key infrastructure associated with the contaminated water management system will remain as per Years 5 and 10. However, the site water balance will alter and it is expected that there will be a mix of both annual water deficits and surpluses depending on rainfall. It is therefore expected that the irrigation system will be required for disposal of surplus contaminated water during wet years. Details of the site water balance are provided in Section 5.

5. Water balance analysis

A long term water balance analysis has been undertaken for the proposed water management system for the Project. The purpose of the analysis was to estimate annual runoff volumes and to identify likely contaminated water deficits and surpluses as a result of the Project.

The water balance model was built using GoldSim software, and incorporated the Australian Water Balance Model (AWBM) to simulate catchment runoff. The model was built for the following landforms:

- **Year 1** landform
- **Year 5** landform
- **Year 10** landform
- **Year 21** landform.

Details of the water balance analysis are provided below.

5.1 Methodology

5.1.1 GoldSim water balance model

GoldSim, developed by GoldSim Technology Group LLC, is a Microsoft Windows based software for carrying out probabilistic simulations of complex systems to support management and decision making in engineering, science and business. GoldSim can be used for a wide range of applications, and is well suited to water balance modelling of mine sites.

The GoldSim water balance model developed by PB has a daily time step, and was used to calculate the volume of water in storages at the end of each day accounting for daily inflow, evaporation from the storage, water usage, pumping between storages in the form of a pumping policy and storage overflow, if it occurs.

Inflow to a storage may be the result of localised runoff from an adjacent contributing catchment, groundwater inflow, or direct transfer between storages. Where inflow is derived from localised runoff, the volume is calculated within the water balance model using the AWBM runoff model. Direct transfer between storages is accounted for in a pumping policy, whilst mine usage is accounted for in demand data.

Pumping Policies allow for ‘too empty’ or ‘too full’ storage scenarios. If the storage is ‘too empty’, then a volume is withdrawn from a known source and deposited into the storage. If the storage is ‘too full’, then a volume is withdrawn from the storage and deposited into another storage. Make up and reduction priorities have been incorporated into the pumping policies. Pumping policies do not vary throughout the duration of modelling.

Evaporation from a storage varies daily and is applied over the open water surface area of the storage on a daily basis.

Overflow occurs when the storage has reached its maximum capacity. Excess flows are added to a nominated receiving storage, which can also be a watercourse.

A summary of the pumping policies adopted in the water balance model is provided in Appendix C.

5.1.2 AWBM runoff model and parameters

The AWBM runoff model was incorporated into the GoldSim water balance model, and was used to generate a daily times series of runoff from each catchment.

AWBM uses three surface store estimates to simulate partial areas of runoff. Rainfall is added to each of the three surface moisture stores and evapotranspiration is subtracted at each timestep. If the value of moisture in the store exceeds the capacity, the excess moisture becomes runoff. A fraction of the runoff (set by the baseflow index) recharges the baseflow store, the remainder is surface runoff. The baseflow store is depleted at the rate of (1.0 - K)*BS where BS is the current moisture in the baseflow store and K is the baseflow recession constant. A schematic layout of AWBM is provided in Figure 5-1.

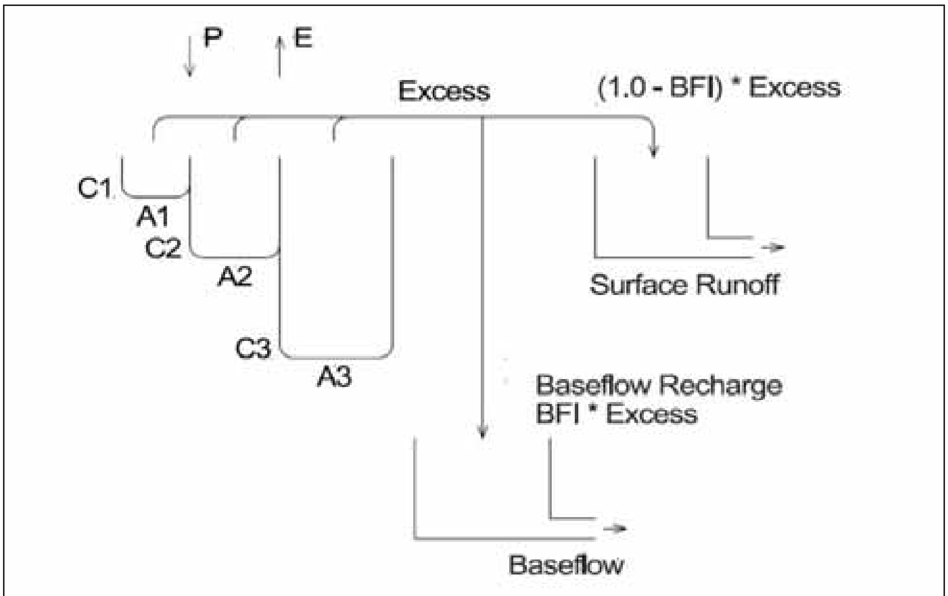


Figure 5-1 Schematic layout of AWBM runoff model

Adopted AWBM parameters are provided in Table 5-1. The adopted parameters for industrial, undisturbed and rehabilitated spoil areas are taken from the report entitled Boggabri Coal Mine 2008 Site Water Balance (PB, 2009). The adopted parameters for the mining void and spoil areas are based on past project experience on mine sites in New South Wales. It has been assumed that the rehabilitated spoil dump will have infiltration characteristics similar to undisturbed ground.

Due to the absence of gauged runoff data from the site, calibration of AWBM parameters has not been undertaken for each landuse.

Table 5-1 AWBM parameters

Landuse	BFI	K_{base}	A1	A2	A3	C1	C2	C3
Undisturbed	0.2	0.98	0.134	0.433	0.433	5.7	57.8	115.7
Rehabilitated spoil	0.2	0.98	0.134	0.433	0.433	5.7	57.8	115.7
Industrial	0	1	0.134	0.433	0.433	2.3	22.9	45.7
Mining void	0	1	0.2	0.2	0.6	5	70	90
Active spoil	0.8	0.7	0.3	0.3	0.4	30	60	120
Pre-strip	0.2	0.98	0.134	0.433	0.433	4.6	46.5	93.0

5.1.3 Model assumptions and limitations

The following assumptions were made in the water balance analysis:

- The model is run for the Year 1, 5, 10 and 21 landforms. No allowance has been made for changes in water demands, water sources, catchment areas, landuse types or landforms between these years.
- Annual groundwater inflows (as provided in Table 5-4) have been adopted and distributed uniformly to obtain daily groundwater inflow rates for the water balance simulation.
- A pumping policy was assumed for inclusion in the water balance model. The adopted pumping policies vary between landforms, but do not vary throughout the duration of the 109 year model simulation. It has been assumed that pumping occurs at an average pump rate and no allowance has been made to modify the pump rate depending on storage capacity. Inter-pumping rates are based on previous mine experience and discussions with the site operators, and are consistent with existing pump rates and considered achievable using current or new / upgraded systems in the future.
- It has been assumed that the low flow outlets from dirty water sediment dams remain open throughout the simulation. Low flow outlets have been represented in the water balance model so that the dams empty over a period of three days. The only exception is SD3, SD7, SD13 in Years 5 and 10 when dirty water is reused and low flow outlets from dirty water sediment dams remain closed through the simulation.
- It has been assumed that the bottom half of the 'sediment zone' of dirty water sediment dams is half full of sediment throughout the simulation. Water that ponds in the top half of the 'sediment zone' of dirty water sediment dams evaporates over time.
- It has been assumed that the bottom half of the 'sediment zone' of contaminated water sediment dams is half full of sediment throughout the simulation. It has been assumed that water contained in the top half of the 'sediment zone' of contaminated water sediment dams cannot be used to supply dust suppression and washery make-up water.
- No allowance has been made for seepage from water storages, or for seepage from product coal or rejects.
- It has been assumed that adequate groundwater / surface water allocations or alternative water sources are available to makeup the site water deficit (an infinite supply has been adopted in the model). However, where the annual water deficit

exceeds Boggabri Coal's current water entitlements, it will be necessary for Boggabri Coal to secure additional water to makeup the deficit.

- The irrigation system has been included in the Year 1 and 21 simulations. It has been assumed that the capacity of the irrigation system is 570ML/yr, based on an irrigation rate of 6ML/ha/yr and utilisation of the full 95ha irrigation area. Water disposed of via irrigation is assumed to be lost from MD3, and cannot be used to satisfy onsite demands when there is an onsite water deficit in later years. It is likely that the approved irrigation system will require upgrading to achieve the proposed irrigation rate of 570ML/yr.

- The irrigation system has not been included in the Year 5 and 10 simulations. It has been assumed that surplus contaminated water will be stored in MD2 / MD5, MD3 or in-pit during Year 5 and 10.

- A maximum pump rate of 5ML/day between the mining void and MD2 / MD5 has been assumed. Pumping ceases if the capacity of MD2 / MD5 exceeds 90%. During prolonged periods of wet weather it is assumed that runoff and groundwater inflows will be stored in the mining void until MD2 / MD5 has available capacity.

- A maximum pump rate of 5ML/day between mine water storage dams MD2 / MD5 and MD3 has been assumed. Pumping to MD3 from MD2 / MD5 ceases if the capacity of MD3 exceeds 500ML.

- A maximum pump rate of 2ML/day between SD2 and MD3 has been assumed. A maximum pump rate of 5ML/day between SD10, SD11 and SD12 and MD3 has been assumed. Pumping starts when the volume in these contaminated water sediment dams exceeds the 'sediment storage' volume.

- For Years 5 and 10, water from dirty water sediment dams SD3, SD7 and SD13 is pumped to MD3 for storage for reuse. Pumping starts when the volume in these dirty water sediment dams exceeds the 'sediment storage' volume. Pumping ceases if the capacity of MD3 exceeds 500ML. For Year 1 and 21, there is no pumping dirty water sediment dams to MD3 for storage for reuse.

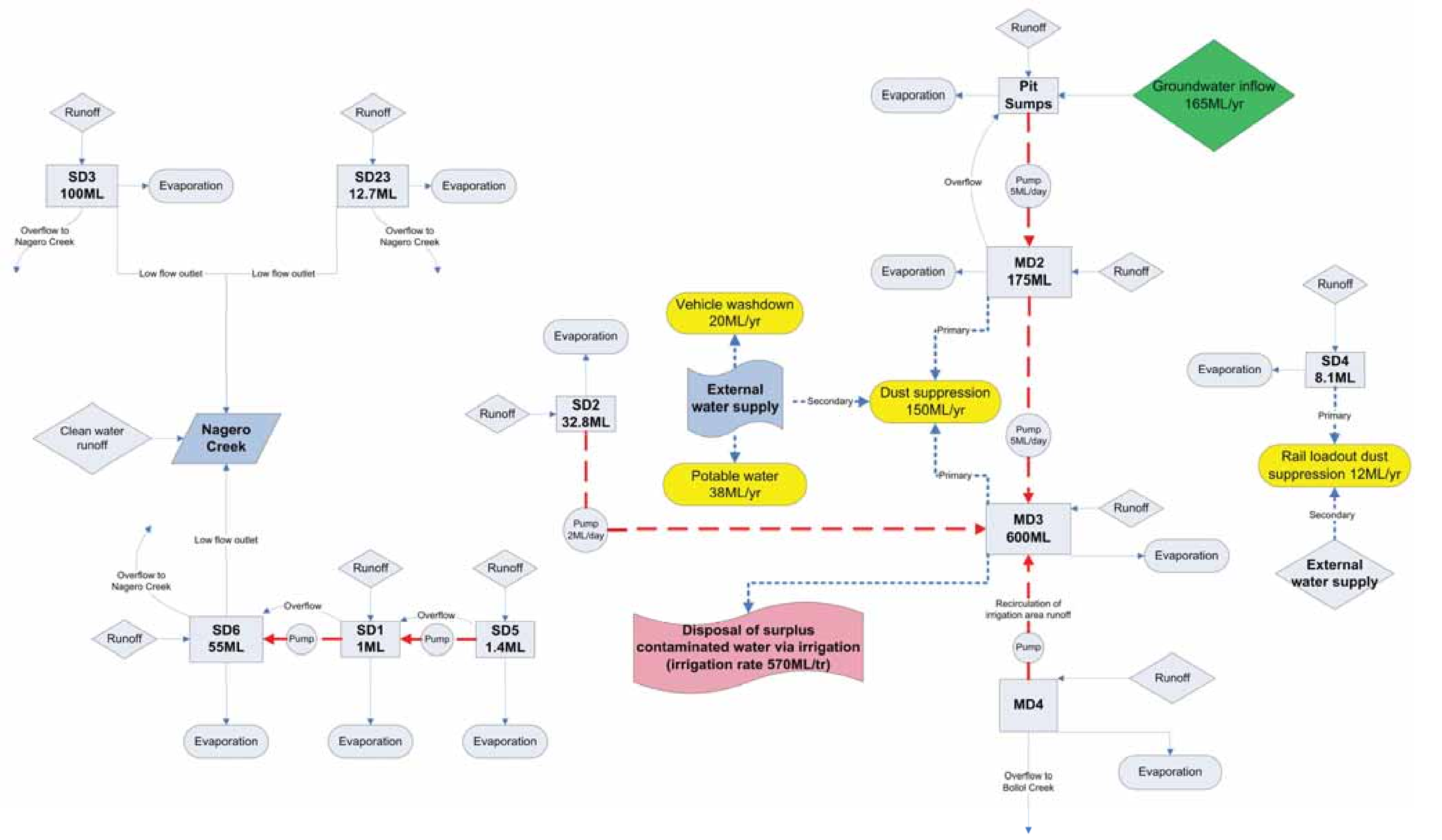
The current water balance model includes only basic operating rules, suitable for conceptual design and impact assessment. Operating rules should be upgraded when further water quality and groundwater data becomes available. Operating rules should be developed to manage competing interests including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

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

5.1.4 Model schematisation

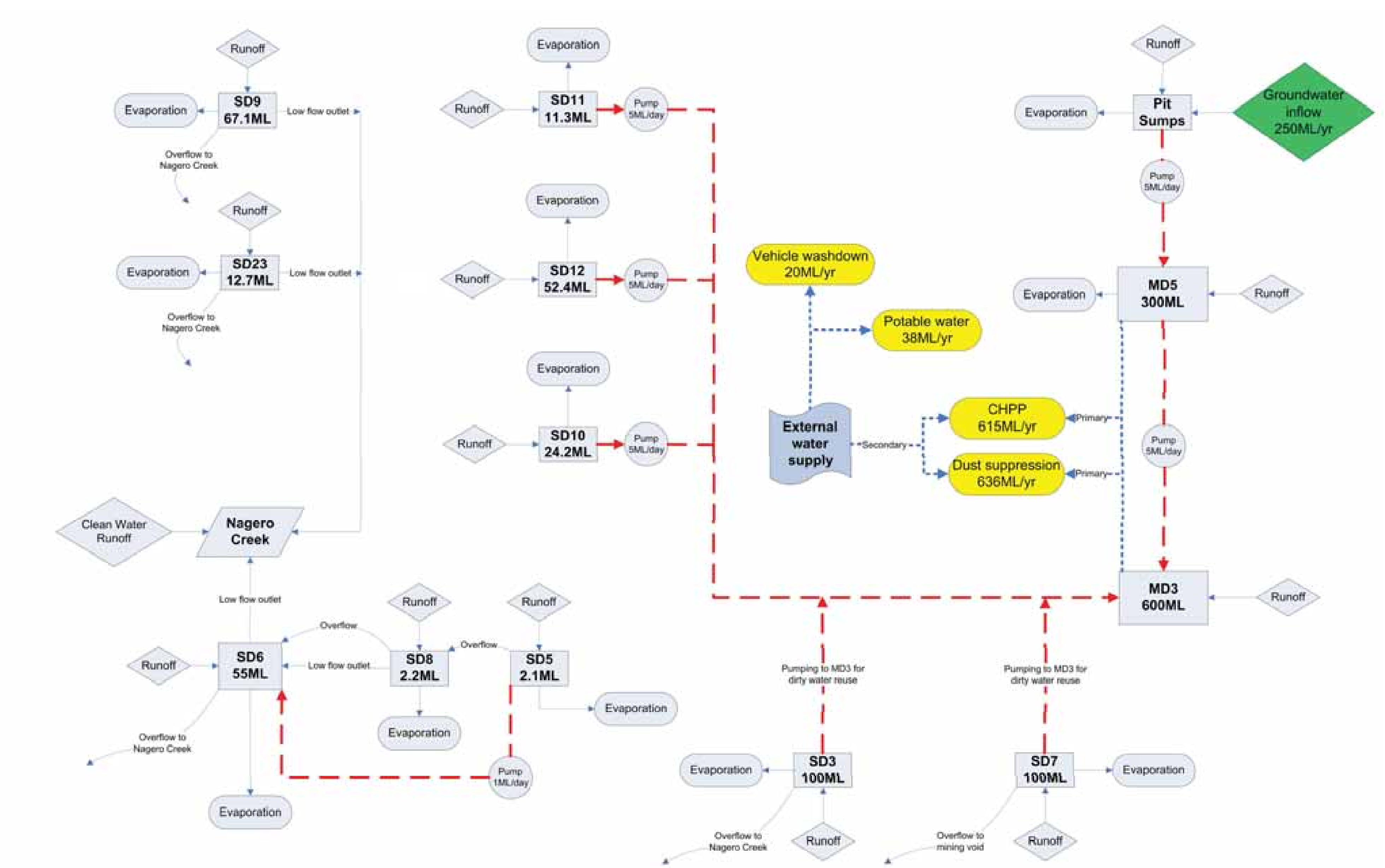
Schematics of the water management system as represented in the water balance model are provided in Figure 5-2, Figure 5-3, Figure 5-4 and Figure 5-5 for Years 1, 5, 10 and 21 respectively.

Client: HANSEN BAILEY PTY LTD
Project: CONTINUATION OF BOGGABRI COAL MINE, SURFACE WATER ASSESSMENT



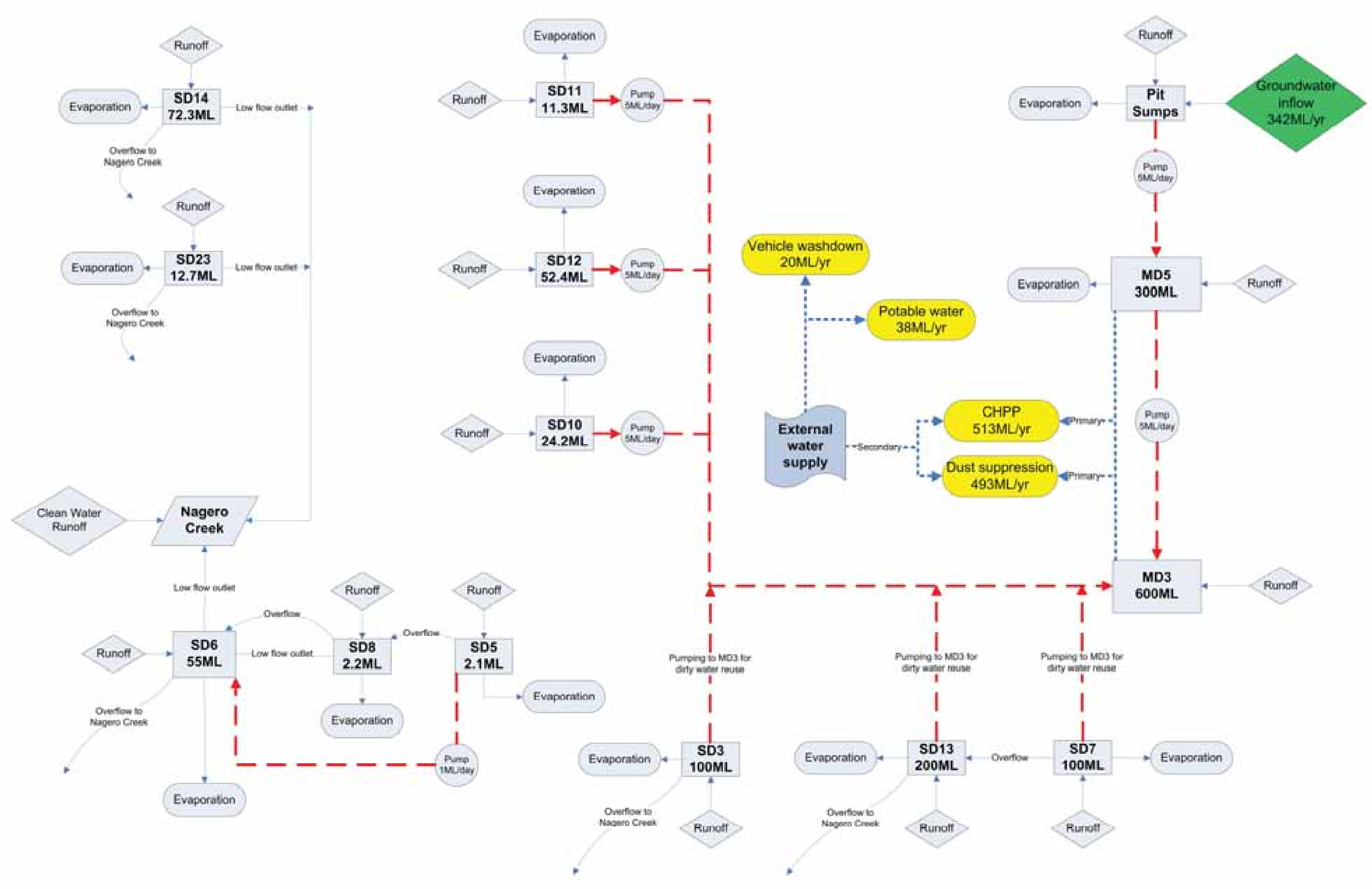
WATER BALANCE MODEL SCHEMATIC – YEAR 1
FIGURE 5-2

Client: HANSEN BAILEY PTY LTD
Project: CONTINUATION OF BOGGABRI COAL MINE, SURFACE WATER ASSESSMENT



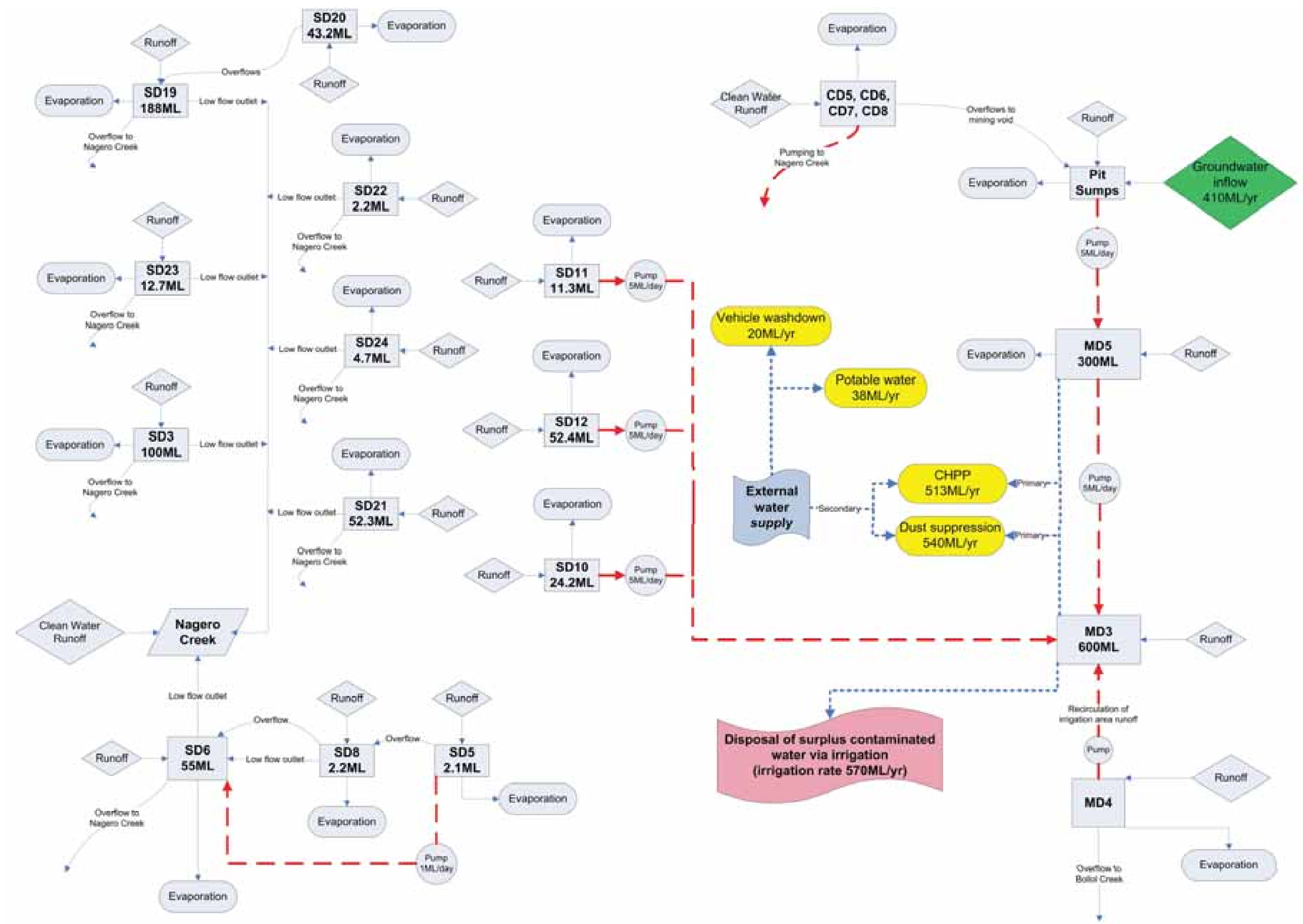
WATER BALANCE MODEL SCHEMATIC – YEAR 5
FIGURE 5-3

Client: HANSEN BAILEY PTY LTD
Project: CONTINUATION OF BOGGABRI COAL MINE, SURFACE WATER ASSESSMENT



WATER BALANCE MODEL SCHEMATIC – YEAR 10
FIGURE 5-4

Client: HANSEN BAILEY PTY LTD
Project: CONTINUATION OF BOGGABRI COAL MINE, SURFACE WATER ASSESSMENT



WATER BALANCE MODEL SCHEMATIC – YEAR 21
FIGURE 5-5

5.1.5 Catchments

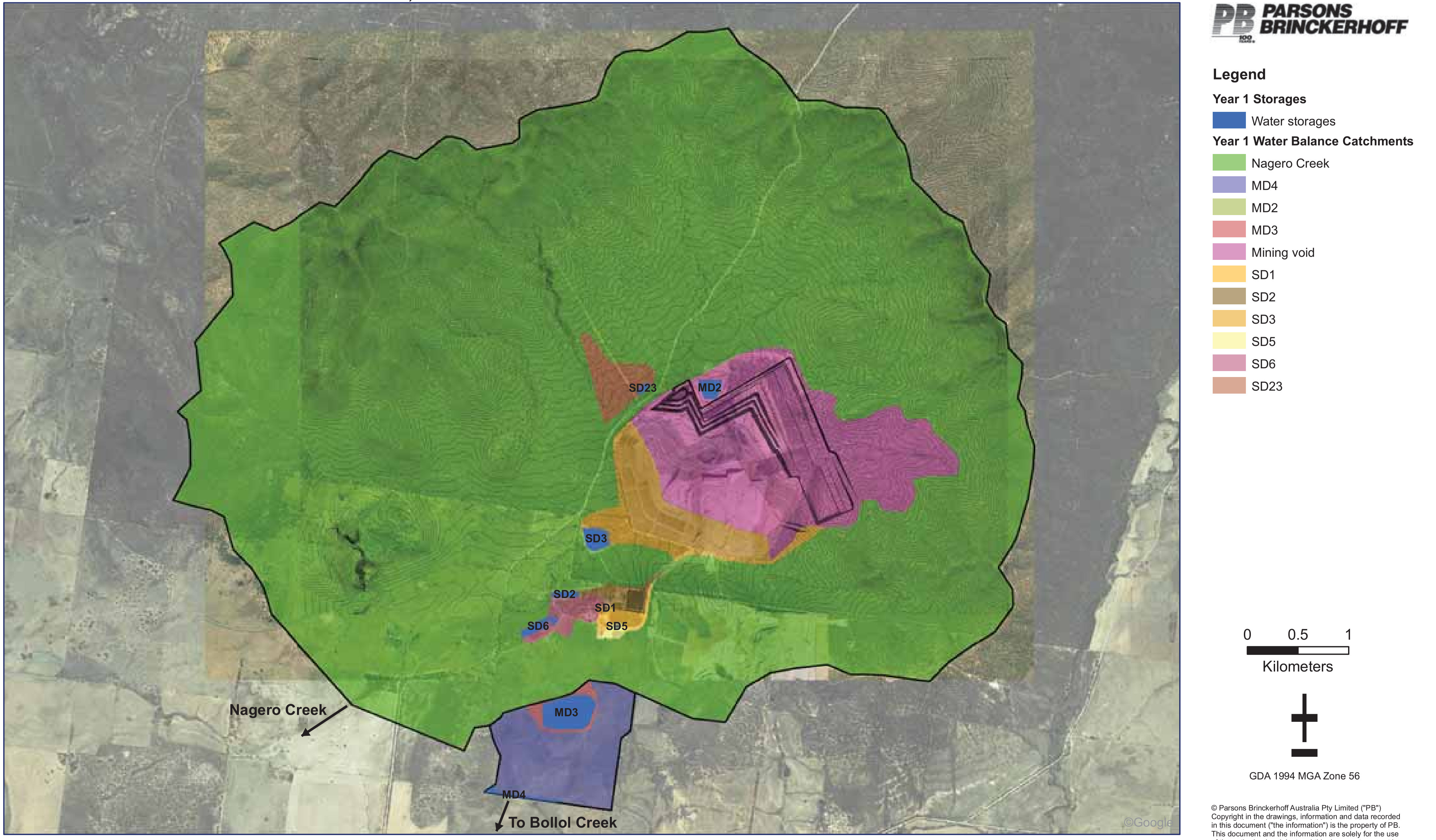
Catchment plans are provided in Figure 5-6, Figure 5-7, Figure 5-8 and Figure 5-9 for the Year 1, 5, 10 and 21 landforms respectively. A summary of catchment areas is provided in Table 5-2.

Table 5-2 Catchment areas adopted in GoldSim water balance model

		Catchment area (ha)			
Storage type	**Storage name**	**Year 1**	**Year 5**	**Year 10**	**Year 21**
Contaminated	MD2	3.2	-	-	-
	MD3	19.0	19.0	19.0	19.0
	MD4	112.2	112.2	112.2	112.2
	MD5	-	9.0	9.0	9.0
	SD2	14.5	-	-	-
	SD10	-	10.7	10.7	10.7
	SD11	-	3.4	3.4	3.4
	SD12	-	23.2	23.2	23.2
	Pit	369.1	506.7	406.4	531.1
	Subtotal	*518.0*	*684.2*	*583.9*	*708.6*
Dirty	SD1	9.3	-	-	-
	SD3	103.7	212.6	211.6	211.6
	SD5	2.8	4.9	4.9	4.9
	SD6	20.1	9.9	9.9	9.9
	SD7	-	274.6	323.6	-
	SD8	-	5.0	5.0	5.0
	SD9	-	291.4	-	-
	SD13	-	-	367.7	-
	SD14	-	-	313.6	-
	SD19	-	-	-	434.2
	SD20	-	-	-	100.0
	SD21	-	-	-	121.1
	SD22	-	-	-	5.1
	SD23	29.4	20.9	20.9	20.9
	SD24	-	-	-	10.9
	Subtotal	*165.3*	*819.3*	*1257.2*	*923.6*
Clean	CD5	-	-	-	19.9
	CD6	-	-	-	20.7
	CD7	-	-	-	102.9
	CD8	-	-	-	18.3
	Nagero Creek	3,731.0	2,910.5	2,572.9	2,620.0
	Subtotal	*3,731.0*	*2,910.5*	*2,572.9*	*2,781.8*
Total		**4,414**	**4,414**	**4,414**	**4,414**

Note. Dash (-) indicates that the storage does not exist for the landform.

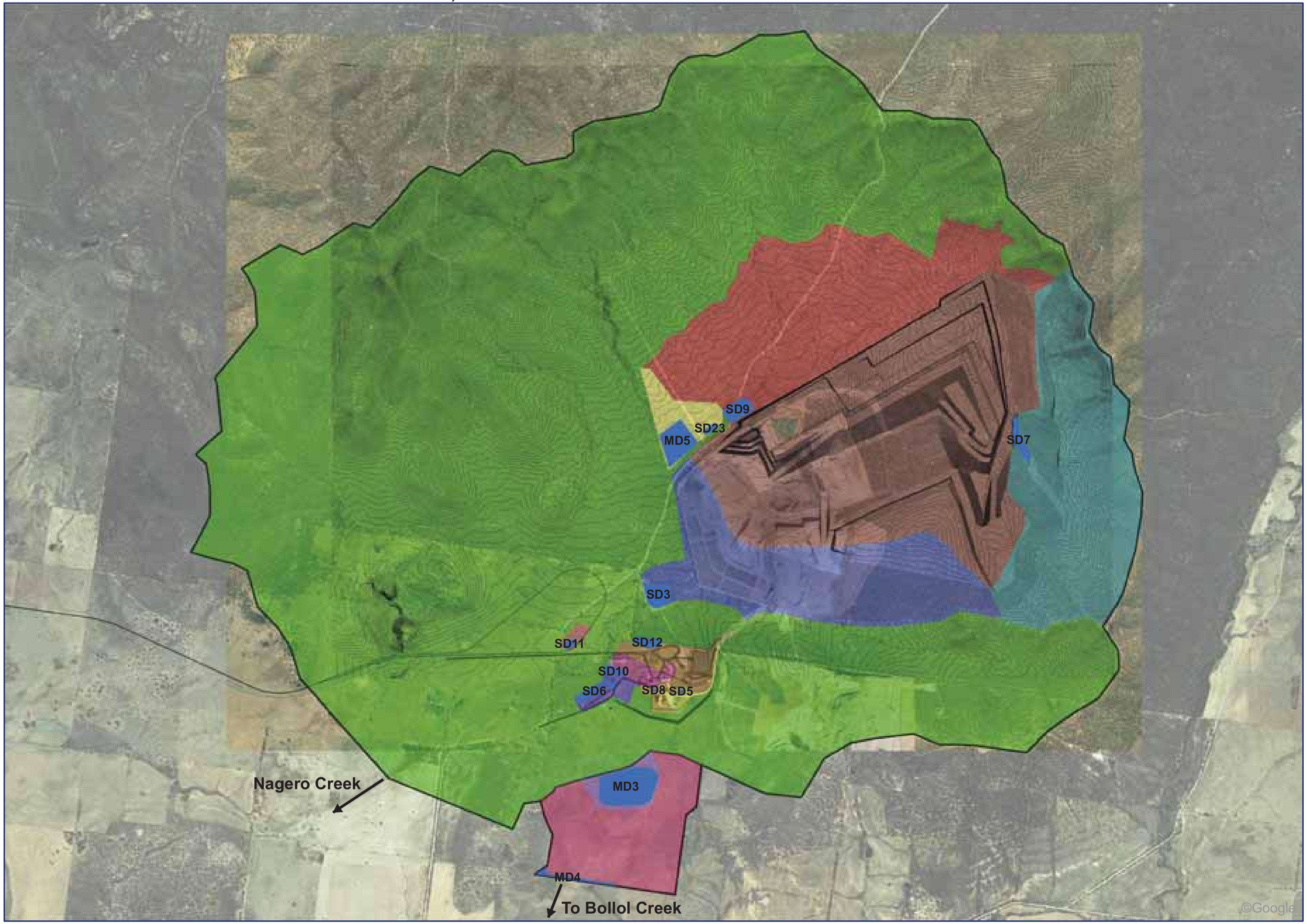
CLIENT: HANSEN BAILEY PTY LTD
PROJECT: CONTINUATION OF BOGGABRI COAL MINE, SURFACE WATER ASSESSMENT



\\AUNCLF\proj\H\Hansen_Bailey\2123173_EMA_BOGGABRI_COAL_EA\05_WrkPapers\GIS\Output\Maps LT

FIGURE 5-6 WATER MANAGEMENT SYSTEM CATCHMENT PLAN - YEAR 1

CLIENT: HANSEN BAILEY PTY LTD
PROJECT: CONTINUATION OF BOGGABRI COAL MINE, SURFACE WATER ASSESSMENT



PARSONS BRINCKERHOFF

Legend

Year 5 Storages

- Water storages

Year 5 Water Balance Catchments

- Nagero Creek
- MD3
- MD4
- MD5
- Mining void
- SD3
- SD5
- SD6
- SD7
- SD8
- SD9
- SD10
- SD11
- SD12
- SD23

0 0.5 1
Kilometers

GDA 1994 MGA Zone 56

FIGURE 5-7 WATER MANAGEMENT SYSTEM CATCHMENT PLAN - YEAR 5

\\AUNCLF\proj\H\Hansen_Bailey\2123173_EMA_BOGGABRI_COAL_EA\05_WrkPapers\GIS\Output\Maps LT

CLIENT: HANSEN BAILEY PTY LTD
PROJECT: CONTINUATION OF BOGGABRI COAL MINE, SURFACE WATER ASSESSMENT

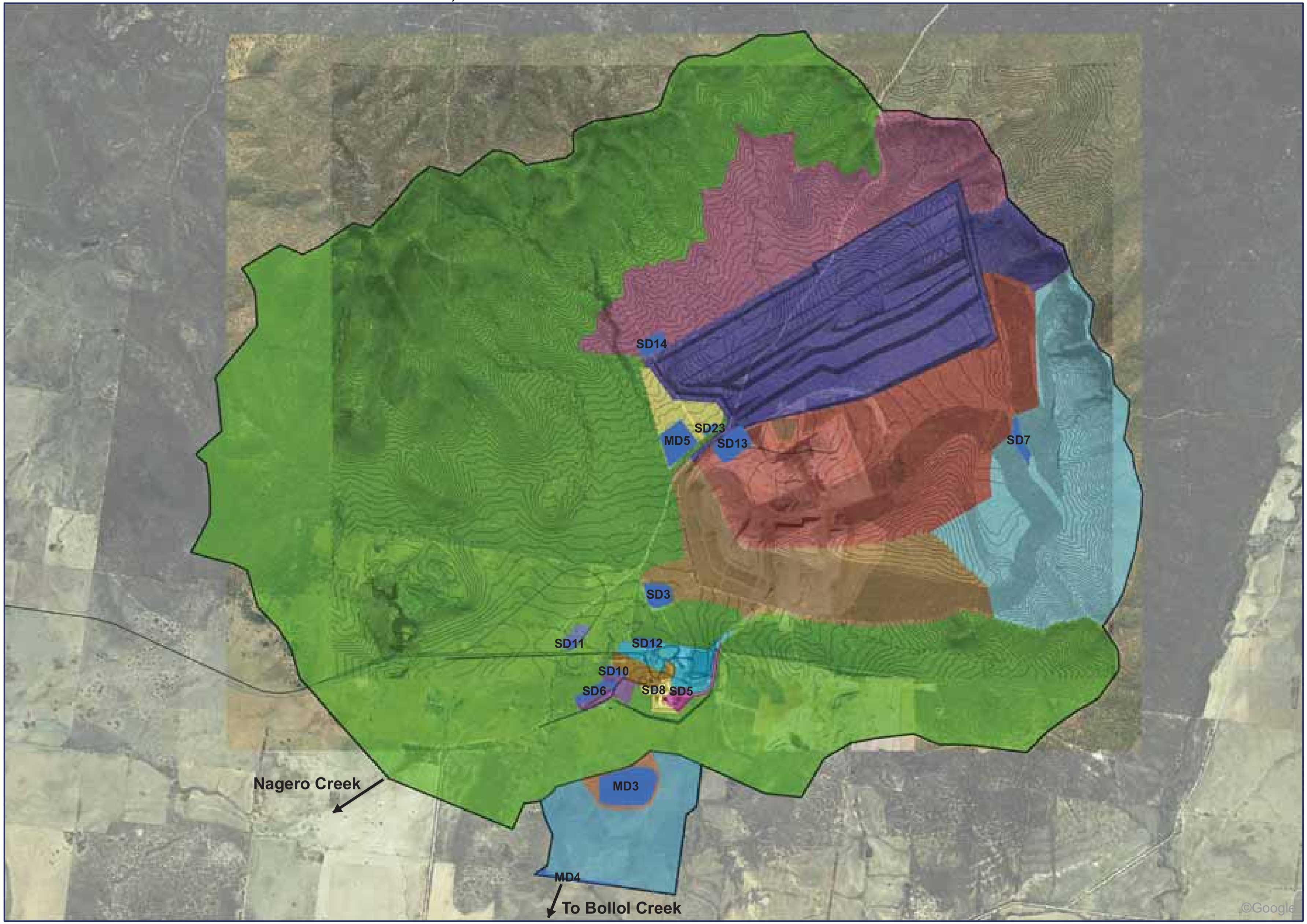
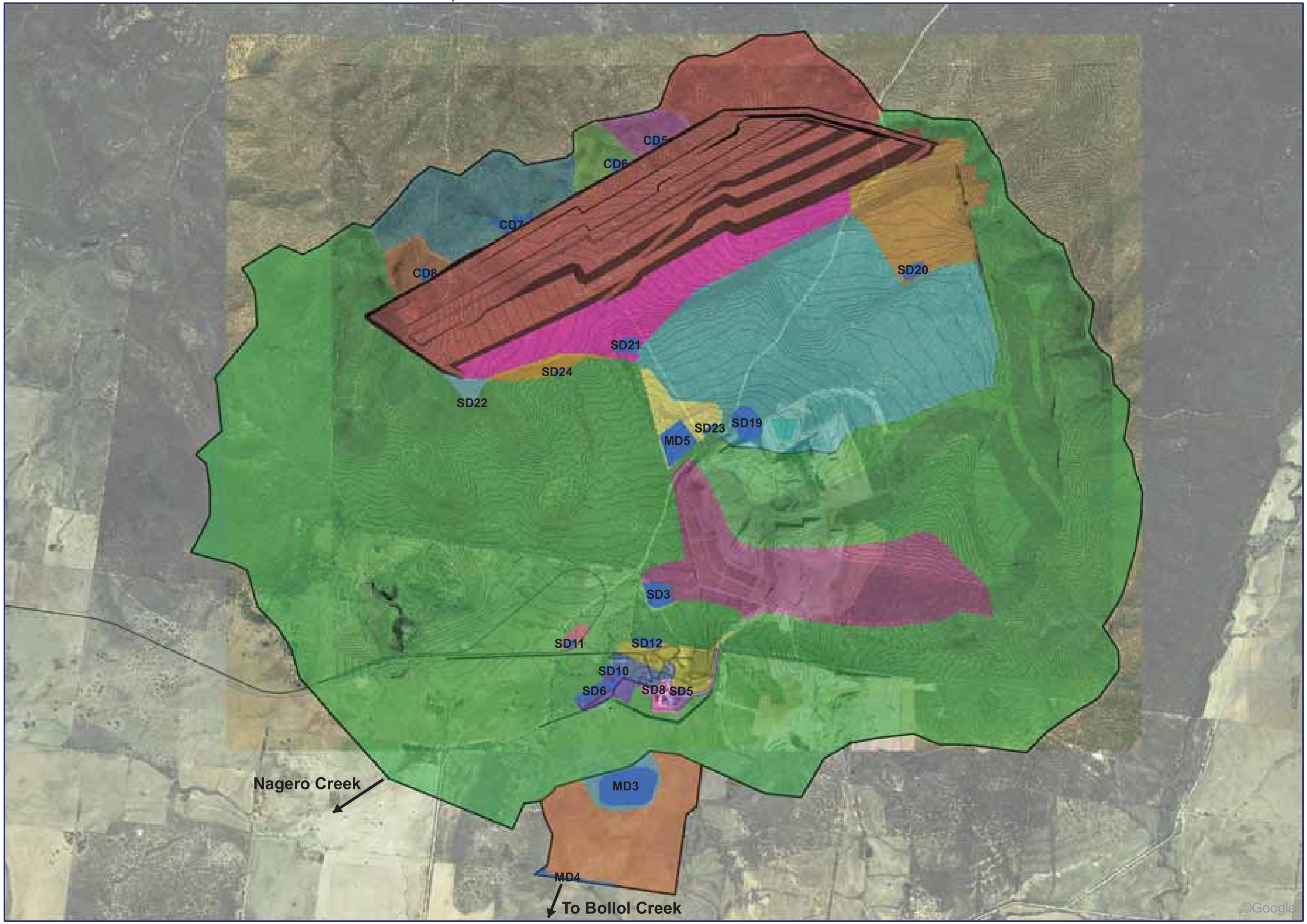


FIGURE 5-8 WATER MANAGEMENT SYSTEM CATCHMENT PLAN - YEAR 10

CLIENT: HANSEN BAILEY PTY LTD
PROJECT: CONTINUATION OF BOGGABRI COAL MINE, SURFACE WATER ASSESSMENT



PARSONS BRINCKERHOFF

Legend

Year 21 Storages

- Water storages

Year 21 Water Balance Catchments

- Nagero Creek
- MD3
- MD4
- MD5
- Mining void
- SD3
- SD5
- SD6
- SD8
- SD10
- SD11
- SD12
- SD19
- SD20
- SD21
- SD22
- SD23
- SD24
- CD5
- CD6
- CD7
- CD8

0 0.5 1
Kilometers

GDA 1994 MGA Zone 56

\\AUNCLF\proj\H\Hansen_Bailey\2123173_EMA_BOGGABRI_COAL_EA\05_WrkPapers\GIS\Output\Maps LT

FIGURE 5-9 WATER MANAGEMENT SYSTEM CATCHMENT PLAN - YEAR 21

From Table 5-2 it can be seen that the combined dirty and contaminated water catchment area generally increases over the life of the Project from 683ha in Year 1 to 1,632ha in Year 21. The clean water catchment area generally decreases over the life of the Project from 3,760ha in Year 1 to 2,690ha in Year 21.

5.2 Climate data

5.2.1 Rainfall

Daily rainfall data for Boggabri for the 120 year period between 1889 and 2009 was obtained from the BOM's Data Drill service. "The Data Drill accesses grids of data derived by interpolating the BOM's station records. Interpolations are calculated by splining and kriging techniques. The data in the Data Drill are all synthetic; there are no original meteorological station data left in the calculated grid fields. However, the Data Drill does have the advantage of being available for any set of coordinates in Australia" (BOM, 2006).

A plot of annual rainfall at Boggabri from 1889 to 2009 is provided in Figure 5-10.

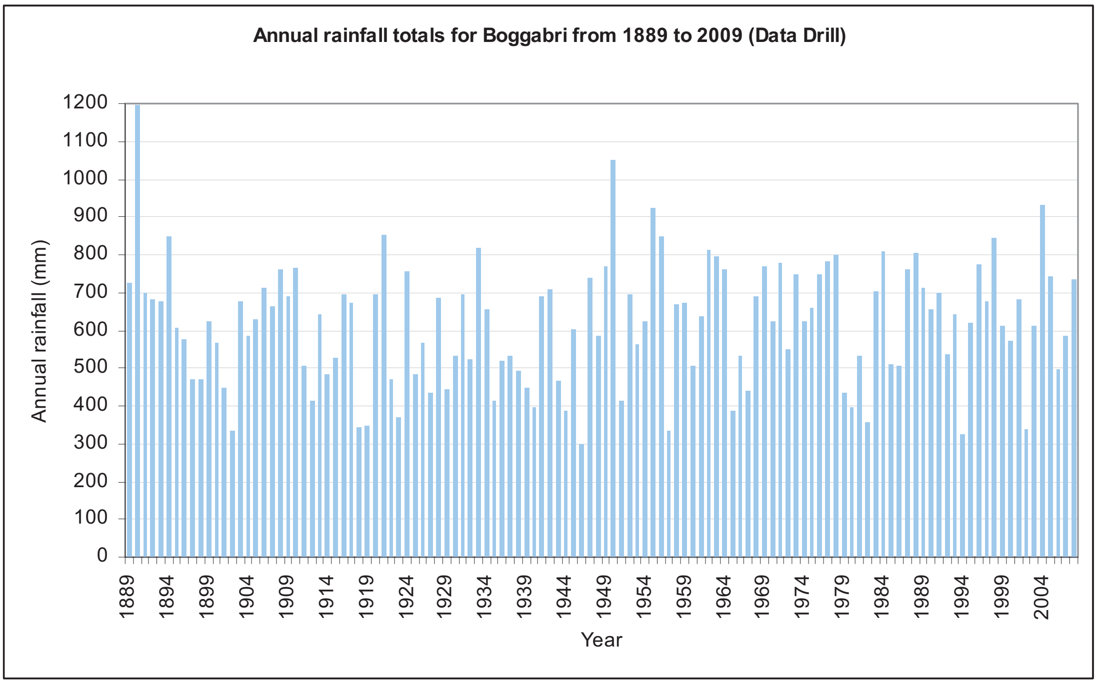


Figure 5-10 Annual rainfall for Boggabri from 1889 to 2009 (Data Drill)

The 10th, 50th and 90th percentile rainfall years (i.e. dry, median and wet rainfall years) are provided in Table 5-3. A 10th percentile rainfall year implies that rainfall is lower than the stated value for 10% of the years on record.

Table 5-3 Summary of annual rainfall statistics for Boggabri from 1889 to 2009 (Data Drill)

Rainfall data	Annual rainfall (mm/yr)	Representative year
10th percentile (dry year)	398	1940
50th percentile (median year)	626	1905
90th percentile (wet year)	802	1977

Daily rainfall data has been recorded at the Boggabri Coal Mine weather station since July 2006. The annual rainfall data obtained from the Data Drill compares reasonably well (i.e. within +/- 10%) to the data obtained from the Boggabri Coal Mine weather station for 2007 and 2008.

5.2.2 Evaporation

Daily evaporation data for Boggabri for the 120 year period between 1889 and 2009 was also obtained from the BOM's Data Drill service. Average daily pan evaporation rates for each month of the year are provided in Figure 5-11. The lowest average daily pan evaporation was 1.9 mm/day occurring in June, and the highest average daily pan evaporation was 8.2 mm/day occurring in December and January.

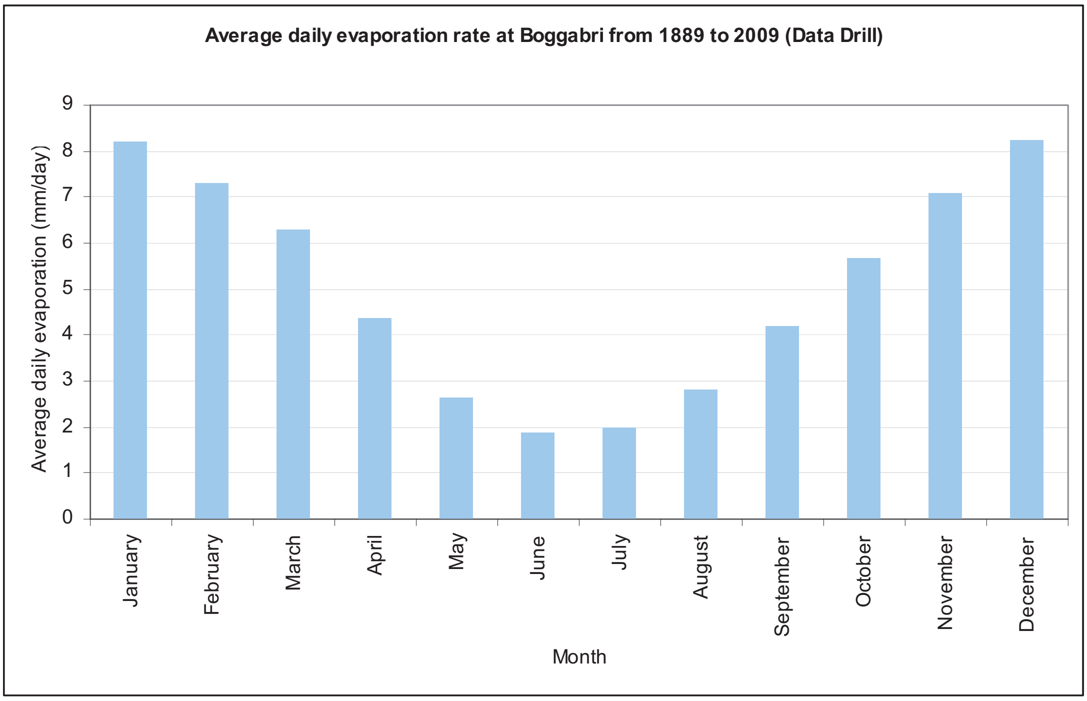


Figure 5-11 Average daily pan evaporation for Boggabri from 1889 to 2009 (Data Drill)

5.3 Water sources

Water sources for the Project comprise:

- Groundwater inflows to the mining void
- Rainfall runoff
- Groundwater allocations from Lower Namoi Groundwater Source
- Surface water allocations from the Lower Namoi Regulated River Water Source.

5.3.1 Groundwater inflow to mining void

Estimated seepage rates of groundwater into the existing approved mine and the mine extension have been provided in the groundwater assessment undertaken by AGE (2010). Seepage rates have been provided for each quarter year over the life of mine.

A summary of the groundwater inflows adopted in the water balance model for Year 1, 5, 10 and 21 are provided in Table 5-4.

Table 5-4 Estimated groundwater inflows to mining void for each year of the Project

Project year	Average daily inflow (ML/day)	Annual inflow (ML/yr)
1	0.451	165
5	0.686	250
10	0.938	342
21	1.123	410

From Table 5-4 it can be seen that groundwater inflow to the mining void will increase over the life of the Project.

Groundwater that collects in the mining void will be pumped to MD2 / MD5 for onsite reuse.

5.3.2 Rainfall runoff

Contaminated surface water runoff is captured in sediment dams for settling of suspended solids prior to onsite reuse. The volume of contaminated surface water runoff is dependent on the rainfall depth and the catchment area of the mining void and industrial areas.

Dirty water runoff is also captured in sediment dams for settling of suspended solids prior to release to Nagero Creek or onsite reuse. It is proposed to reuse runoff from SD3, SD7 and SD13 (that capture runoff from the spoil dump) during Years 5 and 10 of the Project.

5.3.3 Groundwater allocations

Boggabri Coal currently holds licenses for the Namoi Groundwater Source. The total share component under these licenses is 194 unit shares. Details of these water access licenses are provided in Table 5-5.

Table 5-5 Summary of Water Access License's for the Namoi Groundwater Source held by Boggabri Coal

Source	License category	License number	Share component
Namoi Groundwater Source pumped from Lovton Bore	Low security	90BL253854 (yet to be converted to a WAL)	142 unit shares
Namoi Groundwater Source pumped from Daisymede property		90BL252849 converted to WAL 15037	52 unit shares

Assuming an allocation of 1ML/yr per unit share for the 194 unit shares from groundwater licenses, it can be expected that approximately 194ML/yr would be available to Boggabri Coal from these existing licences.

Groundwater pumped from Lovton Bore is currently treated in an onsite treatment plant and used for vehicle washdown and potable water.

Groundwater pumped from Daisymede property is currently used for dust suppression at the existing rail loading facility located west of the site. Dust suppression water at this rail loading facility may only be required for Year 1, as there is the potential to decommission the existing facility by Year 5 following the construction of the rail spur and mine site rail loop.

Groundwater allocations are also utilised to supplement a water deficit onsite after all alternative recycled contaminated water sources have been utilised.

The NSW Office of Water (NOW) still maintain a Bore Field (3 bores) located at Heathcliffe property 10km west of the site. These bores do not have a bore license or water access license number. The Boggabri EIS identified this bore field as the major source of water supply when the mine operates at full production with a washery.

5.3.4 Surface water allocations

Boggabri Coal currently holds general security and supplementary water access licenses for the Lower Namoi Regulated River Water Source. The total share component under these licenses is 325.7 unit shares. Details of these water access licenses are provided in Table 5-6.

Table 5-6 Summary of Water Access License's for the Namoi Regulated River Water Source held by Boggabri Coal

Source	Water Access License category	Water Access License number	Share component
Lower Namoi River	General security	WAL 2571	51 unit shares
Lower Namoi River	General security	WAL 2595	243 unit shares
Lower Namoi River	Supplementary water	WAL 2596	26.1 unit shares
Lower Namoi River	Supplementary water	WAL 2572	5.6 unit shares

As discussed in Section 2.4, water is shared amongst different categories of water access licences by means of Available Water Determinations. For the Lower Namoi, the Available Water Determination for general security access licences is reviewed monthly and depends upon the amount of water held in Split Rock and Keepit Dams. The Available Water Determination for supplementary water access licences is set at the start of each water year.

The estimated long term extraction factors for the Namoi Regulated River are 0.95, 0.76 and 0.18 for high security, general security and supplementary license categories (NSW Department of Water and Energy, 2009). Adopting these long term extraction factors, it can be expected that a long term average of 223.4ML/yr and 5.7ML/yr would be available to Boggabri Coal from their current general security and supplementary licenses respectively. This is a long term average of 229.1ML/yr.

However, during extended dry periods Available Water Determinations for general security and supplementary licence categories can be much less than the long term extraction factors. This was demonstrated during the four year period from 2004 to 2008, when Available Water Determination announcements for general security licences in the Lower Namoi were set at zero for a period of 17 months between February 2006 and July 2007. When water was made available for general security licences, Available Water Determination announcements ranged from zero to a maximum of 0.117 ML per share in September 2005 (NSW Department of Water and Energy, 2009). The existing general security and supplementary surface water licenses held by Boggabri Coal have therefore not been considered when assessing the adequacy of the existing licenses to meet water demands for the Project during a dry year.

5.4 Water demands

Water demands comprise:

- Potable water (for drinking water and amenities)
- Dust suppression water
- Vehicle washdown water
- Washery make-up water.

5.4.1 Potable water

Potable water is utilised in the administration building and amenities. This water will be sourced from groundwater pumped from the Lovton Bore, and will be treated in an onsite water treatment plant prior to use for potable applications.

Boggabri Coal has estimated that approximately 38ML/yr of potable water will be required at the site for the life of mine.

Wastewater from the administration building and amenities will be treated in an onsite Envirocycle treatment plant and irrigated to an adjacent vegetated area. Wastewater generated by the onsite Envirocycle treatment plant has not been considered in the water balance analysis.

5.4.2 Dust suppression

Water is required for dust suppression on haul roads, coal stockpiles, coal crushing areas, and coal loading areas.

The estimated dust suppression demand for 2011 is provided in Boggabri Coal Mine 2008 Site Water Balance (PB, 2008). The dust suppression demand was estimated at 162ML/yr, based on a crusher demand of 12ML/yr and a haul road demand of 150ML/yr. This demand of 162ML/yr has been adopted for Year 1.

Boggabri Coal has provided estimates of total dust suppression demands for Year 5, 10 and 21.

A summary of the dust suppression demands adopted in the water balance model for Year 1, 5, 10 and 21 is provided in Table 5-7.

Table 5-7 Dust suppression demand estimates for each year of the Project

Project year	Dust suppression demand (ML/yr) ^
1	162
5	636
10	493
21	504

Note. ^ Dust suppression demand provided by Boggabri Coal. Dust suppression demand is applied on dry days only (approximately 250 dry days per year).

For the purposes of the water balance analysis, it has been assumed that dust suppression water will not be required on days with 10 mm or more of rainfall.

Water used for dust suppression is sourced as a priority from recycled contaminated water contained in MD2 / MD5 and MD3. When there is a water deficit onsite, groundwater allocations and/or surface water allocations will be used to supplement recycled contaminated water sourced from MD2 / MD5 and MD3.

5.4.3 Vehicle washdown

Water is required for vehicle washdown. Washdown water is recycled, however, water is required to make-up evaporative losses. Boggabri Coal estimates that approximately 20ML/yr of vehicle washdown make-up water will be required at the site for the life of mine.

Make-up water for vehicle washdown is currently sourced from groundwater pumped from Lovton Bore. Groundwater is treated in an onsite water treatment plant prior to use for vehicle washdown.

5.4.4 Coal handling and preparation plant

Boggabri Coal has estimated that approximately 205L of make-up water will be required in the washery for each tonne of coal feed. This water is required to make-up for water lost in product coal and rejects. Note that the washery will not be operational for Year 1.

Washery feed and make-up water estimates for Year 1, 5, 10 and 21 are provided in Table 5-8. The washery feed varies over the life of the Project, and is dependent on the ash content of ROM coal as well as the tonnage of ROM coal mined. Details of coal production rates for the Project are provided in Section 1.3 (refer to Table 1-1).

Table 5-8 Coal handling and preparation plant make-up water demand estimates for each year of the Project

Project year	Coal feed to washery (Mt/yr) ^	Washery make-up demand (ML/yr) ^^
1	0	0
5	3.0	615
10	2.5	513
21	2.5	513

Note. ^ Washery will not be operational for Year 1. ^^ Washery demand provided by Boggabri Coal.

Make-up water for the washery will be sourced from MD2 / MD5 or MD3 as a priority. Groundwater and surface water allocations will be used to supplement a water deficit onsite, when insufficient contaminated water is available from MD2 / MD5 or MD3.

5.4.5 Summary

A summary of estimated water demands for Years 1, 5, 10 and 21 is provided in Table 5-9.

Table 5-9 Summary of estimated water demands for each year of the Project

	Project year			
Demand (ML/yr)	**Year 1**	**Year 5**	**Year 10**	**Year 21**
Washery make-up ^	0	615	513	513
Dust suppression ^^	162	636	493	504
Vehicle washdown	20	20	20	20
Potable water	38	38	38	38
Total	**220**	**1,309**	**1,064**	**1,075**

Note. ^ Washery is not operational in Year 1. ^^ Dust suppression demand applies to dry days only.

5.5 Water balance results

The GoldSim water balance model was run using Data Drill sourced daily rainfall and evaporation data for the 109 year period from 1900 to 2009. A summary of the results for the Year 1, 5, 10 and 21 landforms is provided in the following sections.

5.5.1 Year 1 landform

A plot showing the relationship between annual rainfall depths and annual contaminated water surpluses / deficits is provided in Figure 5-12 for the Year 1 landform. The plot is based on 109 years of rainfall and evaporation data. A positive volume on the y-axis of the plot represents an annual surplus, which occurs when contaminated water generated onsite exceeds site demands. A negative volume on the y-axis of the plot represents an annual deficit, which occurs when there is insufficient contaminated water onsite to meet site demands. Note that the plot does not allow for carryover of water surpluses / deficits from previous years.

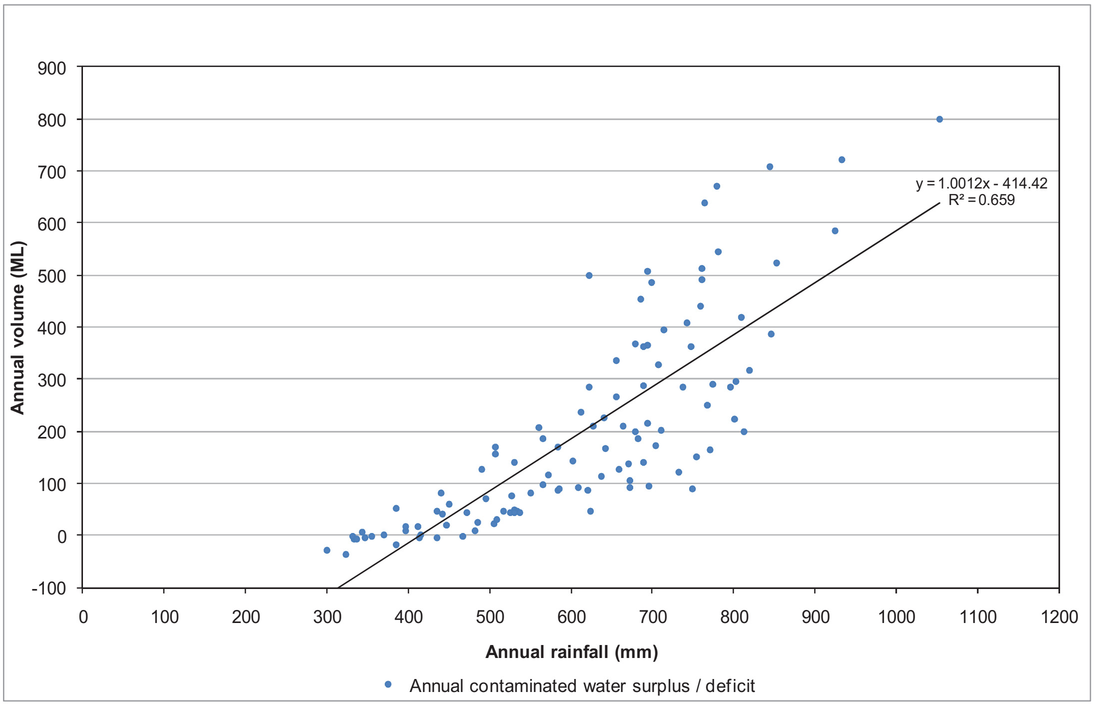


Figure 5-12 Annual rainfall depth versus estimated annual contaminated water deficit / surplus for Year 1 based on 109 years of rainfall data

From Figure 5-12 it can be seen that annual contaminated water surpluses were predicted for the majority of the 109 year water balance model simulation for the Year 1 landform. The data scatter on the plot may be attributed to the inter-relationship of the annual volume of contaminated runoff to the distribution of rainfall throughout the year, total rainfall and soil wetness / dryness. This scenario assumes no supply of water from the available groundwater and surface water licences or other external sources with the exception of the minimum requirement of 58ML/yr groundwater for potable water and vehicle washdown.

The trend line on Figure 5-12 shows that an annual contaminated water surplus will typically occur on years when the annual rainfall depth exceeds approximately 414mm.

The trend line on Figure 5-12 also shows that the annual contaminated water surplus did not exceed the out-of-pit storage capacity of 808ML during the 109 year simulation assuming that these storages are empty at the start of the year. The highest surplus was 800ML/yr, and was experienced during 1950 when the annual rainfall was 1052mm.

A water balance is provided in Table 5-10 for the Year 1 landform. The water balance is provided for the 10th percentile (dry), 50th percentile (median) and 90th percentile (wet) rainfall years. Note that the balance does not allow for carryover of water surpluses / deficits from previous years.

Table 5-10 Water balance results for Year 1 landform

	Dry year (1940)		Median year (1905)		Wet year (1977)		
Element	**Input (ML/yr)**	**Output (ML/yr)**	**Input (ML/yr)**	**Output (ML/yr)**	**Input (ML/yr)**	**Output (ML/yr)**	**Source of information**
Clean							
Runoff	617		1,746		4,448		Calculated from model
Site discharge		617		1,746		4,448	Calculated from model
Total	**617**	**617**	**1,746**	**1,746**	**4,448**	**4,448**	
Balance	**0**		**0**		**0**		
Dirty							
Runoff	32		89		225		Calculated from model
Evaporation		18		23		31	Calculated from model
Site discharge		14		66		196	Calculated from model
Total	**32**	**32**	**89**	**89**	**225**	**227**	
Balance	**0**		**0**		**+2**		
Contaminated							
Runoff	98		277		659		Calculated from model
Recycling of irrigation area runoff	18		54		68		Calculated from model
Evaporation		111		126		185	Calculated from model
Groundwater inflow to pit	165		165		165		Groundwater Consultant
Washery		0		0		0	Boggabri Coal
Dust suppression		162		162		162	Boggabri Coal
Potable water		38		38		38	Boggabri Coal
Vehicle washdown		20		20		20	Boggabri Coal
Groundwater allocations ^	58		58		58		PB estimate
Total	**339**	**331**	**554**	**346**	**950**	**405**	
Balance	**+8**		**+208**		**+545**		

Note. ^ A minimum groundwater allocation of 58ML/yr is required to meet vehicle washdown and potable water demands. The water balance assumes no supply of water from the existing groundwater and surface water licences or other external sources with the exception of this 58 ML/yr.

The imbalance in the dirty water system (i.e. +2ML for a wet rainfall year) can be attributed to carry over storage in dirty water sediment basins between the various calendar years of the water balance simulation.

The results in Table 5-10 show that for the Year 1 landform:

- The volume of clean water discharged directly to Nagero Creek was estimated to be 617ML/yr, 1,746ML/yr and 4,448ML/yr for dry, median and wet years respectively. This water drains directly to the creek system, and is not captured onsite.

- The volume of water discharged to Nagero Creek from dirty water sediment basins was estimated to be 14ML/yr, 66ML/yr and 196ML/yr for dry, median and wet years respectively. Onsite reuse of dirty water is not proposed during Year 1.

- The total volume of water discharged to Nagero Creek was estimated to be 631ML/yr, 1,812ML/yr and 4,644ML/yr for dry, median and wet years respectively (including both clean and dirty water).

- The volume of contaminated water generated at the mine site was estimated to be 281ML/yr, 496ML/yr and 892ML/yr (including rainfall runoff, groundwater inflows to the mining void, and recirculation of irrigation area runoff).

- Contaminated water surpluses of 8ML/yr, 208ML/yr and 545ML/yr were estimated for dry, median and wet years, respectively.

- Although contaminated water surpluses were estimated for dry, median and wet years, a minimum of 58ML/yr would still be required from external sources to meet potable water and vehicle washdown demands. Assuming full allocation for the groundwater licenses, but zero allocation for the general security and supplementary surface water licenses for a dry year, it can be expected that the total water available from existing licences held by Boggabri Coal would be in the order of 194ML/yr for a dry year. This would be more than adequate to meet potable water and vehicle washdown demands.

- The estimated contaminated water surplus for a wet year exceeds the average capacity of the approved irrigation system of 318ML/yr based on utilisation of 53ha of irrigation area. The full 95ha irrigation area will need to be utilised to irrigate the estimated surplus for a wet year of 545ML/yr. However, it is likely that the approved irrigation system will require upgrades to allow for 'spelling' if the full 95ha is utilised.

For years when the annual contaminated water surplus exceeds the proposed 570ML/yr capacity of the irrigation system, storage of contaminated water will be provided in SD2, MD2 and MD3. The total capacity of these out-of-pit storages is 808ML. It has been assumed that during prolonged wet periods, surplus contaminated water will be stored in-pit.

Options available to cater for onsite contaminated water surpluses are discussed in Section 7.2.2.

5.5.2 Year 5 landform

A plot showing the relationship between annual rainfall depths and annual contaminated water surpluses / deficits is provided in Figure 5-13 for the Year 5 landform. The plot is based on 109 years of rainfall and evaporation data. Note that the plot does not allow for carryover of water surpluses / deficits from previous years.

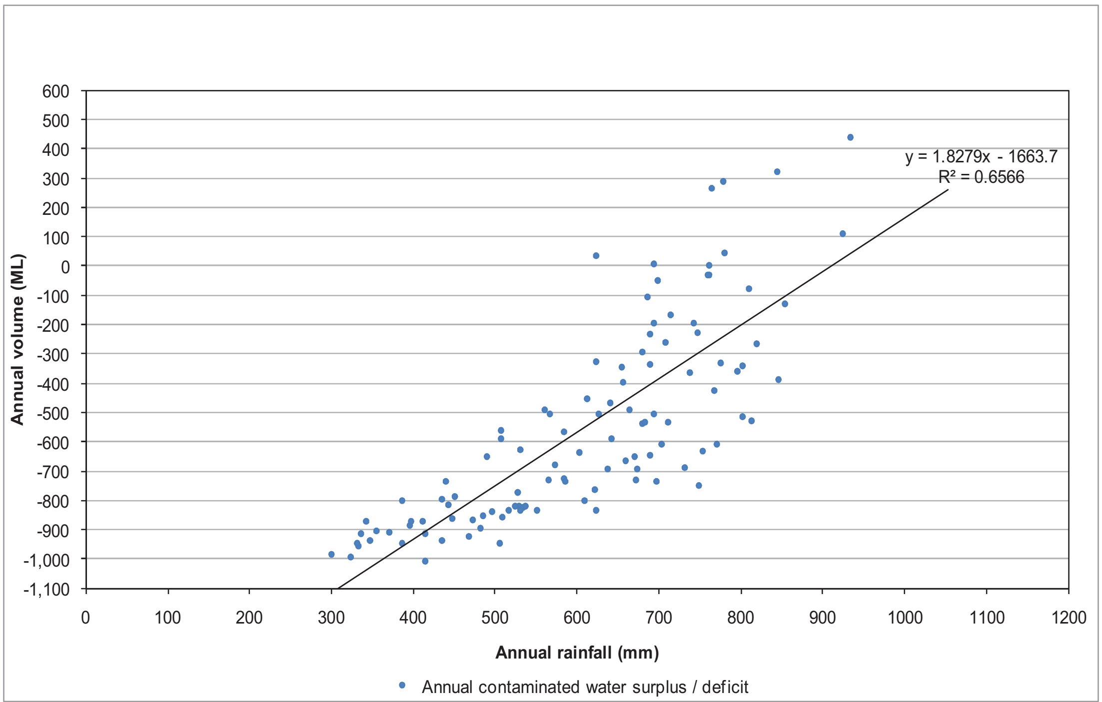


Figure 5-13 Annual rainfall versus estimated annual contaminated water deficit / surplus for Year 5 based on 109 years of rainfall data

From Figure 5-13 it can be seen that annual contaminated water deficits were estimated during the majority of the 109 year water balance model simulation for the Year 5 landform. The data scatter on the plot may be attributed to the inter-relationship of the annual volume of contaminated runoff to the distribution of rainfall throughout the year, total rainfall and soil wetness / dryness.

The trend line on Figure 5-13 shows that an annual contaminated water surplus will typically occur on years when the annual rainfall depth exceeds approximately 910mm. The annual contaminated water surplus did not exceed the out-of-pit storage capacity of 988ML during the 109 year simulation assuming that these storages are empty at the start of the year.

A water balance is provided in Table 5-11 for the Year 5 landform. The water balance is provided for the 10th percentile (dry), 50th percentile (median) and 90th percentile (wet) rainfall years. Note that the balance does not allow for carryover of water surpluses / deficits from previous years.

Table 5-11 Water balance results for Year 5 landform

Element	Dry year (1940)		Median year (1905)		Wet year (1977)		Source of information
	Input (ML/yr)	Output (ML/yr)	Input (ML/yr)	Output (ML/yr)	Input (ML/yr)	Output (ML/yr)	
Clean							
Runoff	487		1,373		3,498		Calculated from model
Site discharge		487		1,373		3,498	Calculated from model
Total	**487**	**487**	**1,373**	**1,373**	**3,498**	**3,498**	
Balance	**0**		**0**		**0**		
Dirty							
Runoff	146		411		1,065		Calculated from model
Evaporation		38		46		56	Calculated from model
Site discharge		33		144		724	Calculated from model
Dirty water pumped to MD3 for reuse		75		222		304	Calculated from model
Total	**146**	**146**	**411**	**412**	**1,065**	**1,084**	
Balance	**0**		**-1**		**-19**		
Contaminated							
Dirty water pumped to MD3 for reuse	75		222		304		Calculated from model
Runoff	115		372		929		Calculated from model
Evaporation		75		96		190	Calculated from model
Groundwater inflow to pit	250		250		250		Groundwater Consultant
Washery		615		615		615	Boggabri Coal
Dust suppression		636		636		636	Boggabri Coal
Potable water		38		38		38	Boggabri Coal
Vehicle washdown		20		20		20	Boggabri Coal
Groundwater allocations ^	58		58		58		PB estimate
Total	**498**	**1,384**	**902**	**1,405**	**1,541**	**1,499**	
Balance	**-886**		**-503**		**+42**		

Note. ^ A minimum groundwater allocation of 58ML/yr is required to meet vehicle washdown and potable water demands. The water balance assumes no supply of water from the existing groundwater and surface water licences or other external sources with the exception of this 58 ML/yr.

The imbalance in the dirty water system can be attributed to carry over storage in dirty water sediment basins between the various calendar years of the water balance simulation.

The results in Table 5-11 show that for Year 5:

- The volume of clean water discharged directly to Nagero Creek was estimated to be 487ML/yr, 1,373ML/yr and 3,498ML/yr for dry, median and wet years respectively. This water drains directly to the creek system, and is not captured onsite.

- The volume of water discharged to Nagero Creek from dirty water sediment basins was estimated to be 33ML/yr, 144ML/yr and 724ML/yr for dry, median and wet years respectively.

- The volume of water captured in dirty water sediment basins and pumped to MD3 for reuse onsite was estimated to be 75ML/yr, 222ML/yr and 304ML/yr for dry, median and wet years respectively.

- The total volume of water discharged to Nagero Creek was estimated to be 520ML/yr, 1,517ML/yr and 4,222ML/yr for dry, median and wet years respectively (including both clean and dirty water).

- The volume of contaminated water generated at the mine site was estimated to be 440ML/yr, 844ML/yr and 1,483ML/yr (including rainfall runoff, groundwater inflows to the mining void and dirty water pumped to MD3 for reuse). These volumes are higher than those for Year 1, which may be attributed to the increase in catchment area contributing to the contaminated water system, the increase in groundwater inflows into the mining void, and the reuse of dirty water runoff from the spoil catchments.

- Contaminated water deficits of 886ML/yr and 503ML/yr were estimated for dry and median years respectively. A contaminated water surplus of 42ML/yr was estimated for a wet year. The higher contaminated water deficits during Year 5 may be attributed to the dust suppression and washery make-up water demands increasing significantly above Year 1 levels. A total of 944ML/yr, 561ML/yr, 58ML/yr would be required from external sources for dry, median and wet years respectively including the minimum requirement of 58ML/yr for potable water and vehicle washdown.

- The reason for the contaminated water surplus of 42ML during a wet rainfall year is that dirty water is captured and pumped to MD3 for onsite reuse. If dirty water was not pumped to MD3 for reuse, there would be a water deficit during a wet rainfall year.

- Assuming full allocation for the groundwater licenses, but zero allocation for the general security and supplementary surface water licenses during a dry year, it can be expected that the total water available from existing licences held by Boggabri Coal would be in the order of 194ML/yr for a dry year. This would not be adequate to make-up the estimated contaminated water deficit during dry and median years.

Boggabri Coal will need to secure water from external sources to makeup the predicted deficit for dust suppression and washery demands, as well as supply water to meet potable water and vehicle washdown demands. For a dry year (i.e. 10^{th} percentile rainfall year), 886ML/yr is required from external sources to meet dust suppression and washery demands. An additional 58ML/yr is required from external sources to meet potable water and vehicle washdown demands. This is a total water requirement of 944ML/yr from external sources for the Year 5 landform.

Options available to cater for an onsite contaminated water deficit are discussed in Section 7.2.1.

5.5.3 Year 10 landform

A plot showing the relationship between annual rainfall depths and annual contaminated water surpluses / deficits is provided in Figure 5-14 for the Year 10 landform. The plot is based on 109 years of rainfall and evaporation data. Note that the plot does not allow for carryover of water surpluses / deficits from previous years.

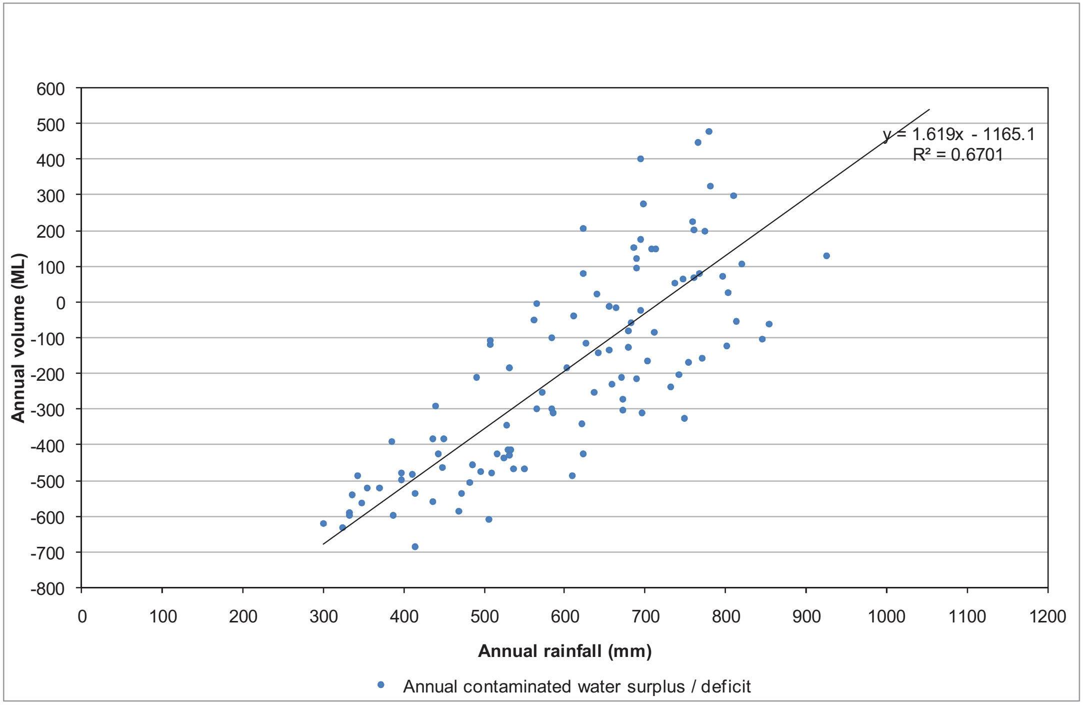


Figure 5-14 Annual rainfall versus estimated annual contaminated water deficit / surplus for Year 10 based on 109 years of rainfall data

From Figure 5-14 it can be seen that both annual contaminated water surpluses and deficits were estimated during the 109 years water balance model simulation for the Year 10 landform. The data scatter on the plot may be attributed to the inter-relationship of the annual volume of contaminated runoff to the distribution of rainfall throughout the year, total rainfall and soil wetness / dryness.

The trend line on Figure 5-14 shows that an annual contaminated water surplus will typically occur on years when the annual rainfall depth exceeded approximately 720mm. The annual contaminated water surplus did not exceed the out-of-pit storage capacity of 988ML during the 109 year simulation assuming that these storages are empty at the start of the year.

A water balance is provided in Table 5-12 for the Year 10 landform. The water balance is provided for the 10th percentile (dry), 50th percentile (median) and 90th percentile (wet) rainfall years. Note that the balance does not allow for carryover of water surpluses / deficits from previous years.

Table 5-12 Water balance results for Year 10 landform

Element	Dry year (1940) Input (ML/yr)	Dry year (1940) Output (ML/yr)	Median year (1905) Input (ML/yr)	Median year (1905) Output (ML/yr)	Wet year (1977) Input (ML/yr)	Wet year (1977) Output (ML/yr)	Source of information
Clean							
Runoff	431		1,216		3,098		Calculated from model
Site discharge		431		1,216		3,098	Calculated from model
Total	**431**	**431**	**1,216**	**1,216**	**3,098**	**3,098**	
Balance	**0**		**0**		**0**		
Dirty							
Runoff	203		593		1,580		Calculated from model
Evaporation		40		49		61	Calculated from model
Site discharge		36		245		1,211	Calculated from model
Dirty water pumped to MD3 for reuse		126		302		343	Calculated from model
Total	**203**	**202**	**593**	**596**	**1,580**	**1,615**	
Balance	**+1**		**-3**		**-35**		
Contaminated							
Dirty water pumped to MD3 for reuse	126		302		343		Calculated from model
Runoff	121		369		864		Calculated from model
Evaporation		80		122		218	Calculated from model
Groundwater inflow to pit	342		342		342		Groundwater Consultant
Washery		513		513		513	Boggabri Coal
Dust suppression		493		493		493	Boggabri Coal
Potable water		38		38		38	Boggabri Coal
Vehicle washdown		20		20		20	Boggabri Coal
Groundwater allocations ^	58		58		58		PB estimate
Total	**647**	**1,144**	**1,013**	**1,186**	**1,607**	**1,282**	
Balance	**-497**		**-173**		**+325**		

Note. ^ A minimum groundwater allocation of 58ML/yr is required to meet vehicle washdown and potable water demands. The water balance assumes no supply of water from the available groundwater and surface water licences or other external sources with the exception of this 58 ML/yr.

The imbalance in the dirty water system can be attributed to carry over storage in dirty water sediment basins between the various calendar years of the water balance simulation.

The results in Table 5-12 show that for Year 10:

- The volume of clean water discharged directly to Nagero Creek was estimated to be 431ML/yr, 1,216ML/yr and 3,098ML/yr for dry, median and wet years respectively. This water drains directly to the creek system, and is not captured onsite.
- The volume of water discharged to Nagero Creek from dirty water sediment basins was estimated to be 36ML/yr, 245ML/yr and 1,211ML/yr for dry, median and wet years respectively.
- The volume of water captured in dirty water sediment basins and pumped to MD3 for reuse onsite was estimated to be 126ML/yr, 302ML/yr and 343ML/yr for dry, median and wet years respectively.
- The total volume of water discharged to Nagero Creek was estimated to be 467ML/yr, 1,461ML/yr and 4,309L/yr for dry, median and wet years respectively (including both clean and dirty water).
- The volume of contaminated water generated at the mine site was estimated to be 589ML/yr, 1,013ML/yr and 1,549ML/yr (including rainfall runoff, groundwater inflows to the mining void and dirty water pumped to MD3 for reuse).
- A contaminated water deficit of 497ML/yr and 173ML/yr was estimated for dry and median years, respectively. A contaminated water surplus of 325ML was estimated for a wet year. The deficit for a dry year is lower than Year 5, which may be attributed to the decline in dust suppression and washery make-up water demands between Year 5 and Year 10. A total of 537ML/yr, 231ML/yr, 58ML/yr would be required from external sources for dry, median and wet years respectively including the minimum requirement of 58ML/yr for potable water and vehicle washdown.
- The reason for the contaminated water surplus of 325ML during a wet rainfall year is that dirty water is captured and pumped to MD3 for onsite reuse. If dirty water was not pumped to MD3 for reuse, there would be a small water deficit during a wet rainfall year.
- Assuming full allocation for the groundwater licenses, but zero allocation for the general security and supplementary surface water licenses for a dry year, it can be expected that the total water available from existing licences held by Boggabri Coal would be in the order of 194ML/yr for a dry year. This would not be adequate to make-up the estimated contaminated water deficit during a dry year.

Options available to cater for an onsite contaminated water deficit are discussed in Section 7.2.1.

5.5.4 Year 21 landform

A plot showing the relationship between annual rainfall depths and annual contaminated water surpluses / deficits is provided in Figure 5-15 for the Year 21 landform. The plot is based on 109 years of rainfall and evaporation data. Note that the plot does not allow for carryover of water surpluses / deficits from previous years.

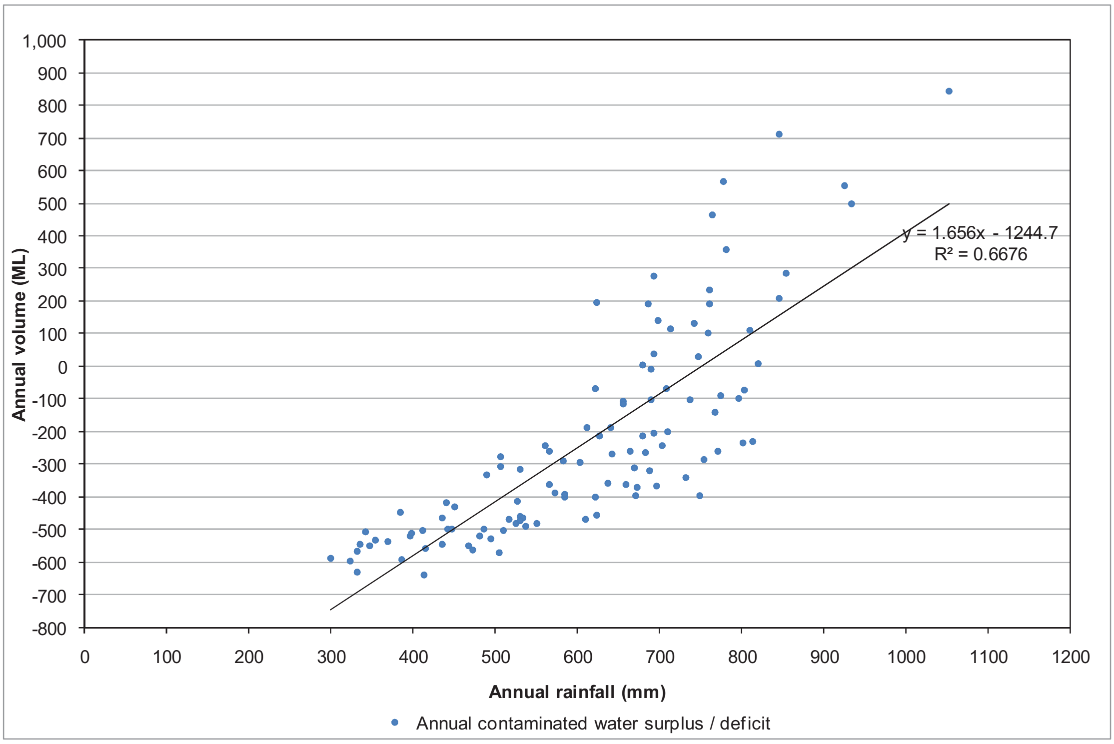


Figure 5-15 Annual rainfall versus estimated annual contaminated water deficit / surplus for Year 21 based on 109 years of rainfall data

From Figure 5-15 it can be seen that both annual contaminated water surpluses and deficits were estimated during the 109 years water balance model simulation for the Year 21 landform. The data scatter on the plot may be attributed to the inter-relationship of the annual volume of contaminated runoff to the distribution of rainfall throughout the year, total rainfall and soil wetness / dryness.

The trend line on Figure 5-15 shows that an annual contaminated water surplus will typically occur on years when the annual rainfall depth exceeds approximately 750mm. The annual contaminated water surplus did not exceed the out-of-pit storage capacity of 988ML during the 109 year simulation assuming that these storages are empty at the start of the year.

A water balance is provided in Table 5-12 for the Year 21 landform. The water balance is provided for the 10th percentile (dry), 50th percentile (median) and 90th percentile (wet) rainfall years. Note that the balance does not allow for carryover of water surpluses / deficits from previous years.

Table 5-13 Water balance results for Year 21 landform

Element	Dry year (1940)		Median year (1905)		Wet year (1977)		Source of information
	Input (ML/yr)	Output (ML/yr)	Input (ML/yr)	Output (ML/yr)	Input (ML/yr)	Output (ML/yr)	
Clean							
Runoff	466		1,314		3,348		Calculated from model
Site discharge		466		1,314		3,348	Calculated from model
Total	**466**	**466**	**1,314**	**1,314**	**3,348**	**3,348**	
Balance	**0**		**0**		**0**		
Dirty							
Runoff	154		446		1,158		Calculated from model
Evaporation		59		73		73	Calculated from model
Site discharge		95		376		1,093	Calculated from model
Total	**154**	**154**	**446**	**449**	**1,158**	**1,166**	
Balance	**0**		**-3**		**-8**		
Contaminated							
Runoff	141		441		1,035		Calculated from model
Recycling of irrigation area runoff	18		54		139		Calculated from model
Evaporation		72		102		210	Calculated from model
Groundwater inflow to pit	410		410		410		Groundwater Consultant
Washery		513		513		513	Boggabri Coal
Dust suppression		504		504		504	Boggabri Coal
Potable water		38		38		38	Boggabri Coal
Vehicle washdown		20		20		20	Boggabri Coal
Groundwater allocations ^	58		58		58		PB estimate
Total	**627**	**1,147**	**963**	**1,177**	**1,642**	**1,285**	
Balance	**-520**		**-214**		**+357**		

Note. ^ A minimum groundwater allocation of 58ML/yr is required to meet vehicle washdown and potable water demands. The water balance assumes no supply of water from the available groundwater and surface water licences or other external sources with the exception of this 58 ML/yr.

The imbalance in the dirty water system can be attributed to carry over storage in dirty water sediment basins between the various calendar years of the water balance simulation.

The results in Table 5-12 show that for Year 21:

- The volume of clean water discharged directly to Nagero Creek was estimated to be 466ML/yr, 1,314ML/yr and 3,348ML/yr for dry, median and wet years respectively. This water drains directly to the creek system, and is not captured onsite.
- The volume of water discharged to Nagero Creek from dirty water sediment basins was estimated to be 95ML/yr, 376ML/yr and 1,093ML/yr for dry, median and wet years respectively. Onsite reuse of dirty water is not proposed during Year 21.
- The total volume of water discharged to Nagero Creek was estimated to be 561ML/yr, 1,690ML/yr and 4,441ML/yr for dry, median and wet years respectively (including both clean and dirty water).
- The volume of contaminated water generated at the mine site was estimated to be 569ML/yr, 905ML/yr and 1,584ML/yr (including rainfall runoff, groundwater inflows to the mining void and recirculation of irrigation area runoff).
- A contaminated water deficit of 520ML/yr and 214ML/yr was estimated for dry and median years, respectively. A contaminated water surplus of 357ML/yr was estimated for a wet year. A total of 578ML/yr, 272ML/yr, 58ML/yr would be required from external sources for dry, median and wet years respectively including the minimum requirement of 58ML/yr for potable water and vehicle washdown.
- Assuming full allocation for the groundwater licenses, but zero allocation for the general security and supplementary surface water licenses for a dry year, it can be expected that the total water available from existing licences held by Boggabri Coal would be in the order of 194ML/yr for a dry year. This would not be adequate to make-up the estimated contaminated water deficit during a dry year.
- The estimated contaminated water surplus for a wet year exceeds the average capacity of the approved irrigation system of 318ML/yr based on utilisation of 53ha of irrigation area.

Options available to cater for onsite contaminated water deficits and surpluses are discussed in Section 7.2.1 and Section 7.2.2 respectively.

6. Local catchment hydrological analysis

A hydrological analysis has been undertaken for the Boggabri Coal Mine local catchment. The main purpose of the analysis was to assess the potential impact of the Project on peak flows in the local catchment. The analysis was also used for preliminary sizing of diversion drains.

The hydrological model was built using XPSWMM software. The model was built for the following landforms:

- **Year 1** landform
- **Year 5** landform
- **Year 10** landform
- **Year 21** landform.

Details of the hydrological analysis are provided below.

6.1 Methodology

6.1.1 XPSWMM hydrologic model

The hydrodynamic model XPSWMM (version 10.6) was used for the hydrologic analysis. XPSWMM is a graphics based stormwater computer model that utilises a proprietary self-modifying dynamic wave solution algorithm to adjust time steps when appropriate. The 'RUNOFF' mode of the model allows for hydrology generation and the 'HYDRAULICS' mode allows hydraulic simulation of open and closed conduits, including detention basins.

Hydrology

Design rainfall for the 5, 20 and 100 year ARI storm events was generated using Australian Rainfall and Runoff (AR&R) Volumes 1 (2001) and 2 (1987). The RUNOFF mode of XPSWMM was used to estimate runoff hydrographs for these storm events from the corresponding design rainfall inputs.

In the absence of long-term stream flow data, calibration of the XPSWMM model was not undertaken. Instead, peak flows estimated by the XPSWMM model were compared to those estimated by the Probabilistic Rational Method as described in Australian Rainfall & Runoff (AR&R) (1987).

Hydraulics

The HYDRAULICS mode in XPSWMM was used to route the runoff hydrographs through the water management system. The Laurenson Non-Linear Runoff Routing method was adopted.

Sediment basins have been represented in the XPSWMM model as storage nodes. However, other hydraulic structures within the site (such as culverts) have not been included in the XPSWMM model.

Sediment basins from the northern spoil dump at the adjacent Tarrawonga Coal Mine have also been included in the model.

6.1.2 Model parameters

Hydrological parameters

Infiltration losses have been estimated in the XPSWMM model using the Horton Loss model in the initial loss / continuing loss mode. Loss parameters adopted for the various landuse types are provided in Table 6-1.

Table 6-1 Infiltration parameters adopted in XPSWMM model

	Landuse					
Parameter	**Undisturbed**	**Industrial / roads**	**Rehabilitated spoil dump**	**Unshaped spoil dump**	**Mining void**	**Pre-strip**
Impervious area Manning's n	0.014	0.014	0.014	0.014	0.014	0.014
Pervious area Manning's n	0.1	0.03	0.03	0.02	0.02	0.03
Pervious area initial loss (mm)	20	20	20	10	2.5	20
Pervious area continuing loss (mm/hr)	2.5	2.5	2.5	1	0.5	1.5
Catchment imperviousness (%)	0	90	0	0	0	0

Hydraulic parameters

A manning's roughness of 0.035 has been adopted in the XPSWMM model for diversion drains.

A free outfall was adopted in the XPSWMM model as the downstream boundary condition.

6.1.3 Model assumptions

The following assumptions were made in the hydrological analysis:

- The model was run for the Year 1, 5, 10 and 21 landforms. No allowance has been made for changes in catchment areas or landuse types between these landforms.
- Low flow discharge pipes from dirty water sediment dams are assumed to remain open. Low flow discharge pipes have been represented in the model as pipes, sized so that the dams empty over a 3 day period. The only exception is SD3, SD7, SD13 in Years 5 and 10 when dirty water is reused and low flow outlets from dirty water sediment dams remain closed through the simulation.
- Pumps between sediment dams and mine water dams are assumed to remain off.
- It has been assumed that the 'sediment zone' of sediment dams is half full of sediment.
- Hydraulic structures, such as culverts, have not been included in the model.

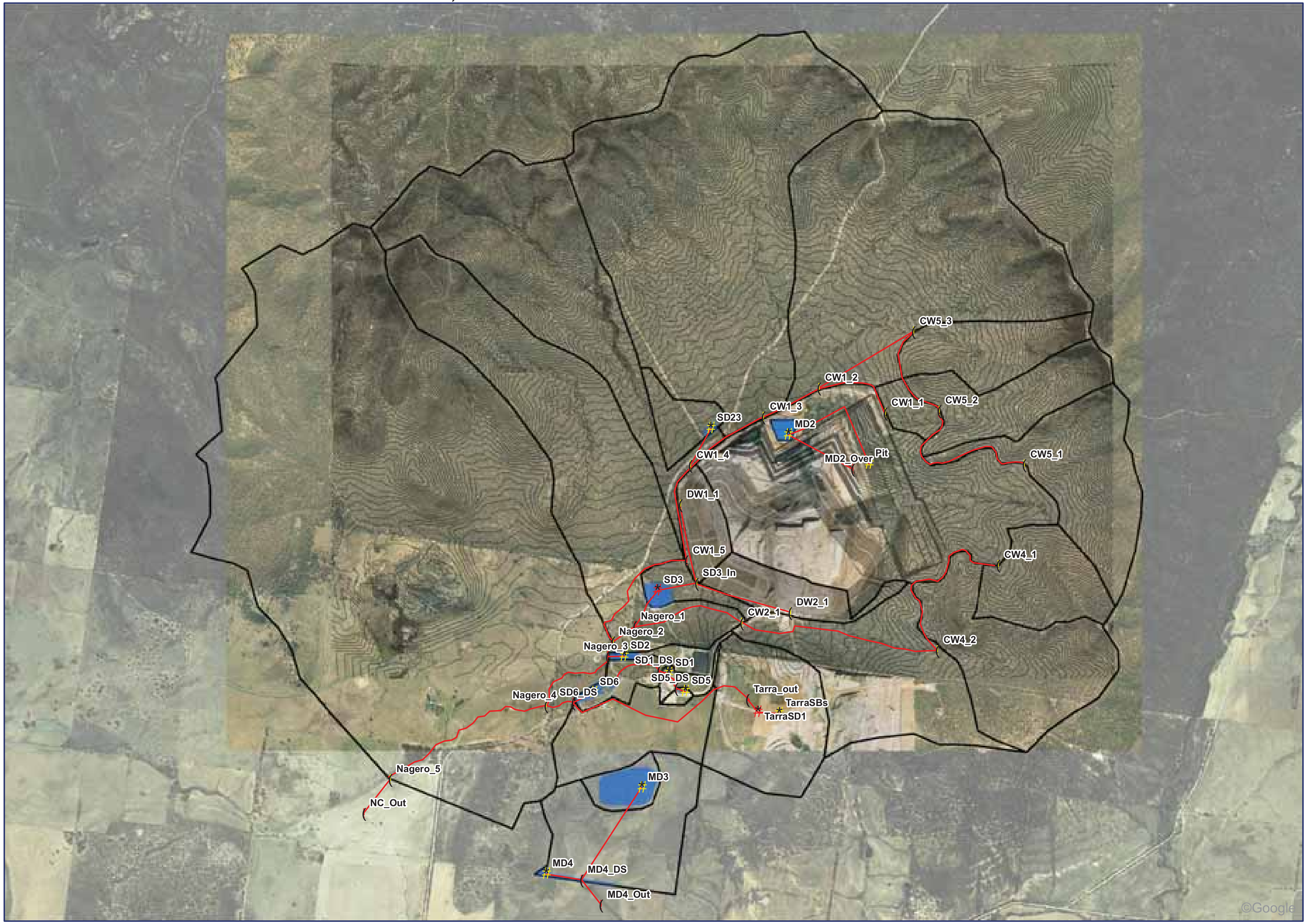
6.1.4 Model schematisation

Schematics of the XPSWMM hydrologic model are provided in Figure 6-1, Figure 6-2, Figure 6-3 and Figure 6-4 for Year 1, 5, 10 and 21, respectively. The schematics show the network of links and nodes in the model, as well as catchment boundaries.

6.1.5 Catchments

Catchment areas adopted in the XPSWMM hydrologic model are provided in Appendix D. Catchment parameters, such as percentage imperviousness and slope, are also provided in Appendix C.

CLIENT: HANSEN BAILEY PTY LTD
PROJECT: CONTINUATION OF BOGGABRI COAL MINE, SURFACE WATER ASSESSMENT



PARSONS BRINCKERHOFF

Legend

Year 1 XPSWMM Nodes

- Hydraulic node
- Runoff node / storage
- Runoff node
- Hydraulic node / stoarge

Year 1 XPSWMM Links

- Link

Year 1 Storages

- Water storages

Year 1 Catchments

- Year 1 Catchments

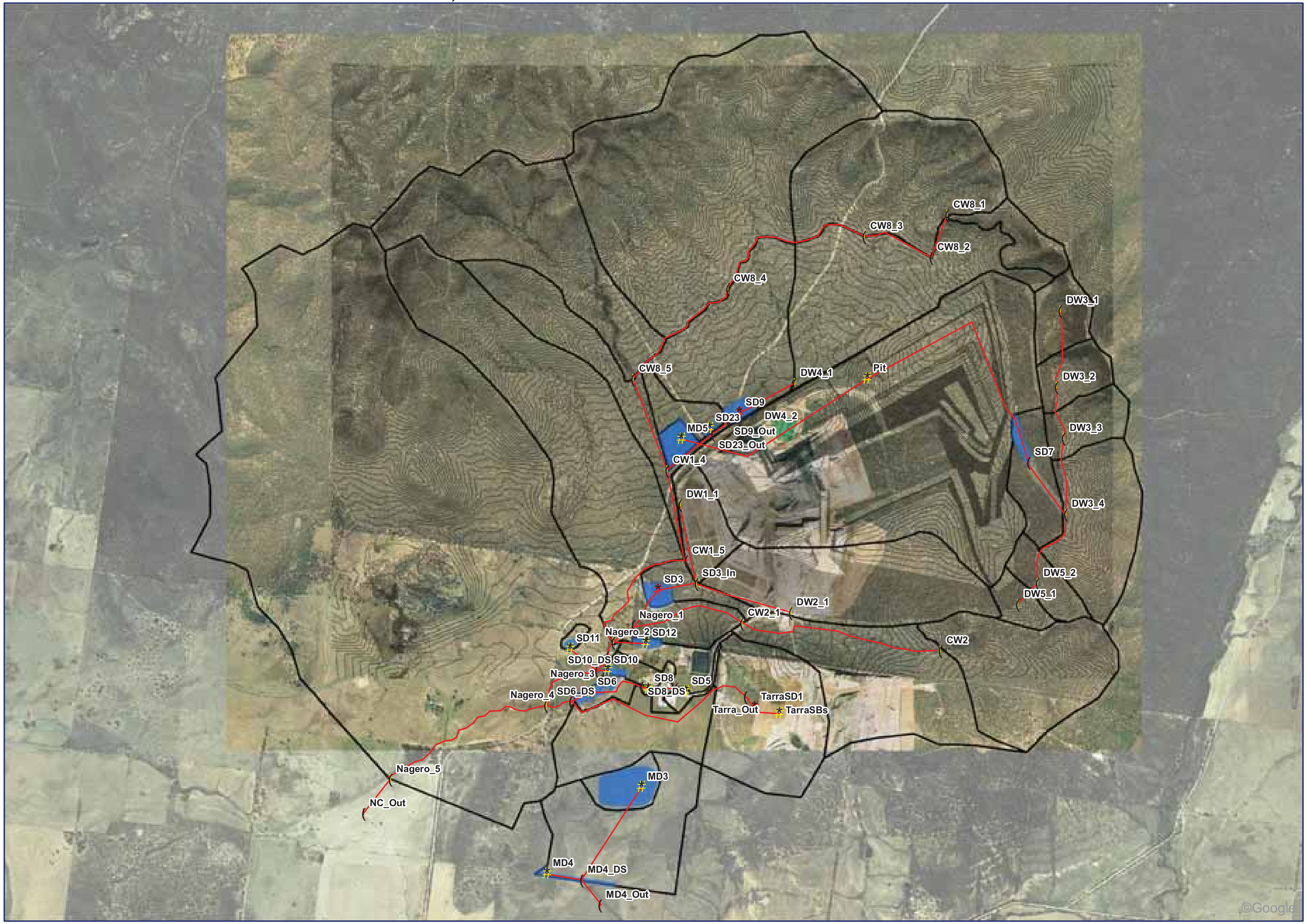
0 0.5 1
Kilometers

GDA 1994 MGA Zone 56

\\AUNCLF\proj\H\Hansen_Bailey\2123173_EMA_BOGGABRI_COAL_EA\05_WrkPapers\GIS\Output\Maps LT

FIGURE 6-1 XPSWMM HYDROLOGIC MODEL NETWORK - YEAR 1

CLIENT: HANSEN BAILEY PTY LTD
PROJECT: CONTINUATION OF BOGGABRI COAL MINE, SURFACE WATER ASSESSMENT



PARSONS BRINCKERHOFF

Legend

Year 5 XPSWMM Nodes

- Hydraulic node / storage
- Hydraulic node
- Runoff node / storage
- Runoff node
- Year 5 XPSWMM Links

Year 5 Storages

- Year 5 Storages

Year 5 Catchments

- Year 5 Catchments

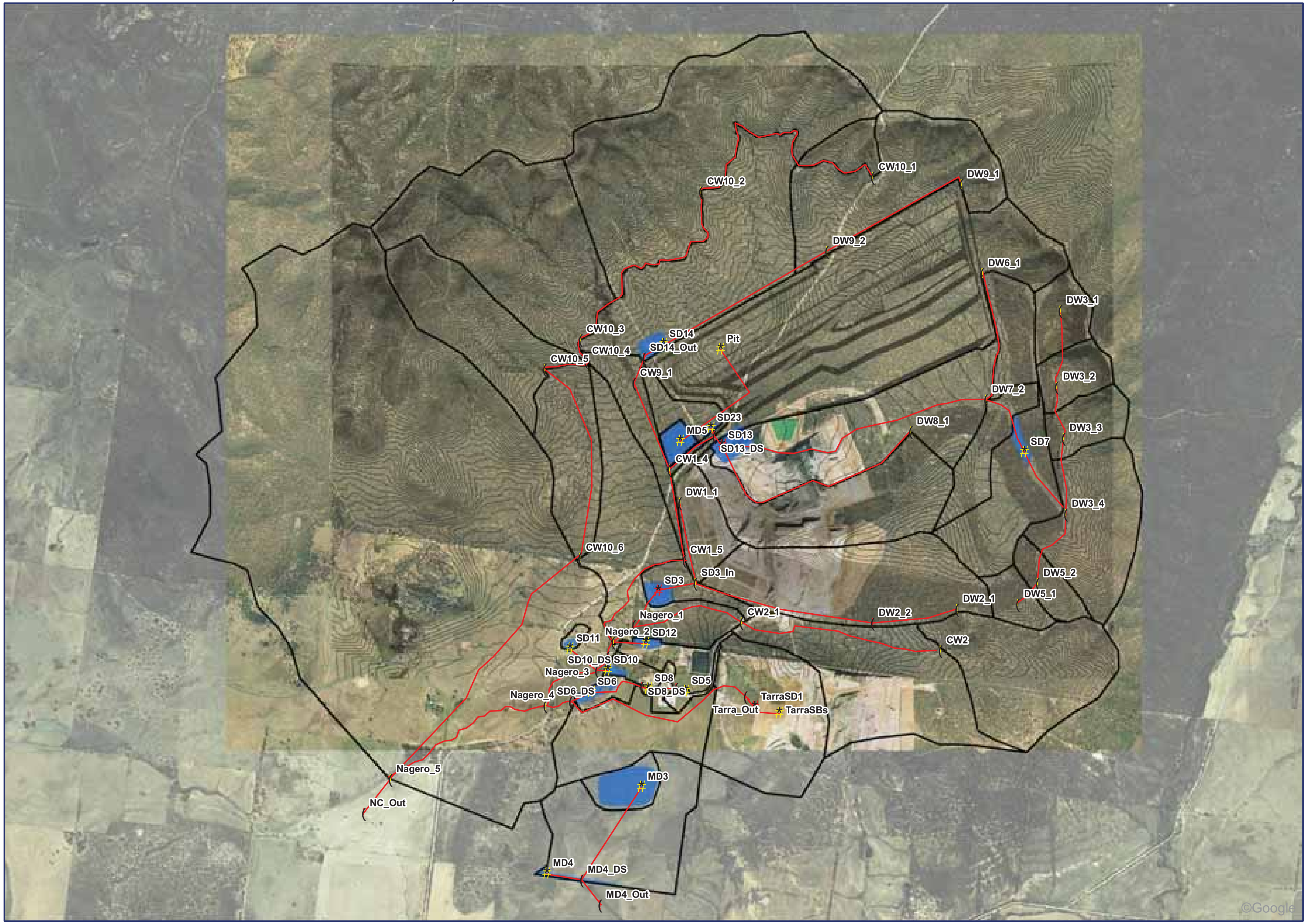
0 0.5 1
Kilometers

GDA 1994 MGA Zone 56

FIGURE 6-2 XPSWMM HYDROLOGIC MODEL NETWORK - YEAR 5

\\AUNCLF\proj\H\Hansen_Bailey\2123173_EMA_BOGGABRI_COAL_EA\05_WrkPapers\GIS\Output\Maps LT

CLIENT: HANSEN BAILEY PTY LTD
PROJECT: CONTINUATION OF BOGGABRI COAL MINE, SURFACE WATER ASSESSMENT



PARSONS BRINCKERHOFF

Legend

Year 10 XPSWMM Nodes
- Hydraulic node/ storage
- Runoff node/ storage
- Hydraulic node
- Runoff node

Year 10 XPSWMM Links
- Link

Year 10 Catchments
- Year 10 Catchments

Year 10 Storages
- Year 10 Storages

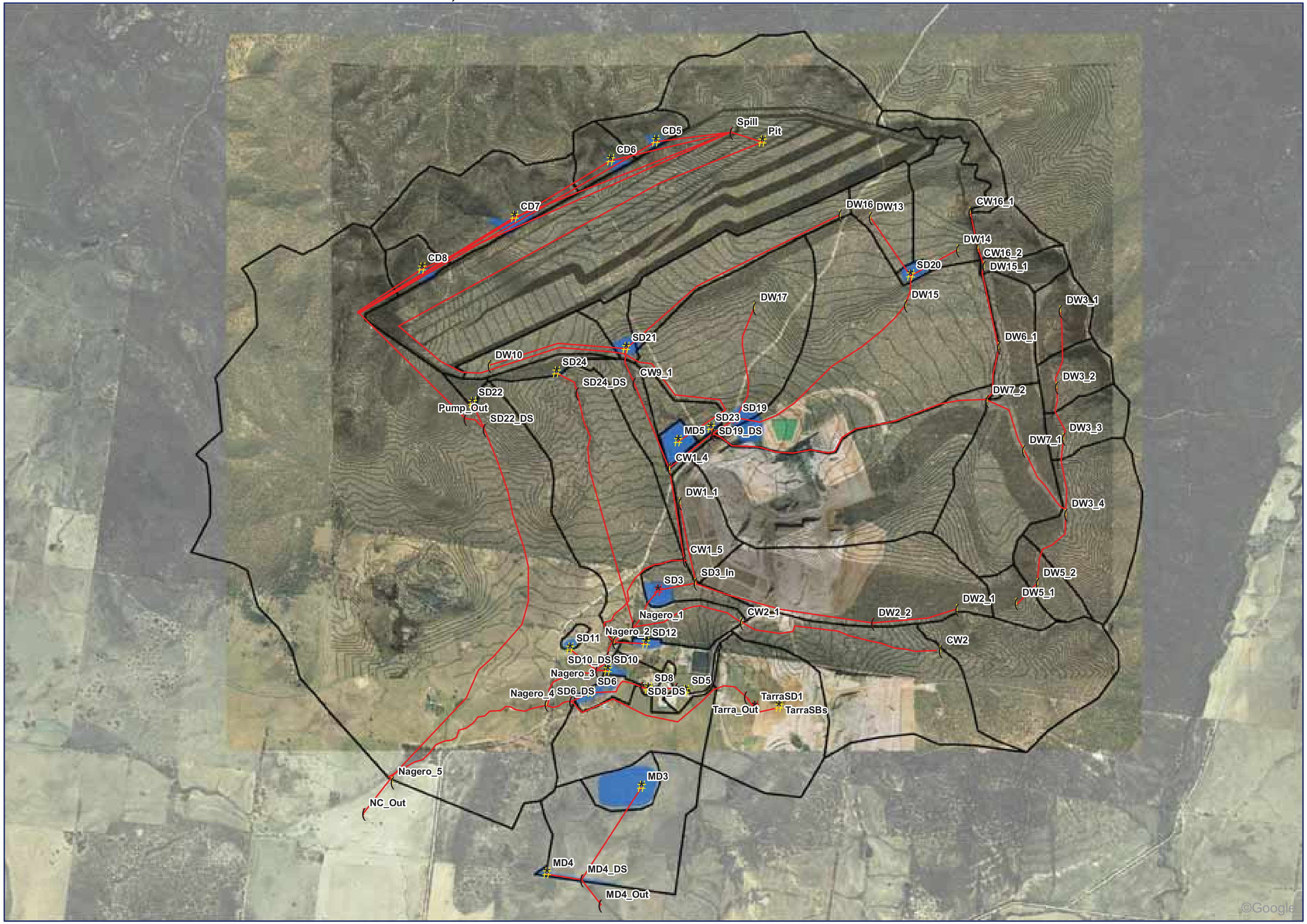
0 0.5 1
Kilometers

GDA 1994 MGA Zone 56

FIGURE 6-3 XPSWMM HYDROLOGIC MODEL NETWORK - YEAR 10

\\AUNCLF\proj\H\Hansen_Bailey\2123173_EMA_BOGGABRI_COAL_EA\05_WrkPapers\GIS\Output\Maps LT

CLIENT: HANSEN BAILEY PTY LTD
PROJECT: CONTINUATION OF BOGGABRI COAL MINE, SURFACE WATER ASSESSMENT



Legend

Year 21 XPSWMM Nodes
- Hydraulic node / storage
- Hydraulic node
- Runoff node / storage
- Runoff node

Year 21 XPSWMM Links
- Link

Year 21 Catchments
- Year 21 Catchments

Year 21 Storages
- Year 21 Storages

0 0.5 1
Kilometers

GDA 1994 MGA Zone 56

FIGURE 6-4 XPSWMM HYDROLOGIC MODEL NETWORK - YEAR 21

\\AUNCLF\proj\H\Hansen_Bailey\2123173_EMA_BOGGABRI_COAL_EA\05_WrkPapers\GIS\Output\Maps LT

6.2 Results

The XPSWMM hydrologic model of the local catchment was run for the 5, 20 and 100 year ARI design storm events (for various storm durations). A summary of the results for Year 1, 5, 10 and 21 is provided in the following sections.

6.2.1 Year 1 landform

A summary of the peak flow rates at key locations in the local catchment is provided in Table 6-2 for Year 1.

Table 6-2 Peak flow rates at key locations for Year 1 landform

XPSWMM Node	Location	Peak flow (m^3/s)		
		5yr ARI	20yr ARI	100yr ARI
Nagero_1	Nagero Creek downstream of SD3	7.8	15.2	24.2
Nagero_3	Nagero Creek downstream of SD2	40.0	79.7	126.5
Nagero_4	Nagero Creek downstream of SD6	40.0	83.4	135.3
Nagero_5	Nagero Creek at outlet	53.4	111.1	177.6

The critical storm duration was typically between 1 and 3 hours for steep bushland areas in the upper catchment, and for the steep areas of spoil dump. The critical storm duration for Nagero Creek at the catchment outlet was typically between 36 and 72 hours, which may be attributed to flatter slopes in the lower catchment, as well as the attenuation affect of sediment dams.

From Table 6-2 it can be seen that the estimated peak flow at the catchment outlet is approximately $53m^3/s$, $111m^3/s$ and $178m^3/s$ for the 5, 20 and 100 year ARI storm events respectively. This is the location where Nagero Creek meets the Namoi River floodplain, approximately 1km downstream of the Project Boundary.

6.2.2 Year 5 landform

A summary of the peak flow rates at key locations in the local catchment is provided in Table 6-3 for Year 5.

Table 6-3 Peak flow rates at key locations for Year 5 landform

XPSWMM Node	Location	Peak flow (m^3/s)		
		5yr ARI	20yr ARI	100yr ARI
Nagero_1	Nagero Creek downstream of SD3	5.6	10.1	16.6
Nagero_3	Nagero Creek downstream of SD10, SD11 and SD12	30.4	58.8	101.9
Nagero_4	Nagero Creek downstream of SD6	33.0	63.9	110.5
Nagero_5	Nagero Creek at outlet	47.3	91.6	152.8

As for the Year 1 analysis, the critical storm duration was typically 1 to 3 hours for steep areas in the spoil dump and upper catchment, and 36 to 72 hours for Nagero Creek at the catchment outlet.

From Table 6-3 it can be seen that the estimated peak flow at the catchment outlet is approximately 47m^3/s, 92m^3/s and 153m^3/s for the 5, 20 and 100 year ARI storm events respectively.

6.2.3 Year 10 landform

A summary of the peak flow rates at key locations in the local catchment is provided in Table 6-4 for Year 10.

Table 6-4 Peak flow rates at key locations for Year 10 landform

		Peak flow (m^3/s)		
XPSWMM Node	**Location**	**5yr ARI**	**20yr ARI**	**100yr ARI**
Nagero_1	Nagero Creek downstream of SD3	5.6	10.1	16.1
Nagero_3	Nagero Creek downstream of SD10, SD11 and SD12	9.6	25.7	61.5
Nagero_4	Nagero Creek downstream of SD6	13.0	32.2	68.1
Nagero_5	Nagero Creek at outlet	37.3	81.3	137.0

As for the Year 1 and Year 5 analyses, the critical storm duration was typically 1 to 3 hours for steep areas in the spoil dump and upper catchment, and 36 to 72 hours for Nagero Creek at the catchment outlet.

From Table 6-4 it can be seen that the estimated peak flow at the catchment outlet is approximately 37m^3/s, 81m^3/s and 137m^3/s for the 5, 20 and 100 year ARI storm events respectively.

6.2.4 Year 21 landform

A summary of the peak flow rates at key locations in the local catchment is provided in Table 6-5 for Year 21.

Table 6-5 Peak flow rates at key locations for Year 21 landform

		Peak flow (m^3/s)		
XPSWMM Node	**Location**	**5yr ARI**	**20yr ARI**	**100yr ARI**
Nagero_1	Nagero Creek downstream of SD3	6.1	11.0	17.4
Nagero_3	Nagero Creek downstream of SD10, SD11 and SD12	31.1	55.8	100.4
Nagero_4	Nagero Creek downstream of SD6	31.6	56.5	94.1
Nagero_5	Nagero Creek at outlet	43.1	79.8	136.0

As for the Year 1, 5 and 10 analyses, the critical storm duration was typically 1 to 3 hours for steep areas in the spoil dump and upper catchment. However, the critical storm duration at nodes 'Naegro_3' and 'Nagero_4' decreased to 1 to 3hours as a result of the release of a large section of rehabilitated spoil directly to Nagero Creek. For previous landforms, runoff from this section of spoil was captured by dirty water sediment dams.

From Table 6-5 it can be seen that the estimated peak flow at the catchment outlet is approximately 43m^3/s, 80m^3/s and 136m^3/s for the 5, 20 and 100 year ARI storm events respectively.

7. Potential impacts of Project on existing surface water environment

7.1 Water demand

The proposed water management system aims to reuse as much contaminated water onsite as possible. Contaminated water will be used as a priority to meet dust suppression and washery make-up water demands. Water from external sources will only be used to meet these demands when there is an onsite water deficit. As contaminated water is not suitable to meet vehicle washdown and potable water demands, this water will be sourced from external sources.

A summary of the estimated annual contaminated water surplus / deficit is provided in Table 7-1 for Year 1, 5, 10 and 21 landforms. A surplus occurs when the volume of contaminated water exceeds demands and is represented by a positive volume in Table 7-1. A deficit occurs when the volume of contaminated water is not adequate to meet demands and is represented by a negative volume in Table 7-1.

Table 7-1 Summary of estimated water contaminated surplus / deficit based on 109 years of rainfall data

Landform	Vehicle washdown / potable water demand (ML/yr)	Dust suppression / washery demand (ML/yr)	Contaminated water surplus / deficit (ML/yr) ^		
			Dry year (1940)	Median year (1905)	Wet year (1977)
Year 1	58	162	+8	+208	+545
Year 5	58	1,251	-886	-503	+42
Year 10	58	1,006	-497	-173	+325
Year 21	58	1,017	-520	-214	+357

Note. ^ Surpluses / deficits do not account for the supply of water from existing water entitlements held by Boggabri Coal.

A summary of the estimated volumes of water required from external sources is provided in Table 7-2 for the Year 1, 5, 10 and 21 landforms. Note that a minimum requirement of 58ML/yr is required from external sources to meet vehicle washdown and potable water demands throughout the life of the Project.

Table 7-2 Summary of external water requirements for a dry year (1940)

Landform	Contaminated water surplus / deficit (ML/yr)	External water requirement (ML/yr)	Current water entitlements (ML/yr)^	Requirement for additional water entitlements (ML/yr)
Year 1	+8	58	194	0
Year 5	-886	944	194	750
Year 10	-497	555	194	361
Year 21	-520	578	194	384

Note. ^ Entitlement from licenses currently held by Boggabri Coal is based on an assumed allocation of 1ML/yr/unit share for groundwater licenses and 0ML/yr /unit share for general security and supplementary surface water licenses during a dry year.

The water balance analysis indicates that the annual water surplus / deficit varies significantly throughout the life of the Project, and is highly dependent on rainfall throughout the year, total rainfall and soil wetness / dryness.

The highest contaminated water deficits were estimated for the Year 5 landform, when washery and dust suppression demands are at their greatest. For this landform, a total of 944ML/yr would be required from external sources for a dry rainfall year (including 886ML/yr for dust suppression and washery demands and a minimum requirement of 58ML/yr for potable water and vehicle washdown demands). Boggabri Coal has access to 194ML/yr from its existing groundwater licences and therefore the outstanding water deficit in a dry year will be 750ML as shown in Table 7-2.

Boggabri Coal currently holds licenses for 194 unit shares of groundwater from the Namoi Groundwater Source and 325.7 unit shares of surface water from the Namoi Regulated River Water Source. This is a total of 519.7 unit shares, or 519.7ML/yr assuming 100% allocation. However, the surface water licenses are ‘general security’ and ‘supplementary’ categories, so Available Water Determinations can be much less than the average long term extraction factors during extended dry periods. This was demonstrated during the four year period from 2004 to 2008, when Available Water Determinations announcements for general security licences in the Lower Namoi were set at zero for a period of 17 months between February 2006 and July 2007. When water was made available for general security licences, Available Water Determination announcements ranged from zero to a maximum of 0.117 ML per unit share in September 2005 (NSW Department of Water and Energy, 2009).

For the purposes of assessing the adequacy of existing licenses held by Boggabri Coal to meet demands for the Project during a dry year, zero allocation has been assumed for general security and supplementary surface water licenses. An allocation of 1ML/yr/unit share has been assumed for groundwater licenses. Based on these assumptions, a total allocation of 194ML/yr could be expected from existing licenses during a dry year. This would not be adequate to meet estimated water demands during a dry year for the Year 5, 10 and 21 landforms.

The highest surplus of 545ML/yr was estimated during a wet year for the Year 1 landform, when demands are low relative to other years. Demands are low for Year 1 as the washery is not yet operational and less land area (haul roads, stockpiles etc) requires spraying to suppress dust.

The average disposal rate for the approved system is estimated to be 318ML/yr based on an average irrigation rate of 6ML/ha/yr and utilisation of 53ha of the total 95ha irrigation area. This rate is not adequate to dispose of the estimated contaminated water surplus of 545ML/yr for a wet year for the Year 1 landform. An irrigation rate of 570ML/yr is proposed for the Project.

It may be possible to temporarily increase the irrigation rate to a maximum of 570ML/yr by utilising the full 95ha irrigation area. However, this maximum rate could not be maintained on a long term basis, as it does not allow for ‘spelling’ of the discrete irrigation areas. It is therefore likely that upgrades to the approved irrigation system will be required to achieve the proposed irrigation rate of 570ML/yr for the Project.

7.2 Water surplus / deficit options

7.2.1 Deficit

The following options, given in order of preference, are available to cater for an onsite contaminated water deficit:

1. Water sharing arrangements with the adjacent Tarrawonga Coal Mine. Boggabri Coal has a 30% ownership of Tarrawonga Coal Mine, and will continue to liaise with East Boggabri Joint Venture with regards to water sharing. Boggabri Coal will also liaise with any proposed adjacent future mine development.

2. Reduce water demand through operational efficiencies and new developing technologies.

3. Groundwater extraction using current licenses.

4. Surface water extraction using current licenses. New infrastructure will be needed to transfer water from the Namoi River to the site (i.e. dam and pump / pipeline system).

5. Obtain additional licenses in conjunction with property acquisition. Boggabri Coal is currently in negotiation with a number of neighbouring landholders over property acquisition, and it is likely that such acquisitions would result in Boggabri Coal acquiring or accessing associated water licenses.

6. Obtain additional licenses from the open water market.

7. Reduce coal washing and have a higher percentage of unwashed coal in product coal stream.

8. Reduce production.

It is likely that additional infrastructure will be required to transfer make-up water to the site, and to store an adequate supply of make-up water onsite. Typically, water supply to meet demands for 1 to 2 years should be stored onsite (i.e. 1,309ML to 2,618ML to meet peak demands during Year 5). The volume of water to be stored onsite will depend on the source of make-up water and reliability of supply.

As part of the ongoing site water management, the security of water supply will be reviewed and decisions to improve this security will be undertaken and coordinated / licensed with the appropriate parties and authorities.

A High Level Water Buying Assessment (Parsons Brinckerhoff, 2010) has been undertaken for the Project, and is provided in Appendix E. The high level assessment concluded that it is possible for Boggabri Coal to secure an additional 750ML/yr of water via the open water market to meet the estimated water deficit for a dry year during Year 5 of the Project.

7.2.2 Surplus

The following options, given in order of preference, are available to cater for an onsite contaminated water surplus:

1. Water sharing arrangements with the adjacent Tarrawonga Coal Mine and any proposed adjacent future mine development.
2. Utilisation by irrigation. It is likely that upgrades to the approved irrigation system will be required to achieve the proposed irrigation rate of 570ML/yr for the Project. The requirement for upgrades (such as the provision of additional crop area) should be determined based on detailed irrigation calculations, including consideration of long term soil hydraulic loading capacity and soil chemistry.
3. Temporary storage in pit voids (un-mined).
4. Temporary storage in pit voids (mined).
5. Construction of temporary mine water storage dams in advance of mining.

The requirement to upgrade the approved irrigation system should be reviewed in consultation with an irrigation specialist. The decision to implement any upgrade strategy will be undertaken and coordinated / licensed with the appropriate parties and authorities.

7.3 Local hydrology

7.3.1 Catchment area

The Project will result in modifications to the local catchment. The area of undisturbed (or rehabilitated) catchment draining to Nagero Creek will reduce over the life of the Project, as the area draining to the mine sites dirty and contaminated water management systems increases. A summary of catchment areas is provided in Table 7-3.

Table 7-3 Modifications to catchment breakdown over life of the Project

	Catchment area (ha)		
Landform	Clean water system	Dirty water system	Contaminated water system
Year 1	3,731	165	518
Year 5	2,911 (-22%)	819 (+396%)	684 (+32%)
Year 10	2,573 (-31%)	1,257 (+662%)	584 (+13%)
Year 21	2,782 (-25%)	924 (+460%)	709 (+37%)

Note. ^ Percentage change from Year 1 is given in brackets

7.3.2 Peak flow rates

A summary of estimated peak flow rates is provided in Table 7-4 for the Year 1, 5, 10 and 21 landforms where Nagero Creek meets the Namoi River floodplain, approximately 1km downstream of the Project Boundary.

Table 7-4 Summary of estimated peak flow rates at catchment outlet

	Peak flow rate (m^3/s)		
Landform	**5yr ARI**	**20yr ARI**	**100yr ARI**
Year 1	53	111	178
Year 5	47 (-11%)	92 (-17%)	153 (-14%)
Year 10	37 (-30%)	81 (-27%)	137 (-23%)
Year 21	43 (-19%)	80 (-28%)	136 (-24%)

Note. ^ Percentage change from Year 1 is given in brackets

The hydrologic analysis suggests that peak flow rates at the catchment outlet will reduce over the life of the Project.

The reduction in peak flow rates may be attributed to dirty runoff being captured in sediment dams and slowly released to Nagero Creek or reused on site, which attenuates peak flow rates. This affect generally increases over the life of the Project, as the catchment area contributing to the dirty water system generally increases. During Years 5 and 10, dirty water from the spoil dump catchment is reused onsite to supplement a water deficit and is not released to Nagero Creek. During extended wet periods when water is not required to supplement a deficit, dirty water may be released to Nagero Creek following settling of suspended solids in sediment dams and water quality testing.

The reduction in peak flow rates may also be attributed to contaminated runoff being stored onsite for reuse or disposed of via irrigation, rather than being discharged to Nagero Creek. This affect increases over the life of the Project, as the catchment area contributing to the contaminated water system generally increases.

The increase in 5 year ARI peak flows between Years 10 and 21 of the Project may be attributed to the release of runoff from a portion of the rehabilitated spoil dump directly to Nagero Creek in Year 21. This runoff was captured in a dirty water sediment dam in Year 10. The attenuation affect of sediment dams is greatest for small storm events. This is because for small storms events flows discharge slowly via a pipe (rather than spillway) and a greater portion of total catchment runoff is retained in the 'sediment zone'.

7.3.3 Runoff volumes

A summary of estimated annual runoff volumes is provided in Table 7-5 for the Year 1, 5, 10 and 21 landforms where Nagero Creek meets the Namoi River floodplain, approximately 1km downstream of the Project Boundary. Runoff to Nagero Creek includes clean water runoff that is diverted around the mine site, and discharges from sediment basins that capture dirty water runoff from disturbed areas.

Table 7-5 Summary of estimated annual runoff volumes at catchment outlet based on 109 years of rainfall data

Landform	Annual runoff volume (ML/yr) Dry year (1940)	Median year (1905)	Wet year (1977)
Year 1	631	1,812	4,644
Year 5	520 (-18%)	1,517 (-16%)	4,222 (-9%)
Year 10	467 (-26%)	1,461 (-19%)	4,309 (-7%)
Year 21	561 (-11%)	1,690 (-7%)	4,441 (-4%)

Note. ^ Percentage change from Year 1 is given in brackets

The water balance analysis suggests that annual runoff volumes in Nagero Creek at the catchment outlet will reduce over the life of the Project.

The reduction in annual runoff volumes may be attributed to dirty runoff being captured in sediment basins. Water stored in the 'settling zone' is slowly released to Nagero Creek. However, water stored in the 'sediment zone' is retained and evaporates over time, causing an overall reduction in the volume of runoff discharged to Nagero Creek. The largest percentage reduction in annual runoff volumes occurs for a dry year, which may be attributed to the volume of runoff captured in the 'sediment zone' being a larger proportion of total runoff during a dry year.

During Years 5 and 10, dirty water from the spoil dump catchment is reused onsite to supplement a water deficit and is not released to Nagero Creek except during large storm events. This is why reductions are greatest for Years 5 and 10. During Year 21, runoff from a portion of the rehabilitated spoil dump is released directly to Nagero Creek, which is the reason for the increase in runoff volumes compared to Years 5 and 10. Runoff from this portion of rehabilitated spoil dump is released directly to Nagero Creek for Year 21, as it is expected that the rehabilitation success criteria for this portion will have been achieved.

The reduction in annual runoff volumes may also be attributed to contaminated runoff being stored onsite for reuse or disposed of via irrigation, rather than discharged to Nagero Creek. This affect increases over the life of the Project, as the catchment area contributing to the contaminated water system generally increases.

The reduction in annual runoff volumes will result in a reduction in environmental flows in Nagero Creek downstream of the site. The maximum reduction will be experienced during Year 10 of the Project, when median stream flows can be expected to reduce by 19% at the point where Nagero Creek meets the floodplain.

The maximum annual median runoff volume reduction of 351ML/yr (or 19%) for Nagero Creek at the catchment outlet is approximately 0.039% of the mean annual stream flow for the Namoi River at Boggabri of 906,470ML/yr. As such the reduction in runoff volumes associated with the Project is not expected to have a significant impact on environmental flows in the Namoi River.

7.4 Water quality

Management strategies for topsoil stripping and handling, topsoil respreading, post disturbance regrading, erosion and sediment control, and seedbed preparation will be implemented during the construction, operation and rehabilitation phases to control the quality of runoff from the Project site. With the implementation of these strategies, mine infrastructure construction activities, both at the mining area and over and adjacent to the Namoi River along the rail spur and power line route, are not expected to significantly impact surface water quality.

The proposed water management system for the Project has been designed to segregate clean runoff, dirty runoff and contaminated water generated from rainfall events and mining operations.

Contaminated water is defined as runoff generated from coal stockpiles and the mining void, as well as groundwater inflows to the mining void. Key contaminants include suspended solids and soluble salts. Contaminated water will not be discharged to Nagero Creek, and will instead be stored onsite for reuse or disposed of via irrigation. It is therefore considered unlikely that this water will adversely impact surface water quality downstream of the site.

Dirty water is defined as runoff from disturbed areas within the mine site and includes runoff from the MIA, unshaped spoil dumps and haul roads. The key pollutant associated with dirty runoff is suspended solids. Dirty water sediment dams are proposed to capture this water and to encourage settling of suspended solids prior to release of water to Nagero Creek.

There is the potential for runoff from disturbed areas to have elevated acidity, salinity and dissolved metals as a result of leaching from overburden and coal reject materials. Reference has been made to the geochemical assessment (RGS, 2009) to assess the potential impact of leachate from these materials on water quality. The findings of the geochemical assessment (RGS, 2009) are provided in Section 2.6. Key findings relating to water quality are summarised again below:

- Most overburden materials will generate slightly alkaline and relatively low salinity runoff and seepage following surface exposure. The major ion chemistry of initial surface runoff and seepage from overburden materials is likely to be dominated by sodium, bicarbonate, chloride and sulphate.

- The concentration of dissolved metals in initial runoff and seepage from overburden materials is unlikely to present any significant environmental issues associated with surface and ground water quality as a result of the Project.

- Most potential coal reject materials will generate slightly alkaline and relatively low salinity runoff and seepage following surface exposure. The exception is potential coal reject material from the Braymont seam (and potentially the Jeralong seam) where PAF materials may generate acidic and more saline runoff and seepage.

- The major ion chemistry of initial surface runoff and seepage from potential coal reject materials is likely to be dominated by sodium, bicarbonate, chloride and sulphate, although for PAF materials, calcium and sulphate may become more dominant. For PAF materials, the initial concentration of soluble sulphate in runoff and seepage is expected to remain within the applied water quality guideline criterion (1,000mg/L), although further exposure to oxidising conditions could lead to increased soluble sulphate concentrations.

- The concentration of dissolved metals in initial runoff and seepage from potential coal reject materials is unlikely to present any significant environmental issues associated with surface and ground water quality as a result of the Project.

Based on the findings of the geochemical assessment (RGS, 2009), it is considered unlikely that leachate generated from overburden and coal reject materials would significantly impact surface water quality downstream of the site if these materials are managed carefully. Management measures are outlined in the geochemical assessment (RGS, 2009). Nonetheless, there is still the potential for elevated acidity, salinity and dissolved metals in runoff from the spoil dump. Manually operated valves will be provided on the low flow outlets of all dirty water sediment dams so that discharge to Nagero Creek can be prevented if water quality is not suitable.

7.5 Downstream water users

Median runoff volumes can be expected to reduce by 16%, 19% and 7% at the point where Nagero Creek meets the floodplain for the Year 5, 10 and 21 landforms respectively as a result of the Project (compared to a runoff volume of 1,812ML/yr for the Year 1 landform). The reduction in runoff volumes in Nagero Creek will result in a reduction in the volume of water available to downstream water users, including properties along Therribri Road, Manilla Road and Leard Forest Road that currently use this water to fill farm dams and for stock watering.

During high flow events, water from the Nagero Creek catchment overtops a crest on the floodplain and flows south into the Bollol Creek catchment. This water is currently captured in farm dams on several properties located to the south of the Project Boundary. The volume of flows from the Nagero Creek catchment that overtop and flow south into the Bollol Creek catchment, as well as the frequency of overtopping, can be expected to decrease as a result of the Project.

It should be noted that this decrease will be for a relatively short duration whilst mining occurs. At the completion of mining, runoff volumes to Nagero Creek are expected to be similar to pre mining conditions. There will be some reduction in runoff volumes as the final void catchment will retain some water. Details of the post mining landform are provided in Section 8.

7.6 Cumulative impacts

The only other existing coal mine in the vicinity of Boggabri Coal Mine is Tarrawonga Coal Mine. The existing Tarrawonga Coal Mine has been considered in this surface water assessment.

During the course of this surface water assessment, information has become available on a proposed modification to the existing Tarrawonga Coal Mine. An assessment of potential cumulative impacts associated with the proposed Tarrawonga Modification is provided below.

Information, however limited, has also become available on other possible coal mining projects in the vicinity of Boggabri Coal Mine. An assessment of worst case cumulative impacts associated with these other projects is provided in Appendix F.

7.6.1 Tarrawonga Modification

The Tarrawonga Modification is a proposed modification to the existing Tarrawonga Coal Mine. An Environmental Assessment for the Tarrawonga Modification was put on public display by the Department of Planning in April 2010.

The proposed Tarrawonga Modification would involve the extension of the approved open cut boundary up to approximately 600m further east within the Tarrawonga mining lease (ML 1579). The additional land disturbance associated with the open cut extension would be approximately 38ha (Tarrawonga Coal Mine Modification Environmental Assessment, April 2010).

The approved Tarrawonga Coal Mine drains to Nagero, Bollol and Goonbri Creeks, which are all tributaries of the Namoi River. The proposed Tarrawonga Modification would result in a reduction in the Nagero Creek catchment of approximately 30ha and a reduction in the Bollol Creek catchment area of approximately 20ha compared to that for the approved Tarrawonga Coal Mine. There would be virtually no change to the Goonbri Creek catchment (Tarrawonga Coal Mine Modification Surface Water Assessment, March 2010).

Based on a runoff rate of 0.5ML/ha/yr for a median rainfall year for undisturbed catchment areas, a 30ha reduction in catchment area could be expected to result in a 15ML/yr reduction in median runoff volumes to Nagero Creek.

As discussed in Section 7.3.3, the Continuation of Boggabri Coal Mine project will result in a peak reduction in median runoff volumes to Nagero Creek of approximately 351ML/yr. The Tarrawonga Modification would result in a reduction in runoff to the Nagero catchment of approximately 15 ML/yr. The additional reduction associated with the Tarrawonga Modification is not considered significant in the context of the overall reduction.

All discharges from the Tarrawonga Modification water management system would occur from a licensed discharge point in accordance with relevant Environment Protection License discharge criteria. As such, there is unlikely to be any adverse cumulative impacts associated with water quality in Nagero Creek or the Namoi River from mining activities.

Following completion of mining and rehabilitation, drainage from the majority of the Tarrawonga Modification area would be directed to Nagero and Bollol Creeks. The catchment of the final void is estimated to be comparable to that for the approved Tarrawonga Coal Mine (Tarrawonga Coal Mine Modification Surface Water Assessment, March 2010).

8. Post mining surface water management

The mining area will be progressively rehabilitated throughout the life of the Project. Rehabilitated areas will be free draining to Nagero Creek following the successful rehabilitation and stabilisation of overburden emplacement areas. The final landform will generally be consistent with the surrounding environment.

The final landform will be free-draining, with the exception of the final void that will remain at the northern extent of the Project Boundary. Clean water dams located upslope of the final void will be removed at the completion of mining. The final void will have a catchment area of approximately 413ha. The lowest point in the final void will be RL 176m, a depth of approximately 156m below the spill level of the void at approximately RL 332m. Rainfall falling on the final void catchment and groundwater seepage will slowly fill the void forming a lake. The void will eventually reach an average stable water level, which will be influenced by the balance of inflows from rainfall and groundwater, and losses from evaporation. Details of the recovery of water levels in the void are provided in Section 8.1.

The rehabilitated landform will be revegetated with a mixture of native trees and shrubs. The final landuse will predominantly be native forests for conservation purposes and may include some forestry activities, which is similar to the pre mining landuse. Sediment basins will remain in place until rehabilitation has established. These sediment basins will encourage the settling of suspended solids prior to the release of water to Nagero Creek. Temporary erosion and sediment control measures will be required whilst rehabilitation is establishing (e.g. contour banks, contour ripping, graded banks, erosion blankets, ground-cover vegetation, rip-rap). All sediment basins will be removed once rehabilitation success criteria have been achieved.

Management strategies for topsoil stripping and handling, topsoil respreading, post disturbance regrading, erosion and sediment control, and seedbed preparation are outlined in the soil assessment (GSS, 2009). These measures will be incorporated into a Rehabilitation Strategy and will be implemented at the Project site.

Soil infiltration characteristics for rehabilitated areas are expected to be similar to pre mining conditions. There will be some reduction in the volume of runoff discharged to Nagero Creek as the final void catchment will retain some water. The final void catchment will be minimised as much as practical by bunding around the outer edge of the void. It is expected that the final void catchment area will be approximately 413ha. The reduction in runoff volumes to Nagero Creek will be directly proportional to the reduction in catchment area. The catchment area of Nagero Creek to the point where it meets the Namoi River floodplain is expected to reduce from 4,414ha (pre mining) to 4,001ha (post mining). This is a reduction in catchment area of approximately 9%.

The quality of runoff from rehabilitated areas is expected to be similar to pre mining water quality conditions. Based on the conclusions of the geochemical assessment (RGS, 2009), it is considered unlikely that leachate generated from overburden and coal reject materials would significantly impact surface water quality downstream of the site if these materials are managed carefully. The findings of the geochemical assessment are summarised in Section 2.6.

Monitoring data collected to date indicates that baseline water quality in Nagero Creek exhibits elevated suspended solids, low electrical conductivity, and variable pH. Similar water quality is expected following rehabilitation. Baseline water quality monitoring data is provided in Section 2.3.

A surface water management system concept for the final landform has not been prepared as part of this surface water assessment. A detailed assessment of the final landform (including water balance and hydrological modelling) has not been undertaken as part of this surface water assessment.

8.1 Final void

Post mining groundwater impacts have been assessed in the Continuation of Boggabri Coal Mine Groundwater Assessment (AGE, 2010). The groundwater assessment involved modelling to simulate the recovery of water levels in the final void and surrounding aquifer.

Modelling predicted that the water level in the final void and surrounding Permian and spoil aquifers will require approximately 60 to 80 years to reach an equilibrium level. At the completion of mining, there is a relatively high groundwater gradient between the dewatered open void and spoil zone and the surrounding aquifers which results in relatively rapid inflows and contributes to stabilization of the water levels (AGE, 2010).

Modelling predicted that the water level in the final void will stabilize at approximately RL 222m, which is below the pre mining water level, and therefore the pit will remain a permanent sink for groundwater. Evaporative ‘pumping’ from the final void surface will draw in groundwater from the surrounding aquifers, and water in the void will not escape to the surrounding aquifers. The spill level on the final void is approximately RL 332m, which is significantly in excess of pre mining groundwater levels and therefore overtopping of the final void is not expected, and the void will remain a sink for groundwater inflow (AGE, 2010).

Water quality in the final void will be determined by the quality of the rainfall which falls directly in the void, groundwater seepage quality, leaching of salts from the spoil dump and coal reject materials disposed of within the spoil dump and evaporative concentration of these inputs. As rainfall inputs dominate the water balance of the final void, the salinity of water in the void is expected to be initially fresh becoming brackish to saline over time. The final void will act as a sink and draw in groundwater from surrounding aquifers, which will prevent potentially brackish to saline water being released back into the aquifers (AGE, 2010).

Based on the findings of the groundwater assessment that the final void will remain as a sink for groundwater and is not expected to overtop, it is considered unlikely that potentially brackish to saline water in the void would adversely impact surface water quality.

9. Surface water monitoring

A surface water quality monitoring program is already in place at the site in accordance with the conditions of the EPL No. 12407. It is proposed to extend the existing monitoring program to include new sediment dams and mine water storages.

The proposed surface water quality monitoring program for the Project is provided in Table 9-1.

Table 9-1 Proposed surface water quality monitoring program

Location	Parameter	Frequency
Sediment dams	Visual inspection and in situ measurement of pH, EC, turbidity ^	Daily
	pH, EC, nitrate, nitrogen (total), oil and grease, phosphorus (total), reactive phosphorus, TSS, dissolved metals	Quarterly, correction action event
Mining void	pH, EC	Quarterly
Nagero Creek upstream of site (SW2) ^^	pH, EC, nitrate, nitrogen (total), oil and grease, phosphorus (total), reactive phosphorus, TSS, dissolved metals	Quarterly, correction action event
Nagero Creek downstream of site (SW1)	pH, EC, nitrate, nitrogen (total), oil and grease, phosphorus (total), reactive phosphorus, TSS, dissolved metals	Quarterly, correction action event
MD3	pH, standing water level	Weekly

Notes: ^ Refer to Section 4.3.2 for the proposed strategy for operation of dirty water sediment dams.
^^ Monitoring at location SW2 will not be possible after Year 5.

It is proposed to continue monitoring upstream of the site at location SW2 until Year 5. It will not be possible to continue monitoring at SW2 after Year 5, as this location will be disturbed by mining. However, it is expected that by Year 5 there will be sufficient monitoring data (approximately 8 years of data) from SW2 to establish baseline water quality. Other upstream locations are not considered suitable for water quality monitoring due to very low stream flows.

In addition to the above, monitoring of the irrigation system will be undertaken in accordance with the Irrigation Management Plan for Boggabri Coal Mine (Aquatech Consulting, 2009).

9.1 Concentration limits

The water quality monitoring data collected to date indicates that the background surface water runoff has naturally elevated suspended solids concentrations that are above the limits set by EPL No. 12407 for Boggabri Coal Mine. This can be demonstrated at baseline monitoring site SW2 that is located upstream of existing mining operations. Baseline water quality monitoring data is provided in Section 2.3. It is therefore proposed that water quality concentration limits for the Project be based on the monitoring data collected to date at baseline monitoring site SW2.

10. References

Agsol Pty Ltd, February 2009. Environmental Management System for the Reuse and Management of Reclaimed Mine Water.

Aquatech Consulting Pty Ltd, February 2009. Irrigation Management Plan for Boggabri Coal Mine.

Australasian Groundwater & Environmental Consultants Pty Ltd, February 2010. Report on Continuation of Boggabri Coal Mine Groundwater Assessment.

Boggabri Coal Joint Venture, 1987. Boggabri Coal Project Environmental Impact Statement.

DECC, 2008. Managing Urban Stormwater - Soils and Construction - Volume 2D Main road Construction.

DECC, 2008. Managing Urban Stormwater - Soils and Construction - Volume 2E Mines and Quarries guidelines.

Department of Lands - Soil Services, May 2005. Proposed East Boggabri Coal Mine Surface Water Assessment.

Department of Land and Water Conservation, 1999. Guidelines for Establishing Drainage Lines on Rehabilitated Minesites (Draft).

Department of Water and Energy, May 2008. Farm dams - where can they be built without a license?

Department of Water and Energy, May 2008. Farm dams - what size dam can you build without a license?

Department of Water and Energy, 2009. Water availability in New South Wales Murray-Darling Basin regulated rivers.

Gilbert and Associates Pty Ltd, March 2010. Tarrawonga Coal Mine Modification Surface Water Assessment.

GSS Environmental, December 2009. Boggabri Coal Continuation of Mining Project Environmental Assessment – Soil Survey and Land Resource Impact Assessment.

Hansen Bailey Pty Ltd, August 2009. Boggabri Coal Preliminary Environmental Assessment.

Hansen Bailey Pty Ltd, July 2010. Maules Creek Coal Project Preliminary Environmental Assessment.

Landcom, 2004. Managing Urban Stormwater - Soils and Construction - Volume 1.

NSW Department of Infrastructure, Planning and Natural Resources, September 2004. A guide to the Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated River Water Sources.

Parsons Brinckerhoff, January 2006. Boggabri Coal Project Water Environmental Management Plan.

Parsons Brinckerhoff, March 2006. Boggabri Coal Project Surface Water Modelling and Assessment Report (PB reference 2118369B-RPT001-B:mb).

Parsons Brinckerhoff, January 2009. Boggabri Coal Project 2008 Site Water Balance (PB reference 2118840A_pr0541).

Parsons Brinckerhoff, February 2009. Boggabri Coal Project Statement of Environmental Effects to Support Section 96 Application to Modify Development Consent (PB reference 2118840A_pr9039).

Parsons Brinckerhoff, May 2010. Continuation of Boggabri Coal Mine - High Level Water Buying Assessment (PB reference 2123173C/parmenterm/RevA).

RGS Environmental Pty Ltd, November 2009. The Boggabri Continuation of Mining Project - Geochemical Assessment of Overburden and Potential Reject Materials.

Environment Protection Licence No. 12407, issued by the NSW EPA under Section 55 of the Protection of the Environment Operations Act 1997.

Appendix A

Water quality monitoring data

ALS Laboratory Group
ANALYTICAL CHEMISTRY & TESTING SERVICES

Environmental Division

CERTIFICATE OF ANALYSIS

Work Order	: **ES0810297**	Page	: 1 of 3
Client	: **BOGGABRI COAL PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR JOE RENNICK	Contact	: Victor Kedicioglu
Address	: 135 MERTON STREET BOGGABRI NSW, AUSTRALIA 2382	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: joe.rennick@boggabricoal.com.au	E-mail	: victor.kedicioglu@alsenviro.com
Telephone	: 67434027	Telephone	: +61-2-8784 8555
Facsimile	: 67434496	Facsimile	: +61-2-8784 8500
Project	: EP L 12407 SURFACE WATER	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 18-JUL-2008
Sampler	: JOE RENNICK	Issue Date	: 28-JUL-2008
Site	: BOGGABRI		
		No. of samples received	: 4
Quote number	: ----	No. of samples analysed	: 4

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA Accredited Laboratory 825

This document is issued in accordance with NATA accreditation requirements.

Accredited for compliance with ISO/IEC 17025.

WORLD RECOGNISED ACCREDITATION

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Inorganics
Sarah Millington	Senior Inorganic Chemist	Inorganics

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been preformed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insuffient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When date(s) and/or time(s) are shown bracketed, these have been assumed by the laboratory for processing purposes. If the sampling time is displayed as 0:00 the information was not provided by client.

Key : CAS Number = Chemistry Abstract Services number
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting

Analytical Results

Sub-Matrix: **WATER**

			Client sample ID	MW3	SD2	SD3	NAGERO DAM	----
			Client sampling date / time	17-JUL-2008 11:00	17-JUL-2008 10:45	17-JUL-2008 11:15	17-JUL-2008 10:30	----
Compound	CAS Number	LOR	Unit	ES0810297-001	ES0810297-002	ES0810297-003	ES0810297-004	----
EA005: pH								
pH Value	----	0.01	pH Unit	**8.80**	**8.10**	**8.14**	**8.06**	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**1300**	**310**	**818**	**507**	----
EA025: Suspended Solids								
^ Suspended Solids (SS)	----	1	mg/L	**38**	**44**	**46**	**165**	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	----	0.010	mg/L	**0.094**	**0.042**	<0.010	**0.018**	----
EK058G: Nitrate as N by Discrete Analyser								
^ Nitrate as N	14797-55-8	0.010	mg/L	**6.19**	**1.28**	<0.010	**0.169**	----
EK059G: NOX as N by Discrete Analyser								
Nitrite + Nitrate as N	----	0.010	mg/L	**6.28**	**1.32**	<0.010	**0.187**	----
EK061: Total Kjeldahl Nitrogen (TKN)								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**1.6**	**32.0**	**0.9**	**1.5**	----
EK062: Total Nitrogen as N								
^ Total Nitrogen as N	----	0.1	mg/L	**7.8**	**33.3**	**0.9**	**1.7**	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	<0.01	**13.0**	**0.15**	**0.26**	----

ALS Laboratory Group
ANALYTICAL CHEMISTRY & TESTING SERVICES

Environmental Division

CERTIFICATE OF ANALYSIS

Work Order	: **ES0814091**	Page	: 1 of 3
Client	: **BOGGABRI COAL PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR JOE RENNICK	Contact	: Charlie Pierce
Address	: 135 MERTON STREET BOGGABRI NSW, AUSTRALIA 2382	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: joe.rennick@boggabricoal.com.au	E-mail	: charlie.pierce@alsenviro.com
Telephone	: 67434027	Telephone	: +61-2-8784 8555
Facsimile	: 67434496	Facsimile	: +61-2-8784 8500
Project	: EPL 12407 SURFACE WATER	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 25-SEP-2008
Sampler	: J.R.	Issue Date	: 07-OCT-2008
Site	: BOGGABRI		
		No. of samples received	: 3
Quote number	: ----	No. of samples analysed	: 3

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA Accredited Laboratory 825

This document is issued in accordance with NATA accreditation requirements.

Accredited for compliance with ISO/IEC 17025.

WORLD RECOGNISED ACCREDITATION

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Hoa Nguyen	Inorganic Chemist	Inorganics
Sarah Millington	Senior Inorganic Chemist	Inorganics

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been preformed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insuffient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When date(s) and/or time(s) are shown bracketed, these have been assumed by the laboratory for processing purposes. If the sampling time is displayed as 0:00 the information was not provided by client.

Key :
- CAS Number = Chemistry Abstract Services number
- LOR = Limit of reporting
- **^** = This result is computed from individual analyte detections at or above the level of reporting

Analytical Results

Sub-Matrix: **WATER**

Compound	CAS Number	LOR	Unit	SW3	SD2	SW1	----	----
			Client sampling date / time	23-SEP-2008 08:00	23-SEP-2008 08:15	23-SEP-2008 08:30	----	----
				ES0814091-001	**ES0814091-002**	**ES0814091-003**	----	----
EA005: pH								
pH Value	----	0.01	pH Unit	**5.85**	**6.80**	**6.69**	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**56**	**337**	**231**	----	----
EA025: Suspended Solids								
^ Suspended Solids (SS)	----	1	mg/L	**99**	**273**	**2070**	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	----	0.01	mg/L	**0.01**	**0.02**	**0.16**	----	----
EK058G: Nitrate as N by Discrete Analyser								
^ Nitrate as N	14797-55-8	0.01	mg/L	**0.05**	**1.28**	**2.24**	----	----
EK059G: NOX as N by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.06**	**1.29**	**2.40**	----	----
EK061: Total Kjeldahl Nitrogen (TKN)								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.6**	**2.1**	**1.4**	----	----
EK062: Total Nitrogen as N								
^ Total Nitrogen as N	----	0.1	mg/L	**0.7**	**3.4**	**3.8**	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.19**	<0.01	**0.38**	----	----

ALS Laboratory Group
ANALYTICAL CHEMISTRY & TESTING SERVICES

Environmental Division

CERTIFICATE OF ANALYSIS

Work Order	: **ES0814765**	Page	: 1 of 4
Client	: **BOGGABRI COAL PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR JOE RENNICK	Contact	: Charlie Pierce
Address	: 135 MERTON STREET BOGGABRI NSW, AUSTRALIA 2382	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: joe.rennick@boggabricoal.com.au	E-mail	: charlie.pierce@alsenviro.com
Telephone	: 67434027	Telephone	: +61-2-8784 8555
Facsimile	: 67434496	Facsimile	: +61-2-8784 8500
Project	: EPI 12407 SURFACE WATER	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 08-OCT-2008
Sampler	: JR	Issue Date	: 17-OCT-2008
Site	: BOGGABRI		
		No. of samples received	: 6
Quote number	: ----	No. of samples analysed	: 6

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA Accredited Laboratory 825

This document is issued in accordance with NATA accreditation requirements.

Accredited for compliance with ISO/IEC 17025.

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Hoa Nguyen	Inorganic Chemist	Inorganics

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been preformed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insuffient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When date(s) and/or time(s) are shown bracketed, these have been assumed by the laboratory for processing purposes. If the sampling time is displayed as 0:00 the information was not provided by client.

Key : CAS Number = Chemistry Abstract Services number
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting

- **EK057G, It has been noted that NO2 is greater than NOX (for sample ID 9 WS3) however this difference is within the limits of experimental variation.**
- **EK059G & EKO58G: LOR raised for NOx and NO3 on sample ID (SW1 and SW3) due to sample matrix.**

Analytical Results

Sub-Matrix: **WATER**

			Client sample ID	SW1	SW3	SD3	SD2	SD6
			Client sampling date / time	06-OCT-2008 12:40	06-OCT-2008 13:00	06-OCT-2008 12:15	06-OCT-2008 12:30	06-OCT-2008 12:40
Compound	*CAS Number*	*LOR*	*Unit*	**ES0814765-001**	**ES0814765-002**	**ES0814765-003**	**ES0814765-004**	**ES0814765-005**
EA005: pH								
pH Value	----	0.01	pH Unit	**7.44**	**7.02**	**7.20**	**7.26**	**7.10**
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**127**	**72**	**295**	**247**	**355**
EA025: Suspended Solids								
^ Suspended Solids (SS)	----	1	mg/L	**169**	**32**	**656**	**382**	**60**
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	----	0.01	mg/L	**0.05**	**0.03**	**0.05**	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
^ Nitrate as N	14797-55-8	0.01	mg/L	<0.05	<0.05	**1.83**	**0.97**	**0.43**
EK059G: NOX as N by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	<0.05	<0.01	**1.88**	**0.97**	**0.43**
EK061: Total Kjeldahl Nitrogen (TKN)								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**3.1**	**0.6**	**4.1**	**0.4**	**1.1**
EK062: Total Nitrogen as N								
^ Total Nitrogen as N	----	0.1	mg/L	**3.1**	**0.6**	**6.0**	**1.3**	**1.5**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.29**	**0.13**	**1.72**	**0.10**	**0.23**

Analytical Results

Sub-Matrix: **WATER**

Compound	CAS Number	LOR	Unit					
			Client sample ID	**TARRAWONA DISCHARGE**	----	----	----	----
			Client sampling date / time	06-OCT-2008 12:00	----	----	----	----
				ES0814765-006	**----**	**----**	**----**	**----**
EA005: pH								
pH Value	----	0.01	pH Unit	**6.97**	----	----	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**750**	----	----	----	----
EA025: Suspended Solids								
^ Suspended Solids (SS)	----	1	mg/L	**12**	----	----	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	----	0.01	mg/L	**0.04**	----	----	----	----
EK058G: Nitrate as N by Discrete Analyser								
^ Nitrate as N	14797-55-8	0.01	mg/L	**0.32**	----	----	----	----
EK059G: NOX as N by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.36**	----	----	----	----
EK061: Total Kjeldahl Nitrogen (TKN)								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.6**	----	----	----	----
EK062: Total Nitrogen as N								
^ Total Nitrogen as N	----	0.1	mg/L	**1.0**	----	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.07**	----	----	----	----

CERTIFICATE OF ANALYSIS

Work Order	: **ES0815378**	Page	: 1 of 6
Client	: **BOGGABRI COAL PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: J. MCDONOUGH	Contact	: Charlie Pierce
Address	: 135 MERTON STREET BOGGABRI NSW, AUSTRALIA 2382	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: jmcdonough@pb.com.au	E-mail	: charlie.pierce@alsenviro.com
Telephone	: +61 02 65718328	Telephone	: +61-2-8784 8555
Facsimile	: +61 02 67434496	Facsimile	: +61-2-8784 8500
Project	: ----	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: 45259	Date Samples Received	: 17-OCT-2008
Sampler	: ----	Issue Date	: 29-OCT-2008
Site	: BOGGABRI		
		No. of samples received	: 5
Quote number	: ----	No. of samples analysed	: 5

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

NATA Accredited Laboratory 825

This document is issued in accordance with NATA accreditation requirements.

Accredited for compliance with ISO/IEC 17025.

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Celine Conceicao	Spectroscopist	Inorganics
Edwandy Fadjar	Senior Organic Chemist	Organics
Hoa Nguyen	Inorganic Chemist	Inorganics
Sarah Millington	Senior Inorganic Chemist	Inorganics

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insuffient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When date(s) and/or time(s) are shown bracketed, these have been assumed by the laboratory for processing purposes. If the sampling time is displayed as 0:00 the information was not provided by client.

Key : CAS Number = Chemistry Abstract Services number
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting

- **EK50G: Matrix spike failed for NH3 due to sample matrix (confirm by re-analysis).**
- **EP080: Level of Reporting raised for toluene due to ambient background levels in the laboratory.**
- **TDS by method EA-015 may bias high for sample ID 'SD6' due to the presence of fine particulate matter, which may pass through the prescribed GF/C paper.**

Analytical Results

Sub-Matrix: **WATER**

Compound	CAS Number	LOR	Unit	LV1	MW2	SD6	DMH1	DMB1
			Client sampling date / time	16-OCT-2008 15:00	16-OCT-2008 15:00	16-OCT-2008 15:00	16-OCT-2008 15:00	16-OCT-2008 15:00
				ES0815378-001	ES0815378-002	ES0815378-003	ES0815378-004	ES0815378-005
EA005: pH								
pH Value	----	0.01	pH Unit	7.45	8.59	7.75	7.03	6.91
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	1020	1300	394	2290	3500
EA015: Total Dissolved Solids								
^ Total Dissolved Solids @180°C	GIS-210-010	1	mg/L	614	814	----	1640	2580
Total Dissolved Solids @180°C	GIS-210-010	1	mg/L	----	----	572	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	78	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	451	314	122	741	425
Total Alkalinity as CaCO3	----	1	mg/L	451	392	122	741	425
ED041: Sulfate (Turbidimetric) as SO4 2-								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	8	65	4	41	196
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	1	mg/L	75	110	42	335	905
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	22	14	11	87	128
Magnesium	7439-95-4	1	mg/L	8	11	5	57	90
Sodium	7440-23-5	1	mg/L	238	282	59	384	540
Potassium	7440-09-7	1	mg/L	7	9	10	3	3
EG020F: Dissolved Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	<0.001	0.004	----	<0.001	0.004
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	----	0.0004	<0.0001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	----	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	0.009	0.002	----	0.030	<0.001
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	----	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	<0.001	0.002	----	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L	0.069	0.011	----	0.084	0.020
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	----	<0.05	0.88
EG020T: Total Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	----	----	0.002	----	----
Cadmium	7440-43-9	0.0001	mg/L	----	----	<0.0001	----	----
Chromium	7440-47-3	0.001	mg/L	----	----	0.007	----	----
Copper	7440-50-8	0.001	mg/L	----	----	0.016	----	----
Lead	7439-92-1	0.001	mg/L	----	----	0.006	----	----
Nickel	7440-02-0	0.001	mg/L	----	----	0.009	----	----
Zinc	7440-66-6	0.005	mg/L	----	----	0.022	----	----

Analytical Results

Sub-Matrix: **WATER**

Compound	CAS Number	LOR	Unit	LV1	MW2	SD6	DMH1	DMB1
			Client sampling date / time	16-OCT-2008 15:00	16-OCT-2008 15:00	16-OCT-2008 15:00	16-OCT-2008 15:00	16-OCT-2008 15:00
				ES0815378-001	ES0815378-002	ES0815378-003	ES0815378-004	ES0815378-005
EG020T: Total Metals by ICP-MS - Continued								
Iron	7439-89-6	0.05	mg/L	----	----	6.92	----	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	0.10	<0.01	0.11	<0.01	<0.01
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	----	0.01	mg/L	<0.01	0.15	<0.01	0.03	<0.01
EK058G: Nitrate as N by Discrete Analyser								
^ Nitrate as N	14797-55-8	0.01	mg/L	<0.01	6.76	0.15	2.73	0.16
EK059G: NOX as N by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	6.92	0.15	2.76	0.16
EK062: Total Nitrogen as N (TKN + NOx)								
Total Nitrogen as N	----	0.1	mg/L	0.2	9.1	1.0	3.2	0.2
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	<0.01	0.13	0.31	<0.01	<0.01
EN055: Ionic Balance								
^ Total Anions	----	0.01	meq/L	11.3	----	3.71	25.1	38.1
Total Anions	----	0.01	meq/L	----	12.9	----	----	----
^ Total Cations	----	0.01	meq/L	12.3	14.1	3.78	25.8	37.4
^ Ionic Balance	----	0.01	%	4.16	----	0.90	1.36	0.99
Ionic Balance	----	0.01	%	----	4.44	----	----	----
EP020: Oil and Grease (O&G)								
Oil & Grease	----	5	mg/L	----	<5	<5	----	----
EP030: Biochemical Oxygen Demand (BOD)								
Biochemical Oxygen Demand	----	2	mg/L	4	<2	5	<2	<2
EP080/071: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	20	µg/L	----	<20	<20	----	----
EP080: BTEX								
Benzene	71-43-2	1	µg/L	----	<1	<1	----	----
Toluene	108-88-3	2	µg/L	----	<5	<5	----	----
Ethylbenzene	100-41-4	2	µg/L	----	<2	<2	----	----
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	----	<2	<2	----	----
ortho-Xylene	95-47-6	2	µg/L	----	<2	<2	----	----
EP080S: TPH(V)/BTEX Surrogates								
1.2-Dichloroethane-D4	17060-07-0	0.1	%	----	96.8	93.4	----	----
Toluene-D8	2037-26-5	0.1	%	----	92.4	86.0	----	----
4-Bromofluorobenzene	460-00-4	0.1	%	----	80.6	97.1	----	----

Surrogate Control Limits

Sub-Matrix: **WATER**

Compound	CAS Number	Recovery Limits (%) Low	Recovery Limits (%) High
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	80	120
Toluene-D8	2037-26-5	88	110
4-Bromofluorobenzene	460-00-4	86	115

ALS Laboratory Group
ANALYTICAL CHEMISTRY & TESTING SERVICES

Environmental Division

CERTIFICATE OF ANALYSIS

Work Order	: **ES0818659**	Page	: 1 of 3
Client	: **BOGGABRI COAL PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR JOE RENNICK	Contact	: Charlie Pierce
Address	: 135 MERTON STREET BOGGABRI NSW, AUSTRALIA 2382	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: joe.rennick@boggabricoal.com.au	E-mail	: charlie.pierce@alsenviro.com
Telephone	: 67434027	Telephone	: +61-2-8784 8555
Facsimile	: 67434496	Facsimile	: +61-2-8784 8500
Project	: EPI 12407 SURFACE WATER	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 17-DEC-2008
Sampler	: JR	Issue Date	: 30-DEC-2008
Site	: ----		
		No. of samples received	: 2
Quote number	: ----	No. of samples analysed	: 2

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA WORLD RECOGNISED ACCREDITATION

NATA Accredited Laboratory 825

This document is issued in accordance with NATA accreditation requirements.

Accredited for compliance with ISO/IEC 17025.

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Sarah Millington	Senior Inorganic Chemist	Inorganics

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insuffient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When date(s) and/or time(s) are shown bracketed, these have been assumed by the laboratory for processing purposes. If the sampling time is displayed as 0:00 the information was not provided by client.

Key : CAS Number = Chemistry Abstract Services number

LOR = Limit of reporting

^ = This result is computed from individual analyte detections at or above the level of reporting

Analytical Results

Sub-Matrix: **WATER**

			Client sample ID	SW3	SW1	----	----	----
			Client sampling date / time	13-DEC-2008 08:00	13-DEC-2008 08:30	----	----	----
Compound	CAS Number	LOR	Unit	ES0818659-001	ES0818659-002	----	----	----
EA005: pH								
pH Value	----	0.01	pH Unit	7.82	7.60	----	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	86	174	----	----	----
EA025: Suspended Solids								
^ Suspended Solids (SS)	----	1	mg/L	66	158	----	----	----
EK058G: Nitrate as N by Discrete Analyser								
^ Nitrate as N	14797-55-8	0.01	mg/L	0.01	0.03	----	----	----
EK059G: NOX as N by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	0.01	0.03	----	----	----
EK061: Total Kjeldahl Nitrogen (TKN)								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	0.8	1.2	----	----	----
EK062: Total Nitrogen as N								
^ Total Nitrogen as N	----	0.1	mg/L	0.8	1.2	----	----	----
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	----	0.01	mg/L	0.01	0.13	----	----	----

ALS Laboratory Group
ANALYTICAL CHEMISTRY & TESTING SERVICES

Environmental Division

CERTIFICATE OF ANALYSIS

Work Order	: **ES0902366**	Page	: 1 of 3
Client	: **BOGGABRI COAL PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR JOE RENNICK	Contact	: Charlie Pierce
Address	: 135 MERTON STREET BOGGABRI NSW, AUSTRALIA 2382	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: joe.rennick@boggabricoal.com.au	E-mail	: charlie.pierce@alsenviro.com
Telephone	: 67434027	Telephone	: +61-2-8784 8555
Facsimile	: 67434496	Facsimile	: +61-2-8784 8500
Project	: EPL 12407 SURFACE WATER	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 17-FEB-2009
Sampler	: JR	Issue Date	: 25-FEB-2009
Site	: BOGGABRI		
		No. of samples received	: 2
Quote number	: ----	No. of samples analysed	: 2

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA Accredited Laboratory 825

This document is issued in accordance with NATA accreditation requirements.

Accredited for compliance with ISO/IEC 17025.

WORLD RECOGNISED ACCREDITATION

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Hoa Nguyen	Inorganic Chemist	Inorganics

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insuffient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When date(s) and/or time(s) are shown bracketed, these have been assumed by the laboratory for processing purposes. If the sampling time is displayed as 0:00 the information was not provided by client.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting

Analytical Results

Sub-Matrix: **WATER**

Compound	CAS Number	LOR	Unit	SW3	SW1	----	----	----
			Client sampling date / time	17-FEB-2009 08:05	17-FEB-2009 08:00	----	----	----
				ES0902366-001	**ES0902366-002**	**----**	**----**	**----**
EA005: pH								
pH Value	----	0.01	pH Unit	**7.08**	**7.27**	----	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**33**	**59**	----	----	----
EA025: Suspended Solids								
^ Suspended Solids (SS)	----	1	mg/L	**110**	**160**	----	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	----	0.01	mg/L	<0.01	**0.01**	----	----	----
EK058G: Nitrate as N by Discrete Analyser								
^ Nitrate as N	14797-55-8	0.01	mg/L	**0.03**	**0.32**	----	----	----
EK059G: NOX as N by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.03**	**0.34**	----	----	----
EK061: Total Kjeldahl Nitrogen (TKN)								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.5**	**1.5**	----	----	----
EK062: Total Nitrogen as N								
^ Total Nitrogen as N	----	0.1	mg/L	**0.5**	**1.9**	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.11**	**0.12**	----	----	----
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	----	0.01	mg/L	**0.05**	**0.03**	----	----	----
EP020: Oil and Grease (O&G)								
Oil & Grease	----	5	mg/L	<5	<5	----	----	----

Appendix B

Sediment dam and diversion drain sizing

Landform	Year 1	Year 1	Year 1	Year 1
Storage Name	SD1	SD2	SD3	SD4
Runoff type	Dirty	Contaminated	Dirty	Contaminated
Design criteria	Blue Book	100yr ARI 72hr	Blue Book	100yr ARI 72hr
Design storm ARI (years)	90th %ile 5 day	100	90th %ile 5 day	100
Design storm duration (min)	7200	4320	7200	4320
Sediment storage (% of settling zone)	50%	20%	50%	20%
Catchment area (ha)	9.3	14.5	103.7	2.3
Rainfall intensity (mm/hr)	0.3	3.5	0.3	3.5
Total rainfall depth (mm)	38.4	251.3	38.4	251.3
Runoff coefficient Cv	0.75	0.75	0.40	0.75
Settling volume (ML)	2.7	27.3	15.9	4.3
Sediment storage volume (ML)	1.3	5.5	8.0	0.9
Total required volume (ML)	4.0	32.8	23.9	5.2
Proposed volume (ML)	1.0 (shortfall provided in SD6)	32.8	100.0	8.1

Landform	Year 1	Year 1	Year 1
Storage Name	SD5	SD6	SD23
Runoff type	Dirty	Dirty	Dirty
Design criteria	Blue Book	Blue Book	Blue Book
Design storm ARI (years)	90th %ile 5 day	90th %ile 5 day	90th %ile 5 day
Design storm duration (min)	7200	7200	7200
Sediment storage (% of settling zone)	50%	50%	50%
Catchment area (ha)	2.8	20.1	29.4
Rainfall intensity (mm/hr)	0.3	0.3	0.3
Total rainfall depth (mm)	38.4	38.4	38.4
Runoff coefficient Cv	0.75	0.75	0.75
Settling volume (ML)	0.8	5.8	8.5
Sediment storage volume (ML)	0.4	2.9	4.2
Total required volume (ML)	1.2	8.7	12.7
Proposed volume (ML)	1.4	55.0	12.7

Landform	Year 5	Year 5	Year 5	Year 5
Storage Name	**SD3**	**SD5**	**SD6**	**SD7**
Runoff type	Dirty	Dirty	Dirty	Dirty
Design criteria	Blue Book	Blue Book	Blue Book	Blue Book
Design storm ARI (years)	90th %ile 5 day	90th %ile 5 day	90th %ile 5 day	90th %ile 5 day
Design storm duration (min)	7200	7200	7200	7200
Sediment storage (% of settling zone)	50%	50%	50%	50%
Catchment area (ha)	212.6	4.9	9.9	274.6
Rainfall intensity (mm/hr)	0.3	0.3	0.3	0.3
Total rainfall depth (mm)	38.4	38.4	38.4	38.4
Runoff coefficient Cv	0.58 (weighted average)	0.75	0.75	0.51 (weighted average)
Settling volume (ML)	47.4	1.4	2.9	53.8
Sediment storage volume (ML)	23.7	0.7	1.4	26.9
Total required volume (ML)	71.0	2.1	4.3	80.7
Proposed volume (ML)	100.0	2.1	55.0	100.0

Landform	Year 5	Year 5	Year 5	Year 5
Storage Name	**SD8**	**SD9**	**SD10**	**SD11**
Runoff type	Dirty	Dirty	Contaminated	Contaminated
Design criteria	Blue Book	Blue Book	100yr ARI 72hr	100yr ARI 72hr
Design storm ARI (years)	90th %ile 5 day	90th %ile 5 day	100	100
Design storm duration (min)	7200	7200	4,320	4320
Sediment storage (% of settling zone)	50%	50%	20%	20%
Catchment area (ha)	5.0	291.4	10.7	5.0 (nominal area)
Rainfall intensity (mm/hr)	0.3	0.3	3.5	3.5
Total rainfall depth (mm)	38.4	38.4	251.3	251.3
Runoff coefficient Cv	0.75	0.40	0.75	0.75
Settling volume (ML)	1.4	44.8	20.2	9.4
Sediment storage volume (ML)	0.7	22.4	4.0	1.9
Total required volume (ML)	2.2	67.1	24.2	11.3
Proposed volume (ML)	2.2	67.1	24.2	11.3

Landform	Year 5	Year 5
Storage Name	**SD12**	**SD23**
Runoff type	Contaminated	Dirty
Design criteria	100yr ARI 72hr	Blue Book
Design storm ARI (years)	100	90th %ile 5 day
Design storm duration (min)	4320	7200
Sediment storage (% of settling zone)	20%	50%
Catchment area (ha)	23.2	20.4
Rainfall intensity (mm/hr)	3.5	0.3
Total rainfall depth (mm)	251.3	38.4
Runoff coefficient Cv	0.75	0.75
Settling volume (ML)	43.7	5.9
Sediment storage volume (ML)	8.7	2.9
Total required volume (ML)	52.5	8.8
Proposed volume (ML)	52.5	12.7

Landform	Year 10	Year 10	Year 10	Year 10
Storage Name	**SD3**	**SD5**	**SD6**	**SD7**
Runoff type	Dirty	Dirty	Dirty	Dirty
Design criteria	Blue Book	Blue Book	Blue Book	Blue Book
Design storm ARI (years)	90th %ile 5 day	90th %ile 5 day	90th %ile 5 day	90th %ile 5 day
Design storm duration (min)	7200	7200	7200	7200
Sediment storage (% of settling zone)	50%	50%	50%	50%
Catchment area (ha)	211.6	4.9	9.9	323.6
Rainfall intensity (mm/hr)	0.3	0.3	0.3	0.3
Total rainfall depth (mm)	38.4	38.4	38.4	38.4
Runoff coefficient Cv	0.40	0.75	0.75	0.51 (weighted average)
Settling volume (ML)	32.5	1.4	2.9	63.4
Sediment storage volume (ML)	16.3	0.7	1.4	31.7
Total required volume (ML)	48.8	2.1	4.3	95.1
Proposed volume (ML)	100.0	2.1	55.0	100.0

Landform	Year 10	Year 10	Year 10	Year 10
Storage Name	**SD8**	**SD10**	**SD11**	**SD12**
Runoff type	Dirty	Contaminated	Contaminated	Contaminated
Design criteria	Blue Book	100yr ARI 72hr	100yr ARI 72hr	100yr ARI 72hr
Design storm ARI (years)	90th %ile 5 day	100	100	100
Design storm duration (min)	7200	4,320.00	4,320.00	4,320.00
Sediment storage (% of settling zone)	50%	20%	20%	20%
Catchment area (ha)	5.0	10.7	5.0 (nominal area)	23.2
Rainfall intensity (mm/hr)	0.3	3.5	3.5	3.5
Total rainfall depth (mm)	38.4	251.3	251.3	251.3
Runoff coefficient Cv	0.75	0.75	0.75	0.75
Settling volume (ML)	1.4	20.2	9.4	43.7
Sediment storage volume (ML)	0.7	4.0	1.9	8.7
Total required volume (ML)	2.2	24.2	11.3	52.5
Proposed volume (ML)	2.2	24.2	11.3	52.5

Landform	Year 10	Year 10	Year 10
Storage Name	**SD13**	**SD14**	**SD23**
Runoff type	Dirty	Dirty	Dirty
Design criteria	Blue Book	Blue Book	Blue Book
Design storm ARI (years)	90th %ile 5 day	90th %ile 5 day	90th %ile 5 day
Design storm duration (min)	7200	7200	7200
Sediment storage (% of settling zone)	50%	50%	50%
Catchment area (ha)	367.7	313.6	20.4
Rainfall intensity (mm/hr)	0.3	0.3	0.3
Total rainfall depth (mm)	38.4	38.4	38.4
Runoff coefficient Cv	0.75	0.40	0.75
Settling volume (ML)	98.8	48.2	5.9
Sediment storage volume (ML)	49.4	24.1	2.9
Total required volume (ML)	148.3	72.3	8.8
Proposed volume (ML)	200.0	72.3	12.7

Landform	Year 21	Year 21	Year 21	Year 21
Storage Name	**SD3**	**SD5**	**SD6**	**SD8**
Runoff type	Dirty	Dirty	Dirty	Dirty
Design criteria	Blue Book	Blue Book	Blue Book	Blue Book
Design storm ARI (years)	90th %ile 5 day	90th %ile 5 day	90th %ile 5 day	90th %ile 5 day
Design storm duration (min)	7200	7200	7200	7200
Sediment storage (% of settling zone)	50%	50%	50%	50%
Catchment area (ha)	211.6	4.9	9.9	5.0
Rainfall intensity (mm/hr)	0.3	0.3	0.3	0.3
Total rainfall depth (mm)	38.4	38.4	38.4	38.4
Runoff coefficient Cv	0.40	0.75	0.75	0.75
Settling volume (ML)	32.5	1.4	2.9	1.4
Sediment storage volume (ML)	16.3	0.7	1.4	0.7
Total required volume (ML)	48.8	2.1	4.3	2.2
Proposed volume (ML)	100	2.1	55.0	2.2

Landform	Year 21	Year 21	Year 21	Year 21
Storage Name	**SD10**	**SD11**	**SD12**	**SD19**
Runoff type	Contaminated	Contaminated	Contaminated	Dirty
Design criteria	100yr ARI 72hr	100yr ARI 72hr	100yr ARI 72hr	Blue Book
Design storm ARI (years)	100	100	100	90th %ile 5 day
Design storm duration (min)	4,320.00	4,320.00	4,320.00	7200
Sediment storage (% of settling zone)	20%	20%	20%	50%
Catchment area (ha)	10.7	5.0 (nominal area)	23.2	434.2
Rainfall intensity (mm/hr)	3.5	3.5	3.5	0.3
Total rainfall depth (mm)	251.3	251.3	251.3	38.4
Runoff coefficient Cv	0.75	0.75	0.75	0.75
Settling volume (ML)	20.2	9.4	43.7	125.0
Sediment storage volume (ML)	4.0	1.9	8.7	62.5
Total required volume (ML)	24.2	11.3	52.5	187.6
Proposed volume (ML)	24.2	11.3	52.5	187.6

Landform	Year 21	Year 21	Year 21	Year 21
Storage Name	**SD20**	**SD21**	**SD22**	**SD23**
Runoff type	Dirty	Dirty	Dirty	Dirty
Design criteria	Blue Book	Blue Book	Blue Book	Blue Book
Design storm ARI (years)	90th %ile 5 day	90th %ile 5 day	90th %ile 5 day	90th %ile 5 day
Design storm duration (min)	7200	7200	7200	7200
Sediment storage (% of settling zone)	50%	50%	50%	50%
Catchment area (ha)	100.0	121.1	5.1	20.4
Rainfall intensity (mm/hr)	0.3	0.3	0.3	0.3
Total rainfall depth (mm)	38.4	38.4	38.4	38.4
Runoff coefficient Cv	0.75	0.75	0.75	0.75
Settling volume (ML)	28.8	34.9	1.5	5.9
Sediment storage volume (ML)	14.4	17.4	0.7	2.9
Total required volume (ML)	43.2	52.3	2.2	8.8
Proposed volume (ML)	43.2	52.3	2.2	12.7

Landform	Year 21	Year 21	Year 21	Year 21
Storage Name	**SD24**	**CD5**	**CD6**	**CD7**
Runoff type	Dirty	Clean	Clean	Clean
Design criteria	Blue Book	100yr ARI 72hr	100yr ARI 72hr	100yr ARI 72hr
Design storm ARI (years)	90th %ile 5 day	100	100	100
Design storm duration (min)	7200	4,320.00	4,320.00	4,320.00
Sediment storage (% of settling zone)	50%	0%	0%	0%
Catchment area (ha)	10.9	19.9	20.7	102.9
Rainfall intensity (mm/hr)	0.3	3.5	3.5	3.5
Total rainfall depth (mm)	38.4	251.3	251.3	251.3
Runoff coefficient Cv	0.75	0.40	0.40	0.40
Settling volume (ML)	3.1	20.0	20.8	103.4
Sediment storage volume (ML)	1.6	0.0	0.0	0.0
Total required volume (ML)	4.7	20.0	20.8	103.4
Proposed volume (ML)	4.7	20.0	20.8	103.4

Landform	Year 21
Storage Name	**CD8**
Runoff type	Clean
Design criteria	100yr ARI 72hr
Design storm ARI (years)	100
Design storm duration (min)	4,320.00
Sediment storage (% of settling zone)	0%
Catchment area (ha)	18.3
Rainfall intensity (mm/hr)	3.5
Total rainfall depth (mm)	251.3
Runoff coefficient Cv	0.40
Settling volume (ML)	18.4
Sediment storage volume (ML)	0.0
Total required volume (ML)	18.4
Proposed volume (ML)	18.4

Table B-1 Preliminary sizing of diversion drains for Year 1

Drain	Design flow^ (m^3/s)	Shape	Side slope (v:h)	Base width (m)	Min grade (%)	Design depth^^ (m)	Min depth^^^ (m)
CW1	84.9	Trapezoidal	1:3	6	0.5%	2.4	2.7
CW2	23.6	Trapezoidal	1:3	6	1.0%	1.1	1.4
CW4	15.0	Trapezoidal	1:3	6	0.5%	1.0	1.3
CW5	23.2	Trapezoidal	1:3	4	0.5%	1.5	1.8
DW1	8.3	Trapezoidal	1:3	2	1.1%	0.9	1.2
DW2	13.5	Trapezoidal	1:3	2	1.5%	1.0	1.3
DW18	6.7	Trapezoidal	1:3	2	0.5%	1.0	1.3

Notes. ^ Design flow is 100 year ARI critical duration storm peak flow estimated by XPSWMM model. ^^ Design depth calculated using manning's equation. ^^^ Minimum depth calculated for nominal freeboard of 300mm.

Table B-2 Preliminary sizing of diversion drains for Year 5

Drain	Design flow (m^3/s)	Shape	Side slope (v:h)	Base width (m)	Min grade (%)	Design depth^^ (m)	Min depth^^^ (m)
CW1	69.1	Trapezoidal	1:3	6	0.5%	2.2	2.5
CW2	16.5	Trapezoidal	1:3	6	1.0%	0.9	1.2
CW8	51.8	Trapezoidal	1:3	6	0.5%	1.9	2.2
CW9	51.8	Trapezoidal	1:3	6	1.5%	1.4	1.7
DW1	9.9	Trapezoidal	1:3	2	1.1%	1.0	1.3
DW2	38.3	Trapezoidal	1:3	4	1.5%	1.4	1.7
DW3	13.1	Trapezoidal	1:3	2	0.5%	1.3	1.6
DW4	18.1	Trapezoidal	1:3	4	0.5%	1.3	1.6
DW5	7.1	Trapezoidal	1:3	2	0.5%	1.0	1.3
DW7	27.6	Trapezoidal	1:3	6	0.5%	1.4	1.7
DW19	3.0	Trapezoidal	1:3	2	0.5%	0.7	1.0

Notes. ^ Design flow is 100 year ARI critical duration storm peak flow estimated by XPSWMM model. ^^ Design depth calculated using manning's equation. ^^^ Minimum depth calculated for nominal freeboard of 300mm.

Table B-3 Preliminary sizing of diversion drains for Year 10

Drain	Design flow (m^3/s)	Shape	Side slope (v:h)	Base width (m)	Min grade (%)	Design depth^^ (m)	Min depth^^^ (m)
CW1	39.5	Trapezoidal	1:3	6	0.5%	1.7	2.0
CW2	16.5	Trapezoidal	1:3	6	1.0%	0.9	1.1
CW9	17.3	Trapezoidal	1:3	6	1.5%	0.8	1.1
CW10	42.9	Trapezoidal	1:3	6	0.5%	1.7	2.0
DW1	11.4	Trapezoidal	1:3	2	1.1%	1.0	1.3
DW2	32.2	Trapezoidal	1:3	4	1.5%	1.3	1.6
DW3	13.4	Trapezoidal	1:3	2	0.5%	1.3	1.6
DW5	6.8	Trapezoidal	1:3	2	0.5%	1.0	1.3
DW6	11.4	Trapezoidal	1:3	2	0.5%	1.2	1.5
DW7	34.3	Trapezoidal	1:3	6	0.5%	1.5	1.8
DW8	26.0	Trapezoidal	1:3	4	0.5%	1.5	1.8
DW9	27.6	Trapezoidal	1:3	4	0.5%	1.6	1.9
DW19	3.0	Trapezoidal	1:3	2	0.5%	0.7	1.0

Notes. ^ Design flow is 100 year ARI critical duration storm peak flow estimated by XPSWMM model. ^^ Design depth calculated using manning’s equation. ^^^ Minimum depth calculated for nominal freeboard of 300mm.

Table B-4 Preliminary sizing of diversion drains for Year 21

Drain	Design flow (m^3/s)	Shape	Side slope (v:h)	Base width (m)	Min grade (%)	Design depth^^ (m)	Min depth^^^ (m)
CW1	88.8	Trapezoidal	1:3	6	0.5%	2.5	2.8
CW2	16.5	Trapezoidal	1:3	6	1.0%	0.9	1.2
CW9	6.2	Trapezoidal	1:3	6	1.5%	0.5	0.8
CW15	2.7	Trapezoidal	1:3	2	9.0%	0.3	0.6
CW16	6.2	Trapezoidal	1:3	2	0.5%	0.9	1.2
DW1	11.4	Trapezoidal	1:3	2	1.1%	1.0	1.3
DW2	32.2	Trapezoidal	1:3	4	1.5%	1.3	1.6
DW3	13.4	Trapezoidal	1:3	2	0.5%	1.3	1.6
DW5	6.7	Trapezoidal	1:3	2	0.5%	1.0	1.3
DW6	14.1	Trapezoidal	1:3	2	0.5%	1.4	1.7
DW7	96.5	Trapezoidal	1:3	8	0.5%	2.4	2.7
DW10	8.7	Trapezoidal	1:3	2	0.5%	1.1	1.4
DW13	11.2	Trapezoidal	1:3	2	1.5%	1.0	1.3
DW14	15.4	Trapezoidal	1:3	2	0.5%	1.4	1.7
DW15	28.8	Trapezoidal	1:3	4	1.0%	1.4	1.7
DW16	13.9	Trapezoidal	1:3	2	0.5%	1.3	1.6
DW17	14.3	Trapezoidal	1:3	2	1.0%	1.2	1.5
DW19	3.0	Trapezoidal	1:3	2	0.5%	0.7	1.0

Notes. ^ Design flow is 100 year ARI critical duration storm peak flow estimated by XPSWMM model. ^^ Design depth calculated using manning’s equation. ^^^ Minimum depth calculated for nominal freeboard of 300mm.

Appendix C

Water balance modelling data

Table C-1 Water balance catchment areas and landuses for Year 1 landform

Storage name	Landuse	Area (ha)
MD2	Water	3.2
MD3	Undisturbed	14.9
MD3	Water	4.1
MD4	Irrigation	53.3
MD4	Irrigation Cont	13.4
MD4	Undisturbed	44.5
MD4	Water	1.0
Nagero Creek	Industrial	36.0
Nagero Creek	Irrigation Cont	22.0
Nagero Creek	Undisturbed	3673.0
Pit	Industrial	9.6
Pit	Pit	80.8
Pit	Spoil	166.1
Pit	Undisturbed	112.6
SD1	Industrial	8.2
SD1	Undisturbed	0.7
SD1	Water	0.4
SD2	Industrial	12.2
SD2	Undisturbed	0.8
SD2	Water	1.5
SD3	Industrial	6.6
SD3	Rehabilitation	68.9
SD3	Spoil	1.5
SD3	Undisturbed	22.1
SD3	Water	4.6
SD5	Industrial	2.4
SD5	Undisturbed	0.0
SD5	Water	0.3
SD6	Industrial	2.1
SD6	Undisturbed	15.4
SD6	Water	2.7
SD23	Soil Stockpile	29.4

Table C-2 Water balance catchment areas and landuses for Year 5 landform

Storage name	Landuse	Area (ha)
MD3	Undisturbed	14.9
MD3	Water	4.1
MD4	Irrigation	53.3
MD4	Irrigation Cont	13.4
MD4	Undisturbed	44.5
MD4	Water	1.0
MD5	Water	9.0
Nagero Creek	Industrial	48.6
Nagero Creek	Irrigation Cont	22.0
Nagero Creek	Undisturbed	2840.4
Pit	Industrial	5.1
Pit	Pit	150.3
Pit	Spoil	351.3
SD10	Industrial	6.8
SD10	Undisturbed	2.7
SD10	Water	1.2
SD11	Industrial	2.0
SD11	Water	1.5
SD12	Industrial	21.7
SD12	Undisturbed	0.7
SD12	Water	0.8
SD3	Industrial	17.3
SD3	Rehabilitation	132.3
SD3	Spoil	40.4
SD3	Undisturbed	17.8
SD3	Water	4.7
SD5	Industrial	4.7
SD5	Undisturbed	0.2
SD6	Industrial	1.0
SD6	Undisturbed	6.2
SD6	Water	2.7
SD7	Rehabilitation	27.3
SD7	Spoil	58.3
SD7	Undisturbed	186.9
SD7	Industrial	2.1
SD8	Industrial	4.5
SD8	Undisturbed	0.6
SD9	Industrial	3.6
SD9	PreStrip	99.4
SD9	Rehabilitation	2.5
SD9	Spoil	2.2
SD9	Undisturbed	182.1
SD9	Water	1.5
SD23	Soil stockpile	20.4

Table C-3 Water balance catchment areas and landuses for Year 10 landform

Storage name	Landuse	Area (ha)
MD3	Undisturbed	14.9
MD3	Water	4.1
MD4	Irrigation	53.3
MD4	Irrigation Cont	13.4
MD4	Undisturbed	44.5
MD4	Water	1.0
MD5	Water	9.0
Nagero Creek	Industrial	46.3
Nagero Creek	Irrigation Cont	22.0
Nagero Creek	Undisturbed	2505.8
Pit	Industrial	21.8
Pit	Pit	159.8
Pit	Rehabilitation	2.5
Pit	Spoil	180.0
Pit	Undisturbed	42.4
SD7	Undisturbed	187.4
SD7	Rehabilitation	77.9
SD7	Industrial	2.4
SD7	Spoil	55.0
SD10	Industrial	6.8
SD10	Undisturbed	2.7
SD10	Water	1.2
SD11	Industrial	2.0
SD11	Water	1.5
SD12	Industrial	21.7
SD12	Undisturbed	0.7
SD12	Water	0.8
SD13	Rehabilitation	136.0
SD13	Spoil	231.6
SD14	Industrial	1.3
SD14	PreStrip	130.2
SD14	Undisturbed	180.5
SD14	Water	1.6
SD3	Industrial	16.1
SD3	Rehabilitation	173.0
SD3	Undisturbed	17.8
SD3	Water	4.7
SD5	Industrial	4.7
SD5	Undisturbed	0.2
SD6	Industrial	1.0
SD6	Undisturbed	6.2
SD6	Water	2.7
SD8	Industrial	4.5
SD8	Undisturbed	0.6

Storage name	Landuse	Area (ha)
SD23	Soil stockpile	20.4

Table C-4 Water balance catchment areas and landuses for Year 21 landform

Storage name	Landuse	Area (ha)
MD3	Undisturbed	14.9
MD3	Water	4.1
MD4	Irrigation	53.3
MD4	Irrigation Cont	13.4
MD4	Undisturbed	44.5
MD4	Water	1.0
MD5	Water	9.0
Nagero Creek	Industrial	50.1
Nagero Creek	Irrigation Cont	22.0
Nagero Creek	Rehabilitation	431.1
Nagero Creek	Undisturbed	2116.8
Pit	Industrial	1.2
Pit	Pit	217.2
Pit	Spoil	211.9
Pit	Undisturbed	100.8
SD10	Industrial	6.8
SD10	Undisturbed	2.7
SD10	Water	1.2
SD11	Industrial	2.0
SD11	Water	1.5
SD12	Industrial	21.7
SD12	Undisturbed	0.7
SD12	Water	0.8
SD23	Soil stockpile	20.4
SD24	Spoil	10.9
CD5	Undisturbed	19.9
CD6	Undisturbed	20.7
CD7	Undisturbed	102.9
CD8	Undisturbed	18.3
SD19	Rehabilitation	429.0
SD19	Industrial	5.2
SD20	Spoil	89.3
SD20	Undisturbed	8.2
SD20	Water	2.5
SD21	Spoil	113.8
SD21	Industrial	7.3
SD22	Spoil	5.1
SD3	Industrial	16.1
SD3	Rehabilitation	173.0
SD3	Undisturbed	17.8
SD3	Water	4.7
SD5	Industrial	4.7
SD5	Undisturbed	0.2
SD6	Industrial	1.0

Storage name	Landuse	Area (ha)
SD6	Undisturbed	6.2
SD6	Water	2.7
SD8	Industrial	4.5
SD8	Undisturbed	0.6

Appendix D

Hydrologic modelling data

Table D-1 XPSWMM catchment parameters for Year 1 landform

Water balance catchment	Runoff type	XPSWMM Node Name	Infiltration Reference	Area (ha)	Impervious %	Slope (m/m)
MD2	Contaminated	MD2	Water	3.2	100	0.001
MD3	Contaminated	MD3	Undisturbed	14.9	0	0.022
MD3	Contaminated	MD3	Water	4.1	100	0.001
MD4	Contaminated	MD4	Irrigation	53.3	0	0.012
MD4	Contaminated	MD4	Irrigation Cont	13.4	0	0.012
MD4	Contaminated	MD4	Undisturbed	44.5	0	0.019
MD4	Contaminated	MD4	Water	1.0	100	0.001
Nagero Creek	Clean	CW1_1	Undisturbed	18.5	0	0.024
Nagero Creek	Clean	CW1_2	Industrial	6.3	90	0.020
Nagero Creek	Clean	CW1_2	Undisturbed	435.4	0	0.040
Nagero Creek	Clean	CW1_3	Industrial	3.7	90	0.020
Nagero Creek	Clean	CW1_3	Undisturbed	551.3	0	0.048
Nagero Creek	Clean	CW1_4	Industrial	2.4	90	0.020
Nagero Creek	Clean	CW1_4	Undisturbed	264.5	0	0.038
Nagero Creek	Clean	CW2_1	Industrial	1.2	90	0.020
Nagero Creek	Clean	CW2_1	Undisturbed	164.1	0	0.033
Nagero Creek	Clean	CW4_1	Undisturbed	79.9	0	0.055
Nagero Creek	Clean	CW4_2	Industrial	0.2	90	0.020
Nagero Creek	Clean	CW4_2	Undisturbed	156.1	0	0.044
Nagero Creek	Clean	CW5_1	Undisturbed	133.7	0	0.085
Nagero Creek	Clean	CW5_2	Undisturbed	85.6	0	0.066
Nagero Creek	Clean	CW5_3	Undisturbed	74.9	0	0.068
Nagero Creek	Clean	Nagero_2	Industrial	4.2	90	0.020
Nagero Creek	Clean	Nagero_2	Undisturbed	322.4	0	0.045
Nagero Creek	Clean	Nagero_4	Industrial	1.9	90	0.020
Nagero Creek	Clean	Nagero_4	Irrigation Cont	22.0	0	0.012
Nagero Creek	Clean	Nagero_4	Undisturbed	55.9	0	0.030
Nagero Creek	Clean	Nagero_5	Industrial	16.1	90	0.020
Nagero Creek	Clean	Nagero_5	Undisturbed	1170.7	0	0.039
Nagero Creek	Clean	TarraSBs	Undisturbed	160.0	0	0.036
Pit	Contaminated	Pit	Industrial	9.6	90	0.020
Pit	Contaminated	Pit	Pit	80.8	0	0.356
Pit	Contaminated	Pit	Spoil	166.1	0	0.046
Pit	Contaminated	Pit	Undisturbed	112.6	0	0.018
SD1	Dirty	SD1	Industrial	8.2	90	0.020
SD1	Dirty	SD1	Undisturbed	0.7	0	0.020
SD1	Dirty	SD1	Water	0.4	100	0.001
SD2	Contaminated	SD2	Industrial	12.2	90	0.020
SD2	Contaminated	SD2	Undisturbed	0.8	0	0.010
SD2	Contaminated	SD2	Water	1.5	100	0.001
SD3	Dirty	DW1_1	Rehabilitation	29.6	0	0.160
SD3	Dirty	DW1_1	Undisturbed	3.7	0	0.010

Water balance catchment	Runoff type	XPSWMM Node Name	Infiltration Reference	Area (ha)	Impervious %	Slope (m/m)
SD3	Dirty	DW2_1	Industrial	6.3	90	0.020
SD3	Dirty	DW2_1	Rehabilitation	39.3	0	0.160
SD3	Dirty	DW2_1	Spoil	1.5	0	0.010
SD3	Dirty	DW2_1	Undisturbed	1.2	0	0.010
SD3	Dirty	SD3_In	Industrial	0.3	90	0.020
SD3	Dirty	SD3_In	Undisturbed	17.2	0	0.013
SD3	Dirty	SD3_In	Water	4.6	100	0.001
SD5	Dirty	SD5	Industrial	2.4	90	0.020
SD5	Dirty	SD5	Undisturbed	0.0	0	0.020
SD5	Dirty	SD5	Water	0.3	100	0.001
SD6	Dirty	SD6	Industrial	2.1	90	0.020
SD6	Dirty	SD6	Undisturbed	15.4	0	0.009
SD6	Dirty	SD6	Water	2.7	100	0.001
SD23	Dirty	SD23	Soil stockpile	29.4	0	0.020

Table D-2 XPSWMM catchment parameters for Year 5 landform

Water balance catchment	Runoff type	XPSWMM Node Name	Infiltration Reference	Area (ha)	Impervious %	Slope (m/m)
MD3	Contaminated	MD3	Undisturbed	14.9	0	0.022
MD3	Contaminated	MD3	Water	4.1	100	0.001
MD4	Contaminated	MD4	Irrigation	53.3	0	0.012
MD4	Contaminated	MD4	Irrigation Cont	13.4	0	0.012
MD4	Contaminated	MD4	Undisturbed	44.5	0	0.019
MD4	Contaminated	MD4	Water	1.0	100	0.001
MD5	Contaminated	MD5	Water	9.0	100	0.001
Nagero Creek	Clean	CW1_4	Industrial	1.5	90	0.020
Nagero Creek	Clean	CW1_4	Undisturbed	82.0	0	0.045
Nagero Creek	Clean	CW2_1	Industrial	0.7	90	0.020
Nagero Creek	Clean	CW2_1	Undisturbed	150.9	0	0.033
Nagero Creek	Clean	CW2	Undisturbed	132.1	0	0.044
Nagero Creek	Clean	CW8_1	Undisturbed	28.2	0	0.120
Nagero Creek	Clean	CW8_3	Industrial	3.4	90	0.020
Nagero Creek	Clean	CW8_3	Undisturbed	169.3	0	0.060
Nagero Creek	Clean	CW8_4	Industrial	0.3	90	0.020
Nagero Creek	Clean	CW8_4	Undisturbed	408.5	0	0.080
Nagero Creek	Clean	CW8_5	Undisturbed	191.5	0	0.060
Nagero Creek	Clean	Nagero_2	Industrial	12.7	90	0.020
Nagero Creek	Clean	Nagero_2	Undisturbed	305.0	0	0.045
Nagero Creek	Clean	Nagero_4	Industrial	1.8	90	0.020
Nagero Creek	Clean	Nagero_4	Irrigation Cont	22.0	0	0.012
Nagero Creek	Clean	Nagero_4	Undisturbed	51.9	0	0.030
Nagero Creek	Clean	Nagero_5	Industrial	28.3	90	0.020
Nagero Creek	Clean	Nagero_5	Undisturbed	1160.9	0	0.039
Nagero Creek	Clean	TarraSBs	Undisturbed	160.0	0	0.036
Pit	Contaminated	Pit	Industrial	5.1	90	0.020
Pit	Contaminated	Pit	Pit	150.3	0	0.356
Pit	Contaminated	Pit	Spoil	351.3	0	0.160
SD10	Contaminated	SD10	Industrial	6.8	90	0.020
SD10	Contaminated	SD10	Undisturbed	2.7	0	0.020
SD10	Contaminated	SD10	Water	1.2	100	0.001
SD11	Contaminated	SD11	Industrial	2.0	90	0.020
SD11	Contaminated	SD11	Water	1.5	100	0.001
SD12	Contaminated	SD12	Industrial	21.7	90	0.020
SD12	Contaminated	SD12	Undisturbed	0.7	0	0.020
SD12	Contaminated	SD12	Water	0.8	100	0.001
SD3	Dirty	DW1_1	Industrial	6.1	90	0.020
SD3	Dirty	DW1_1	Rehabilitation	30.8	0	0.160
SD3	Dirty	DW2_1	Industrial	10.3	90	0.020
SD3	Dirty	DW2_1	Rehabilitation	101.5	0	0.160
SD3	Dirty	DW2_1	Spoil	40.4	0	0.050

Water balance catchment	Runoff type	XPSWMM Node Name	Infiltration Reference	Area (ha)	Impervious %	Slope (m/m)
SD3	Dirty	DW2_1	Undisturbed	1.3	0	0.020
SD3	Dirty	SD3_In	Industrial	1.0	90	0.020
SD3	Dirty	SD3_In	Undisturbed	16.5	0	0.013
SD3	Dirty	SD3_In	Water	4.7	100	0.001
SD5	Dirty	SD5	Industrial	4.7	90	0.020
SD5	Dirty	SD5	Undisturbed	0.2	0	0.020
SD6	Dirty	SD6	Industrial	1.0	90	0.020
SD6	Dirty	SD6	Undisturbed	6.2	0	0.009
SD6	Dirty	SD6	Water	2.7	100	0.001
SD8	Dirty	SD8	Industrial	4.5	90	0.020
SD8	Dirty	SD8	Undisturbed	0.6	0	0.020
SD9	Dirty	DW4_1	Industrial	2.6	90	0.020
SD9	Dirty	DW4_1	PreStrip	68.6	0	0.019
SD9	Dirty	DW4_1	Rehabilitation	2.5	0	0.160
SD9	Dirty	DW4_1	Spoil	2.2	0	0.160
SD9	Dirty	DW4_1	Undisturbed	89.0	0	0.019
SD9	Dirty	DW4_2	Industrial	1.9	90	0.020
SD9	Dirty	DW4_2	PreStrip	30.8	0	0.024
SD9	Dirty	DW4_2	Undisturbed	93.8	0	0.024
SD7	Dirty	DW3_1	Rehabilitation	14.0	0	0.160
SD7	Dirty	DW3_1	Undisturbed	16.7	0	0.191
SD7	Dirty	DW3_2	Rehabilitation	6.7	0	0.160
SD7	Dirty	DW3_2	Undisturbed	22.5	0	0.144
SD7	Dirty	DW3_3	Rehabilitation	4.3	0	0.160
SD7	Dirty	DW3_3	Undisturbed	28.0	0	0.120
SD7	Dirty	DW3_4	Rehabilitation	1.9	0	0.160
SD7	Dirty	DW3_4	Undisturbed	95.6	0	0.070
SD7	Dirty	DW5_2	Undisturbed	17.0	0	0.070
SD7	Dirty	DW5_2	Spoil	8.5	0	0.160
SD7	Dirty	DW5_1	Undisturbed	7.3	0	0.064
SD7	Dirty	DW5_1	Spoil	7.6	0	0.160
SD7	Dirty	DW5_1	Industrial	2.1	90	0.020
SD7	Dirty	DW7_1	Spoil	41.4	0	0.160
SD23	Dirty	SD23	Soil stockpile	20.4	0	0.020

Table D-3 XPSWMM catchment parameters for Year 10 landform

Water balance catchment	Runoff type	XPSWMM Node Name	Infiltration Reference	Area (ha)	Impervious %	Slope (m/m)
MD3	Contaminated	MD3	Undisturbed	14.9	0	0.022
MD3	Contaminated	MD3	Water	4.1	100	0.001
MD4	Contaminated	MD4	Irrigation	53.3	0	0.012
MD4	Contaminated	MD4	Irrigation Cont	13.4	0	0.012
MD4	Contaminated	MD4	Undisturbed	44.5	0	0.019
MD4	Contaminated	MD4	Water	1.0	100	0.001
MD5	Contaminated	MD5	Water	9.0	100	0.001
Nagero Creek	Clean	CW1_4	Industrial	1.8	90	0.020
Nagero Creek	Clean	CW1_4	Undisturbed	37.3	0	0.025
Nagero Creek	Clean	CW10_1	Industrial	0.8	90	0.020
Nagero Creek	Clean	CW10_1	Undisturbed	17.1	0	0.100
Nagero Creek	Clean	CW10_2	Industrial	0.3	90	0.020
Nagero Creek	Clean	CW10_2	Undisturbed	279.9	0	0.090
Nagero Creek	Clean	CW10_3	Undisturbed	211.3	0	0.070
Nagero Creek	Clean	CW10_5	Undisturbed	105.0	0	0.060
Nagero Creek	Clean	CW10_6	Undisturbed	38.0	0	0.090
Nagero Creek	Clean	CW2_1	Industrial	0.7	90	0.020
Nagero Creek	Clean	CW2_1	Undisturbed	150.9	0	0.033
Nagero Creek	Clean	CW2	Industrial	0.1	90	0.020
Nagero Creek	Clean	CW2	Undisturbed	132.0	0	0.044
Nagero Creek	Clean	Nagero_2	Industrial	12.7	90	0.020
Nagero Creek	Clean	Nagero_2	Undisturbed	200.2	0	0.021
Nagero Creek	Clean	Nagero_4	Industrial	1.8	90	0.020
Nagero Creek	Clean	Nagero_4	Irrigation Cont	22.0	0	0.012
Nagero Creek	Clean	Nagero_4	Undisturbed	51.9	0	0.030
Nagero Creek	Clean	Nagero_5	Industrial	28.3	90	0.020
Nagero Creek	Clean	Nagero_5	Undisturbed	1122.4	0	0.039
Nagero Creek	Clean	TarraSBs	Undisturbed	160.0	0	0.036
Pit	Contaminated	Pit	Industrial	21.8	90	0.020
Pit	Contaminated	Pit	Pit	159.8	0	0.356
Pit	Contaminated	Pit	Rehabilitation	2.5	0	0.160
Pit	Contaminated	Pit	Spoil	180.0	0	0.160
Pit	Contaminated	Pit	Undisturbed	42.4	0	0.090
SD10	Contaminated	SD10	Industrial	6.8	90	0.020
SD10	Contaminated	SD10	Undisturbed	2.7	0	0.020
SD10	Contaminated	SD10	Water	1.2	100	0.001
SD11	Contaminated	SD11	Industrial	2.0	90	0.020
SD11	Contaminated	SD11	Water	1.5	100	0.001
SD12	Contaminated	SD12	Industrial	21.7	90	0.020
SD12	Contaminated	SD12	Undisturbed	0.7	0	0.020
SD12	Contaminated	SD12	Water	0.8	100	0.001
SD7	Dirty	DW3_1	Undisturbed	16.2	0	0.191

Water balance catchment	Runoff type	XPSWMM Node Name	Infiltration Reference	Area (ha)	Impervious %	Slope (m/m)
SD7	Dirty	DW3_1	Rehabilitation	14.0	0	0.160
SD7	Dirty	DW3_2	Undisturbed	22.5	0	0.144
SD7	Dirty	DW3_2	Rehabilitation	6.5	0	0.160
SD7	Dirty	DW3_3	Undisturbed	28.0	0	0.120
SD7	Dirty	DW3_3	Rehabilitation	4.2	0	0.160
SD7	Dirty	DW3_4	Undisturbed	95.9	0	0.070
SD7	Dirty	DW3_4	Rehabilitation	8.2	0	0.160
SD7	Dirty	DW5_1	Undisturbed	7.4	0	0.070
SD7	Dirty	DW5_1	Rehabilitation	10.9	0	0.160
SD7	Dirty	DW5_1	Industrial	2.4	90	0.020
SD7	Dirty	DW5_2	Undisturbed	17.0	0	0.064
SD7	Dirty	DW5_2	Rehabilitation	6.5	0	0.160
SD7	Dirty	DW6_1	Spoil	38.4	0	0.160
SD7	Dirty	SD7	Spoil	54.7	0	0.160
SD7	Dirty	SD7	Rehabilitation	27.6	0	0.160
SD13	Dirty	DW7_2	Rehabilitation	9.1	0	0.160
SD13	Dirty	DW7_2	Spoil	29.5	0	0.160
SD13	Dirty	DW7_2	Spoil	162.9	0	0.012
SD13	Dirty	DW8_1	Rehabilitation	126.3	0	0.160
SD14	Dirty	DW9_1	Industrial	0.9	90	0.020
SD14	Dirty	DW9_1	PreStrip	65.2	0	0.070
SD14	Dirty	DW9_1	Undisturbed	70.4	0	0.070
SD14	Dirty	DW9_2	Industrial	0.4	90	0.020
SD14	Dirty	DW9_2	PreStrip	73.2	0	0.030
SD14	Dirty	DW9_2	Undisturbed	101.4	0	0.030
SD14	Dirty	DW9_2	Water	1.6	100	0.001
SD3	Dirty	DW1_1	Industrial	5.1	90	0.020
SD3	Dirty	DW1_1	Rehabilitation	32.2	0	0.160
SD3	Dirty	DW2_1	Industrial	10.0	90	0.020
SD3	Dirty	DW2_1	Rehabilitation	140.9	0	0.160
SD3	Dirty	DW2_1	Undisturbed	1.3	0	0.020
SD3	Dirty	SD3_In	Industrial	1.0	90	0.020
SD3	Dirty	SD3_In	Undisturbed	16.5	0	0.013
SD3	Dirty	SD3_In	Water	4.7	100	0.001
SD5	Dirty	SD5	Industrial	4.7	90	0.020
SD5	Dirty	SD5	Undisturbed	0.2	0	0.020
SD6	Dirty	SD6	Industrial	1.0	90	0.020
SD6	Dirty	SD6	Undisturbed	6.2	0	0.009
SD6	Dirty	SD6	Water	2.7	100	0.001
SD8	Dirty	SD8	Industrial	4.5	90	0.020
SD8	Dirty	SD8	Undisturbed	0.6	0	0.020
SD23	Dirty	SD23	Soil stockpile	20.4	0	0.020

Table D-4 XPSWMM catchment parameters for Year 21 landform

Water balance catchment	Runoff type	XPSWMM Node Name	Infiltration Reference	Area (ha)	Impervious %	Slope (m/m)
MD3	Contaminated	MD3	Undisturbed	14.9	0	0.022
MD3	Contaminated	MD3	Water	4.1	100	0.001
MD4	Contaminated	MD4	Irrigation	53.3	0	0.012
MD4	Contaminated	MD4	Irrigation Cont	13.4	0	0.012
MD4	Contaminated	MD4	Undisturbed	44.5	0	0.019
MD4	Contaminated	MD4	Water	1.0	100	0.001
MD5	Contaminated	MD5	Water	9.0	100	0.001
Nagero Creek	Clean	CW1_4	Industrial	1.5	90	0.020
Nagero Creek	Clean	CW1_4	Undisturbed	34.9	0	0.025
Nagero Creek	Clean	CW2_1	Industrial	0.7	90	0.020
Nagero Creek	Clean	CW2_1	Undisturbed	150.9	0	0.033
CW5	Clean	CW5	Undisturbed	19.9	0	0.100
CW6	Clean	CW6	Undisturbed	20.7	0	0.100
CW7	Clean	CW7	Undisturbed	102.9	0	0.100
CW8	Clean	CW8	Undisturbed	18.3	0	0.100
Nagero Creek	Clean	CW2	Industrial	0.1	90	0.020
Nagero Creek	Clean	CW2	Undisturbed	132.0	0	0.044
Nagero Creek	Clean	Nagero_2	Industrial	15.6	90	0.020
Nagero Creek	Clean	Nagero_2	Undisturbed	201.8	0	0.021
Nagero Creek	Clean	Nagero_4	Industrial	1.8	90	0.020
Nagero Creek	Clean	Nagero_4	Irrigation Cont	22.0	0	0.012
Nagero Creek	Clean	Nagero_4	Undisturbed	51.9	0	0.030
Nagero Creek	Clean	Nagero_5	Industrial	29.4	90	0.020
Nagero Creek	Clean	Nagero_5	Undisturbed	1129.6	0	0.039
Nagero Creek	Clean	TarraSBs	Undisturbed	160.0	0	0.036
Nagero Creek	Clean	DW3_1	Undisturbed	16.2	0	0.191
Nagero Creek	Clean	DW3_1	Rehabilitation	14.0	0	0.160
Nagero Creek	Clean	DW3_2	Undisturbed	22.5	0	0.144
Nagero Creek	Clean	DW3_2	Rehabilitation	6.5	0	0.160
Nagero Creek	Clean	DW3_3	Undisturbed	28.0	0	0.120
Nagero Creek	Clean	DW3_3	Rehabilitation	4.2	0	0.160
Nagero Creek	Clean	DW3_4	Undisturbed	95.9	0	0.070
Nagero Creek	Clean	DW3_4	Rehabilitation	8.2	0	0.160
Nagero Creek	Clean	DW5_1	Undisturbed	7.4	0	0.070
Nagero Creek	Clean	DW5_1	Rehabilitation	10.9	0	0.160
Nagero Creek	Clean	DW5_1	Industrial	2.4	90	0.020
Nagero Creek	Clean	DW5_2	Undisturbed	17.0	0	0.064
Nagero Creek	Clean	DW5_2	Rehabilitation	6.5	0	0.160
Nagero Creek	Clean	DW6_1	Rehabilitation	38.4	0	0.160
Nagero Creek	Clean	DW7_1	Rehabilitation	122.0	0	0.160
Nagero Creek	Clean	DW7_2	Rehabilitation	217.0	0	0.160
Nagero Creek	Clean	CW16_1	Undisturbed	28.5	0	0.100

Water balance catchment	Runoff type	XPSWMM Node Name	Infiltration Reference	Area (ha)	Impervious %	Slope (m/m)
Nagero Creek	Clean	CW16_2	Undisturbed	24.6	0	0.100
Nagero Creek	Clean	DW15_1	Rehabilitation	4.9	0	0.160
Nagero Creek	Clean	DW15_1	Undisturbed	12.8	0	0.100
Pit	Contaminated	Pit	Industrial	1.2	90	0.020
Pit	Contaminated	Pit	Pit	217.2	0	0.356
Pit	Contaminated	Pit	Spoil	211.9	0	0.100
Pit	Contaminated	Pit	Undisturbed	100.8	0	0.160
SD10	Contaminated	SD10	Industrial	6.8	90	0.020
SD10	Contaminated	SD10	Undisturbed	2.7	0	0.020
SD10	Contaminated	SD10	Water	1.2	100	0.001
SD11	Contaminated	SD11	Industrial	2.0	90	0.020
SD11	Contaminated	SD11	Water	1.5	100	0.001
SD12	Contaminated	SD12	Industrial	21.7	90	0.020
SD12	Contaminated	SD12	Undisturbed	0.7	0	0.020
SD12	Contaminated	SD12	Water	0.8	100	0.001
SD19	Dirty	DW15	Rehabilitation	275.5	0	0.015
SD19	Dirty	DW17	Rehabilitation	151.7	0	0.015
SD19	Dirty	DW17	Spoil	2.4	0	0.160
SD19	Dirty	DW17	Industrial	4.9	90	0.020
SD20	Dirty	DW13	Spoil	36.4	0	0.040
SD20	Dirty	DW14	Spoil	51.6	0	0.040
SD20	Dirty	DW14	Undisturbed	8.2	0	0.100
SD20	Dirty	SD20	Spoil	1.3	0	0.010
SD20	Dirty	SD20	Water	2.5	100	0.001
SD21	Dirty	DW10	Spoil	29.2	0	0.020
SD21	Dirty	DW10	Industrial	6.7	90	0.020
SD21	Dirty	DW16	Spoil	69.6	0	0.020
SD21	Dirty	SD21	Spoil	15.4	0	0.020
SD22	Dirty	SD22	Spoil	5.1	0	0.100
SD3	Dirty	DW1_1	Industrial	5.1	90	0.020
SD3	Dirty	DW1_1	Rehabilitation	32.2	0	0.160
SD3	Dirty	DW2_1	Industrial	10.0	90	0.020
SD3	Dirty	DW2_1	Rehabilitation	140.9	0	0.160
SD3	Dirty	DW2_1	Undisturbed	1.3	0	0.020
SD3	Dirty	SD3_In	Industrial	1.0	90	0.020
SD3	Dirty	SD3_In	Undisturbed	16.5	0	0.013
SD3	Dirty	SD3_In	Water	4.7	100	0.001
SD5	Dirty	SD5	Industrial	4.7	90	0.020
SD5	Dirty	SD5	Undisturbed	0.2	0	0.020
SD6	Dirty	SD6	Industrial	1.0	90	0.020
SD6	Dirty	SD6	Undisturbed	6.2	0	0.009
SD6	Dirty	SD6	Water	2.7	100	0.001
SD8	Dirty	SD8	Industrial	4.5	90	0.020
SD8	Dirty	SD8	Undisturbed	0.6	0	0.020

Water balance catchment	Runoff type	XPSWMM Node Name	Infiltration Reference	Area (ha)	Impervious %	Slope (m/m)
SD23	Dirty	SD23	Soil stockpile	20.4	0	0.020
SD24	Dirty	SD24	Spoil	10.9	0	0.100

Appendix E

High level water buying assessment

Parsons Brinckerhoff Australia Pty Limited
ABN 80 078 004 798

Level 27, Ernst & Young Centre
680 George Street
SYDNEY NSW 2000
GPO Box 5394
SYDNEY NSW 2001
Australia
Telephone +61 2 9272 5100
Facsimile +61 2 9272 5101
Email sydney@pb.com.au

Our reference 2123173C/parmenterm/RevA

13 May 2010

Ben Eastwood
Senior Environmental Scientist
Hansen Bailey Pty Ltd
PO Box 473
Singleton NSW 2330

Dear Ben

Continuation of Boggabri Coal Mine - High Level Water Buying Assessment

Thank you for the opportunity to provide Hansen Bailey with high level advice regarding the potential for securing water via the trading market for the Continuation of Boggabri Coal Mine Project. It is understood that the strategy will support the Environmental Assessment for the Project, which is currently being prepared by Hansen Bailey on behalf of Boggabri Coal (mine operators).

1. Background

Securing access to a long term water supply is a key component of the planning and approvals process for the Continuation of Boggabri Coal Mine Project.

The recent Surface Water Assessment undertaken by PB has identified a significant water deficit for the Project. A deficit of 750ML/yr is predicted for a dry year during Year 5 of the Project (taking into account rainfall runoff on contaminated catchments, groundwater inflows to the pit, and evaporation and supply from existing groundwater licences held by Boggabri Coal). Details of the water balance and assumptions are provided in the Surface Water Assessment report (PB reference: 2123173A PR_1675_RevC).

PB has undertaken a high level assessment to determine whether Boggabri Coal may be able to secure access to additional water by purchasing water entitlements via the water trading market.

This assessment focuses on the potential for purchasing entitlements from water sources in the vicinity of the Boggabri Coal Mine site

This high level assessment has been undertaken as per PB's scope of works, approved by Hansen Bailey (PB reference: LT_0116_RevA).

1.1 Location of the mine site

Boggabri Coal Mine is contained within the catchments of Nagero Creek and Bollol Creek, which are both small ephemeral tributaries of the Regulated Namoi River Water Source. The mine working area, mine infrastructure area and administration area are all contained within the Nagero Creek catchment, and only a small portion of the irrigation area is contained within the Bollol Creek catchment.

The study catchment area is approximately 4,414 ha to the point where Nagero Creek meets the floodplain, approximately 1 km downstream of the mine administration area. The study catchment is bounded by the Willowtree range to the north-east and falls generally to the south-west towards the Namoi River floodplain.

1.2 Water Requirements

Table 7-2 in PB's surface water assessment report (PB reference: 2123173A PR_1675_RevC) lists the estimated external water requirements for the site for a dry year (i.e. 10^{th} percentile rainfall year) throughout the life of the Project. Table 7-2 from the report has been reproduced below.

Table 1 Summary of external water requirements for a dry year (1940)

Landform	Contaminated water surplus / deficit (ML/yr)	External water requirement (ML/yr)	Current water entitlements (ML/yr)^	Requirement for additional water entitlements (ML/yr)
Year 1	+8	58	194	0
Year 5	-886	944	194	750
Year 10	-497	555	194	361
Year 21	-520	578	194	384

(source: PBs surface water assessment – PB reference 2123173A PR_1675_RevC)

Based on PB's surface water assessment the worst case is Year 5 with a requirement to source up to 750ML of water from external sources for a dry year. This assessment assumes that the existing groundwater licences held by Boggabri Coal will contribute 194 ML/annum to water requirement for the mine site. The volume of water required is likely to change over the life of the Project, i.e. drop back during Years 10 and 21. However, for the purposes of this high level assessment it has been assumed that an additional volume of up to 750 ML/yr may need to be accessed.

2. Potential Water Sources and Trading

The key water sources within the vicinity of the proposed mine site where water entitlements may be purchased from include the Upper Namoi and Lower Namoi Regulated Rivers Water Sources and the Upper and Lower Namoi Groundwater Sources – particularly Zones 4, 5 & 11 of the Upper Namoi Groundwater source. These water sources provide reliable water resources and have an active trading market operating and therefore are the focus for this high level assessment. The Gunnedah Basin groundwater management area has also been included.

There are various Unregulated River Water Sources within the vicinity of mine site, however, these are characterised by infrequent flow conditions. In addition, a water trading market in these streams appears to be limited or non-existent. Therefore purchasing entitlements from these unregulated Rivers is not an option that would provide the reliable and secure supply required by Boggabri Coal for the continuation of the mine site and no further investigations into sourcing additional water supply via the trading market from these streams has been included in this high level study.

2.1 Upper and Lower Namoi Regulated River Water Sources

The Namoi Regulated River Valley is the Manilla River between Split Rock Dam and Keepit Dam and the Namoi River downstream of Keepit Dam to the junction of the Namoi River and the Barwon River.

The Namoi Regulated River water source provides a secure water supply option for the continuation of the Boggabri Coal Mine.

Water Access Licences (WALs) may be traded as per the rules outlined in the *Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated Rivers Water Sources 2003* (WSP). Under the WSP the following access licence categories can be traded:

1. Regulated river (high security) access licences
2. Regulated river (general security) access licences; and
3. Supplementary access licences.

Table 2 below provides the total water source share volume for each of these access licence categories.

Table 2 Total share volumes of categories of access licences that can be traded

Access Licence category	Total share volume (ML)	Comment
Regulated river (high security)	3,498	High reliability water product
Regulated river (general security)	255,936	Lower reliability water product with continuous accounting provision.
Supplementary	115,469	Opportunistic water product. Not suitable for Boggabri Coal Mine requirements

2.1.1 Carrying over water allocations and account limits

A continuous accounting system is used in the Upper and Lower Namoi Regulated River Water Sources for general security entitlement holders.

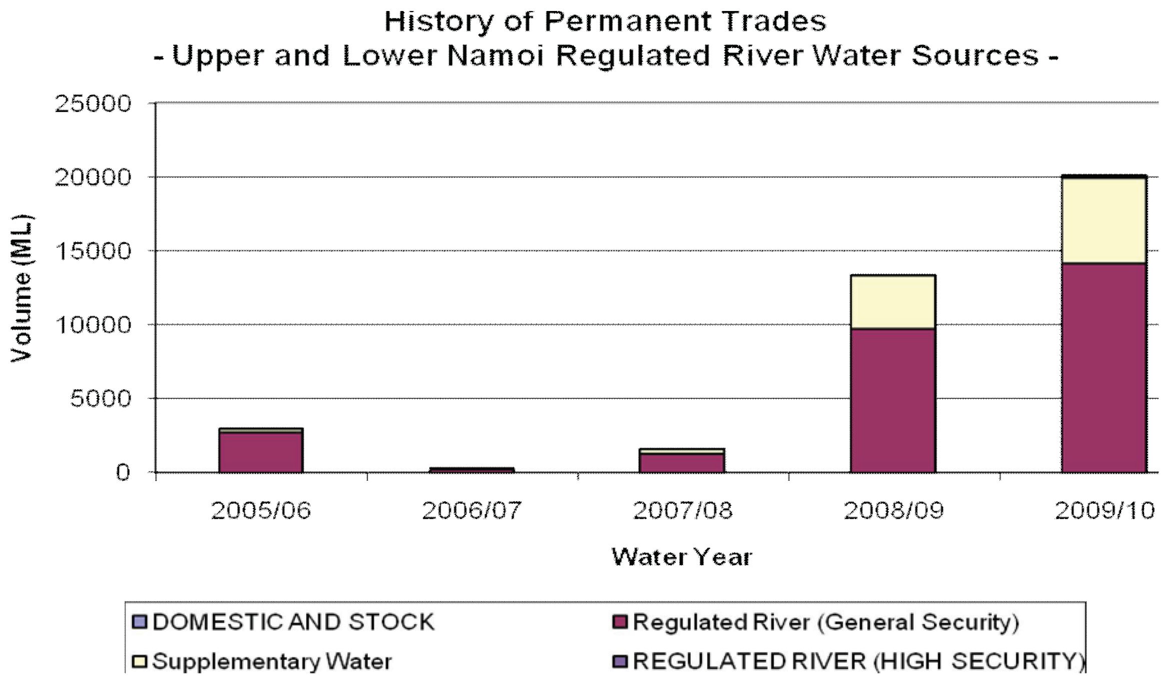
The maximum that may be held in a Regulated River (general security) account in the Lower Namoi Regulated River Water Source is 2.0 ML per unit share. The amount carried over from one year to the next is unlimited. However the maximum account balance effectively limits carryover volumes. The maximum usage (including trade) in any season is 1.25 ML per unit share. The maximum water use over any three consecutive years is 3.0 ML per unit share.

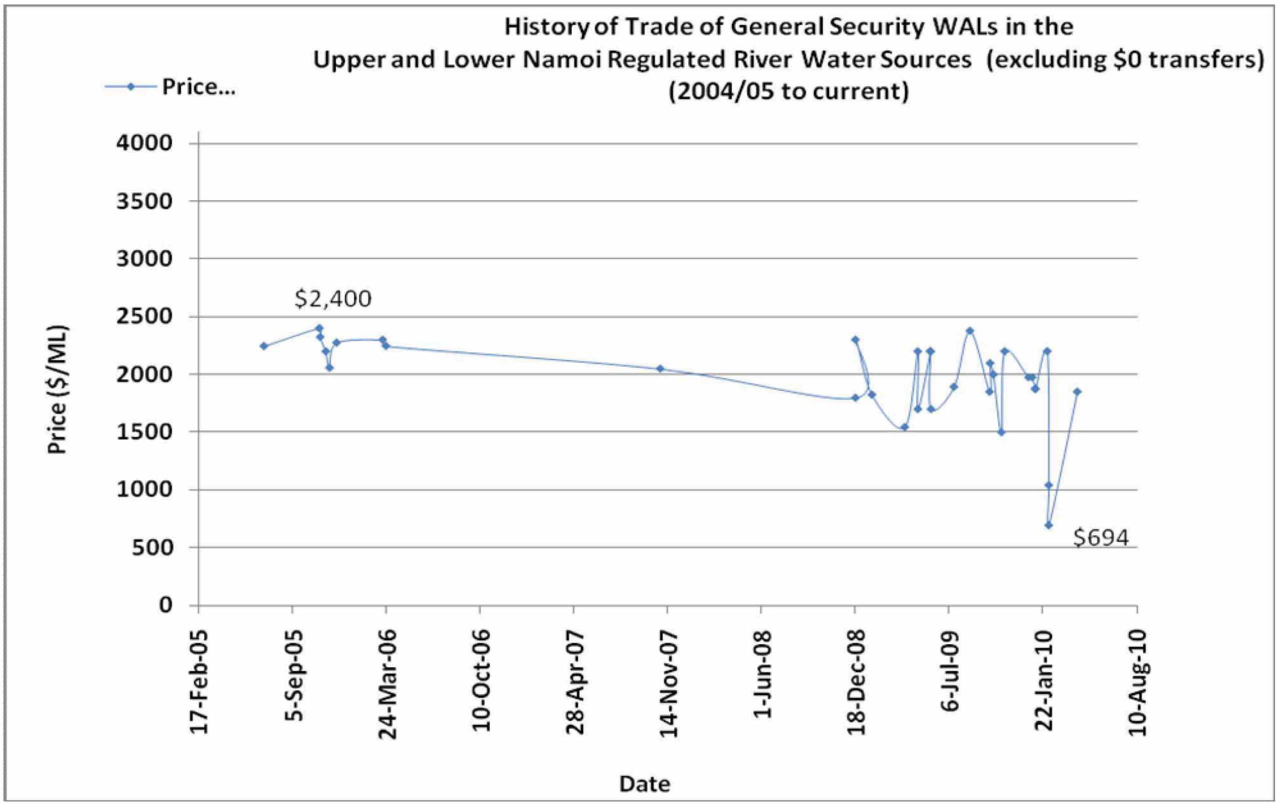
The maximum that may be held in a Regulated River (general security) account in the Upper Namoi Regulated River Water Source is 1.0 ML per unit share plus any water allocations assigned from another access licence in that water year. The amount carried over from one year to the next is limited to 0.5 ML per unit share.

2.1.2 Water Trading – Water Access Licences (Permanent trades)

The permanent water trading market in the Upper and Lower Namoi River Water Sources is quite immature with only 37 water access licences (WALs) totalling a volume of 18,054 ML being traded over the previous five water years (i.e. between 2004/05 to 2008/09). Over 67% of the total number of these trades were regulated river general security WALs which equated to over 76% of the total volume of access licences traded in the Upper and Lower Namoi River Water Sources over this five year period. Prices paid over this period were up to $2,400/ML. The remaining trades were Supplementary WALs and Stock and Domestic WALs. There were no regulated river high security WALs traded over this period.

However, in the current water year, the activity in the market in the Upper and Lower Namoi River Water Sources has increased substantially with a total of 43 WALs being traded from 1 July 2009 to date. The total volume of these trades is 20,058 ML with almost 70% of the total volume traded being regulated river general security WALs. Prices for these regulated river general security WALs have ranged from just under $700/ML up to $2,400/ML. It should be noted that there was also one general security WAL traded for over $4,000/ML, however this appears to be an aberration. There have also been 2 regulated river high security WALs traded in the current water year in the Upper and Lower Namoi River Water Sources. One was for a small volume of 20 ML which traded at a price of $7,500/ML and the second was for 100 ML at a trade price of $2,100/ML. The other trades were Supplementary WALs and Stock and Domestic WALs.


History of Permanent Trades
- Upper and Lower Namoi Regulated River Water Sources -
25000
20000
15000
10000
5000
0
Volume (ML)
2005/06
2006/07
2007/08
2008/09
2009/10
Water Year
DOMESTIC AND STOCK
Regulated River (General Security)
Supplementary Water
REGULATED RIVER (HIGH SECURITY)


History of Trade of General Security WALs in the
Upper and Lower Namoi Regulated River Water Sources (excluding $0 transfers)
(2004/05 to current)
Price...
4000
3500
3000
2500
2000
1500
1000
500
0
Price ($/ML)
$2,400
$694
17-Feb-05
5-Sep-05
24-Mar-06
10-Oct-06
28-Apr-07
14-Nov-07
1-Jun-08
18-Dec-08
6-Jul-09
22-Jan-10
10-Aug-10
Date

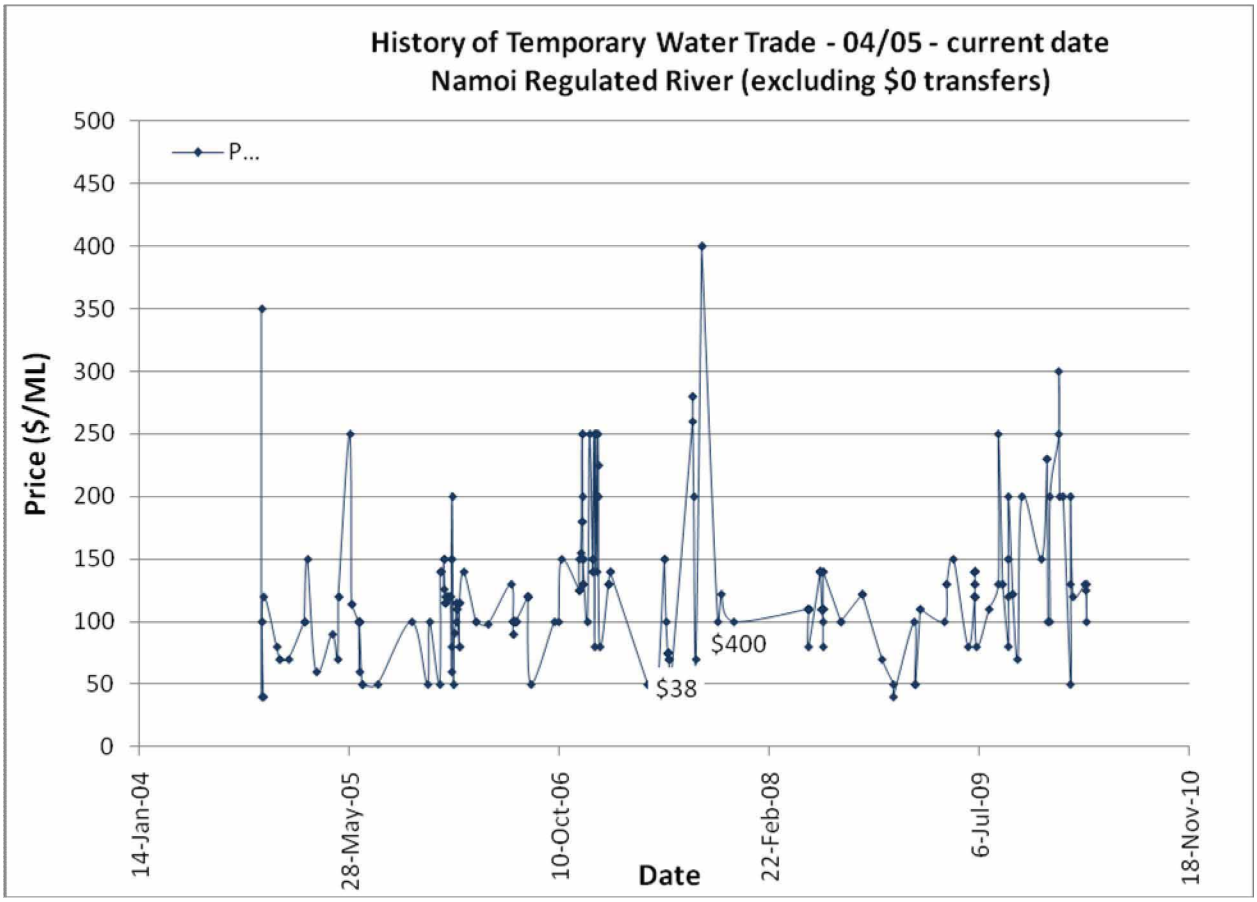
2.1.3 Water Trading – Account Water (Temporary trades)

Over the 5 water period between 2004/05 to 2008/09, there were almost 540 account water transfers (temporary trades) within the Upper and Lower Namoi River Water Sources totalling a volume of almost 83,500 ML. The largest volume traded in any one year was 28,000 ML in 2005/06 via 157 individual trades.

Prices for the trading of account water are very dependent on the water availability at a point in time within any one year and are very responsive to rainfall, any increases in water allocations announced by NSW Office of Water and the demand for water at that particular point in time for crops or other uses.

In the current water year, since 1 July 2009 to date, just over 9,800 ML of account water has been traded via 46 individual trades. Over 65% of the water traded associated with regulated river general security water entitlements. Prices in the current year have ranged from $50/ML to $300/ML with individual parcels ranging from 7 ML up to 3,000ML. One trade was for a total volume of 3,000 ML, which is approximately 30% of the total volume traded.

Prices over the previous five water years (2004/05 to 2008/09) have ranged from $38/ML to $400/ML with individual parcels ranging from 3 ML to 3,000 ML.



2.2 Upper and Lower Namoi Groundwater Sources

The Upper Namoi Zone 4 (Keepit Dam to Gin's Leap) Groundwater Source, Upper Namoi Zone 5 (Gin's Leap to Narrabri) Groundwater Source and Upper Namoi Zone 11 Maules Creek Groundwater Source are in the vicinity of the Boggabri Coal Mine and purchasing water from these sources may provide a potential water supply option for the continuation of the mine.

Water Access Licences (WALs) in these zones may be traded as per the rules outlined in the *Water Sharing Plan for the Upper and Lower Groundwater Sources 2003* (WSP).

Table 3 below provides the total water source share volume for WAL categories that can be traded in each of the 3 groundwater zones.

Table 3 Total share volumes of tradeable WALs in each Zone

Zone	Total share volume of Aquifer Access Licences (ML) [No. of WALs]	Total share volume of Supplementary Access Licences (ML) [No. of WALs]
Zone 4	21,032 [168]	13,639 [71]
Zone 5	15,996 [76]	2,712 [17]
Zone 11	2,203 [26]	15 [1]

2.2.1 Water Trading – Water Access Licences (Permanent trades)

Zone 4

The permanent water trading market in the Upper Namoi Zone 4 Groundwater Source is quite immature with only a total of 20 WALs and a total volume of less than 4,800 ML being traded since the 2007/08 water year to date. 85% of the total number of these trades were aquifer access licences which equated to almost 60% of the total volume of WALs traded in this zone over this period. Prices paid ranged from $1,200/ML to $2,050/ML. The remaining trades were Supplementary WALs.

The majority of the trades occurred in 2007/08 when 13 trades totalling 3,661ML occurred.

In the current water year, there have been only 3 trades totalling 175 ML with prices earlier this year ranging between $1,500/ML and $1,800/ML.

Zone 5

The permanent water trading market in the Upper Namoi Zone 5 Groundwater Source is also very immature with very little activity over the last 3 years. A total of only 12 WALs equalling a volume of just over 3,500ML has been traded since the 2007/08 water year to date. 83% of the total number of these trades were aquifer access licences which equated to almost 88% of the total volume of WALs traded in this zone over this period. The remaining trades were Supplementary WALs. Prices for aquifer access licences over this period ranged from $1,075/ML to $3,500/ML.

The majority of the trades occurred in 2008/09 when 6 trades totalling 2,867 ML was traded.

In the current water year, there have been only 3 trades totalling 367 ML with prices ranging between $2,750/ML and $2,975/ML.

Zone11

There have been no trades in the Zone 11 Groundwater Source

2.3 Gunnedah Basin

The Gunnedah Basin was embargoed in 2008 with policy guidelines for groundwater transfers in inland NSW outside water sharing plan areas were issued in August 2009.

However, water trading is currently not yet operational in the Gunnedah Basin. It would be beneficial to further discuss the implementation of a water sharing plan and water trading options with the NSW Office of Water. It is understood that a macro water sharing plan including the Gunnedah Basin is scheduled for release in mid to late 2011.

3. Conclusion and Recommendations

The high level assessment concludes that it is possible to secure additional water via the trading market to meet the deficit identified in the water supply requirements for the continuation of the Boggabri Coal Mine.

The high level assessment indicates that;

1. Purchasing WALs from the Upper and Lower Namoi Regulated River Water Source may provide the best option for securing additional water quickly. This is based on the high reliability of supply, the volume of licensed entitlement, the number of WALs, and the increasing development in the water trading market in this water source.

2. Purchasing Aquifer Licences from Groundwater Zones in the Upper Namoi (i.e. Zone 4, Zone 5 and Zone 11) is also possible. However, based on the immature market, the low volume of licensed entitlement and low number of licences, sourcing water quickly from these sources may be difficult.

3. Purchasing licences from the Gunnedah Basin may also be an option for securing the additional water. However, this market is not currently operating. Recommend further discussions with NSW Office of Water to determine viability of this option in the future.

4. Next Steps

To ensure an efficient and diligent approach to securing the additional water required, PB recommends undertaking the following actions;

- Boggabri Coal actively pursues the purchase of water entitlements via the trading market.
- A water purchase and water management strategy be developed as soon as possible to actively source and manage the water. (Note it is understood that Boggabri Coal does not currently have any infrastructure to transfer water from the river to the mine site. Therefore this will need to be considered in the development of the water purchase and management strategy)
- A review of the existing water licences (*i.e. both Water Act 1912 and Water Management Act 2000*) currently held by Boggabri Coal be undertaken to confirm the actual volume of water that can be extracted under the conditions of the licences and therefore contribute to the water requirements for the mine operations. This review should be undertaken prior to the purchase of additional water licences.
- The strategy to include;

  1. Purchasing water access licences (WALs)
  2. Developing a plan for the active on-going management of the acquired portfolio of water entitlements to maximise water availability and return on investment though the use of carryover provisions and selling account water on the temporary market in those years the water is not required by the mine
  3. The sale of WALs on the permanent trading market when no longer required by the mine
  4. Annual sale of account water on the temporary market when the full amount of available water is not required
  5. Options for entering into Forward Water Contracts/Long Term Lease arrangements with existing licence holders.

Should you require any additional information, please don't hesitate to contact either myself on 02 9272 5036 or Leigh Tickle on 02 4929 8306.

Yours sincerely

Margie Parmenter
Principal Natural Resource Management Consultant
Water Resources Group, Sustainable Water & Communities
Parsons Brinckerhoff Australia Pty Limited

Appendix F

High level cumulative impact assessment

Parsons Brinckerhoff Australia Pty Limited
ABN 80 078 004 798

Level 3
51–55 Bolton Street
NEWCASTLE NSW 2300
PO Box 1162
NEWCASTLE NSW 2300
Australia
Telephone +61 2 4929 8300
Facsimile +61 2 4929 8382
Email newcastle@pb.com.au

Our reference 2123173A / LT0449_Rev2

8 October 2010

Ben Eastwood
Senior Environmental Scientist
Hansen Bailey Pty Ltd
PO Box 473
Singleton NSW 2330

Dear Ben

Continuation of Boggabri Coal Mine - Surface water cumulative impact assessment

1. Introduction

Parsons Brinckerhoff Pty Ltd (PB) prepared a Surface Water Assessment dated June 2010 for the Continuation of Boggabri Coal Mine Project Environmental Assessment (EA). This assessment included the cumulative impacts of known projects in the vicinity of Boggabri Coal Mine. Since preparing the assessment, further information, however limited, has become available on other large scale coal mining projects proposed in the immediate vicinity of Boggabri Coal Mine. The Department of Planning (DoP) has requested that this additional information be considered for the potential cumulative impacts in the vicinity of the Leard State Forest. The following is a high level assessment of cumulative impacts associated with the Continuation of Boggabri Coal Mine Project and these other projects.

The Cumulative Impacts - A Good Practice Guide for the Australian Coal Mining Industry (Franks et al, 2010) was considered when preparing this high level cumulative impact assessment.

2. Background

In August 2009 Boggabri Coal Pty Limited commenced consultation with the DoP regarding a new project approval for continuation of the existing Boggabri Project. To progress that proposal, the following steps were taken:

1.	26 August 2009	Preliminary Environmental Assessment (PEA) submitted
2.	9 September 2009	Planning focus meeting
3.	25 September 2009	Revised PEA and Project Application submitted
4.	15 December 2009	EPBC Referral submitted
5.	17 December 2009	Director-Generals Requirements (DGRs) issued
6.	2 July 2010	EA submitted for adequacy
7.	20 August 2010	NSW DoP letter requesting further information.

During the course of the above approval process further information has come to the attention of Boggabri Coal relating to other large scale coal mining projects in the immediate vicinity of the Boggabri Project which have since sought or may seek approval at some time in the future (Other Projects).

Accordingly, a Simultaneous Worst Cast Cumulative Impact Scenario (SWCCIS) review has been undertaken in order to attempt to gain a very high level appreciation of the potential worst case cumulative impacts if all of those Other Projects were to proceed in conjunction with the Boggabri Coal project.

The appreciation is necessarily high level and based upon some highly speculative assumptions which are detailed in this review.

The SWCCIS review is separate to the EA for the Boggabri Coal Project. Whilst it draws upon the findings made from the assessments in the Boggabri EA, this review is prepared on a different basis to the quantitative environmental assessments in the Boggabri EA as it is making qualitative assessments for the purposes of a high level review.

This surface water cumulative impact assessment forms part of the SWCCIS review.

3. Description of Other Projects

Other Projects proposed in the immediate vicinity of Boggabri Coal Mine are the Tarrawonga Modification, Maules Creek Coal Project, Tarrawonga Extension and Goonbri Project. The locality of these Other Projects is shown on Figure 1.

The Other Projects are described in the following sections. Project descriptions are in many cases highly speculative and are based on the best information available at the time of writing. For this reason, it is not possible to undertake a detailed quantitative assessment of cumulative impacts, and only a high level qualitative assessment has been undertaken.

The Tarrawonga Modification has been considered in the Boggabri EA, but is considered again here in order to gain an appreciation of the potential worst case cumulative impacts if all of the Other Projects were to proceed in conjunction with the Boggabri Coal project.

3.1 Tarrawonga Modification

The Tarrawonga Modification is a proposed modification to an existing open cut coal mine, and is described (based on the information available) in Table 1. A modification application was lodged with DoP for this project in April 2010. The application included an Environmental Assessment (EA) (April 2010). The existing Tarrawonga Coal Mine is described in the Environmental Impact Statement (EIS) (2005).

Table 1 Description of Tarrawonga Modification Project

Attribute	Assumption	Source
Mine life	8 -10 years	2005 EIS
Production levels	Up to 2Mtpa	2005 EIS
Type of mine	Open cut	2005 EIS
Method of mining	Truck and shovel	2005 EIS
Coal reserves	16.4Mt	EA April 2010
Overburden material generated	123.3Mbcm	EA April 2010
Coal seams	8 – mining down to the Nagero Seam	2005 EIS
Open cut disturbance area	198 ha	EA April 2010
Maximum height of overburden emplacement areas	Northern Emplacement 370m AHD	EA April 2010
	Southern Emplacement 340m AHD	2005 EIS
ROM stockpile	150,000t	2005 EIS
ROM hoppers	1 x 40 t capacity	EA April 2010
Product coal loadout	150t -200t	2005 EIS
Construction commence date	2006	EA April 2010

3.2 Maules Creek Coal Project

The Maules Creek Coal Project is a proposed new open cut coal mine, and is described (based on the information available) in Table 2. An application for project approval has been lodged with the NSW Department of Planning (DoP) and a Referral to the Commonwealth Department of Sustasinability, Environment, Water, Population and Communities (DSEWPC) has been made under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). The application included a Preliminary Environmental Assessment (PEA) (July 2010).

Table 2 Description of Maules Creek Coal Project

Attribute	Assumption	Source
Mine life	21 years	PEA July 2010
Production levels	Up to 13Mtpa by Year 5	PEA July 2010
Type of mine	Open cut	PEA July 2010
Method of mining	Truck and shovel/excavator	PEA July 2010
Coal reserves	240Mt within the Project Boundary	PEA July 2010
Coal seams	15 – mining down to the Templemore Seam	PEA July 2010

Attribute	Assumption	Source
Project boundary	Approximately 3,500 ha	EPBC Referral (July 2010)
Project footprint	Approximately 2,000ha	EPBC Referral (July 2010)
ROM hoppers	2 x 450t	PEA July 2010
CHPP capacity	1750tph and bypass circuit of 1600tph	PEA July 2010
Reject bin capacity	600t	PEA July 2010
Product stockpile	600,000t	PEA July 2010
Rail loadout capacity	5,000tph	PEA July 2010
Construction commence date	During the fourth quarter of 2011	EPBC Referral (July 2010)

3.3 Tarrawonga Extension

It is possible that Tarrawonga Coal Mine will be expanded further into Exploration Lease (EL) 5967, whether by new project approval or further modification of the existing approvals. There have been no approvals issued or applications made for this proposal to date that are publically available. All that is known of this proposal at this time is the existence of EL 5967. As such, a project description is not available.

3.4 Goonbri Project

It is possible that a future open cut or underground coal mine will be developed within EL 7435 under a new project approval which may be made at some time in the future. There have been no approvals issued or applications made for this proposal to date that are publically available. All that is known of this proposal at this time is the existence of EL 7435. As such, a project description is not available.

4. Potential cumulative impacts

4.1 Water quantity

Tarrawonga Modification

The proposed Tarrawonga Modification is located south of Boggabri Coal Mine. The proposed modification would involve extension of the approved open cut boundary up to approximately 600m further east within Mining Lease (ML) 1579. The additional land disturbance associated with the open cut extension would be approximately 38ha (Tarrawonga Coal Mine Modification Environmental Assessment, April 2010).

The approved Tarrawonga Coal Mine (as described in the 2005 EIS) drains to Nagero, Bollol and Goonbri Creeks, which are all tributaries of the Namoi River. The northern portion of ML 1579 drains towards Nagero Creek, however, discharges to Nagero Creek are currently infrequent and generally only occur from a licensed discharge point in accordance with discharge limits. Water currently passes through a number of sediment basins and storage dams prior to discharge (Tarrawonga Coal Mine Modification Surface Water Assessment, March 2010).

The proposed Tarrawonga Modification would result in a reduction in the Nagero Creek catchment of approximately 30ha and a reduction in the Bollol Creek catchment area of approximately 20ha compared to that for the approved Tarrawonga Coal Mine. There would be virtually no change to the Goonbri Creek catchment (Tarrawonga Coal Mine Modification Surface Water Assessment, March 2010).

The median annual rainfall depth at Boggabri is estimated to be 626mm based on Data Drill sourced historical rainfall (1889-2009). Based on a runoff rate of 0.5ML/ha/year for a median rainfall year for undisturbed areas, a 30ha reduction in catchment could be expected to reduce median runoff to Nagero Creek by approximately 15 ML/yr. The median runoff rate of 0.5ML/ha/year was estimated using the AWBM rainfall-runoff model. The AWBM modelling methodology and parameters are described in detail in the Continuation of Boggabri Coal Mine Surface Water Assessment (PB, June 2010).

Following completion of mining and rehabilitation, drainage from the majority of the Tarrawonga Modification area would be directed to Nagero and Bollol Creeks. The catchment of the final void is estimated to be comparable to that for the approved Tarrawonga Coal Mine (Tarrawonga Coal Mine Modification Surface Water Assessment, March 2010).

Maules Creek Coal Project

The proposed Maules Creek Coal Project is located north west of Boggabri Coal Mine. The proposed disturbance area is approximately 2,000ha (based on the EPBC Referral, July 2010).

The large majority of the proposed disturbance area is located north of Willowtree Range and drains north to Back Creek. Back Creek is a tributary of Maules Creek, which is a tributary of the Namoi River. Only a small portion of the disturbance area (approximately 60ha) drains south to Nagero Creek.

Based on the conceptual mine plans presented in the Maules Creek Coal Project PEA (July 2010), the disturbance area would extend into the upper reaches of the Nagero Creek catchment by Year 15 of the Maules Creek Coal Project. This part of the disturbance area would drain into the mining void, and would no longer drain south to Nagero Creek. A reduction in the Nagero Creek catchment of approximately 60ha could therefore be expected as a result of the Maules Creek Coal Project (by Year 15).

Based on a runoff rate of 0.5ML/ha/year for a median rainfall year for undisturbed catchment areas, a 60ha reduction in catchment could be expected to reduce median runoff to Nagero Creek by approximately 30 ML/yr.

Based on the conceptual final landform presented in the Maules Creek Coal Project PEA (July 2010), a final void would remain near the southern project boundary. Assuming that the entire 60ha of original Nagero Creek catchment would drain to the final void, a long term reduction of 60ha in the Nagero Creek catchment could be expected as a result of the Maules Creek Coal Project. This is a worst case scenario, as it is likely that some of the final landform (particularly the south west portion) would drain south to Nagero Creek at the completion of mining and rehabilitation. Rehabilitated land would be topsoiled and comprise a mixture of native trees and shrubs.

Tarrawonga Extension

As discussed above, there is no project description available for the Tarrawonga Extension. A small portion of EL5967 (approximately 80ha) is located in the Nagero Creek catchment. The majority of

EL5967 is located in the Goonbri Creek, Bollol Creek and Barbers Lagoon catchments. A large portion of EL5967 (around 1,000ha) is located within the Namoi River floodplain.

Based on a runoff rate of 0.5ML/ha/year for a median rainfall year for undisturbed catchment areas, an 80ha reduction in catchment could be expected to reduce median runoff to Nagero Creek by approximately 40 ML/yr.

Goonbri Project

As discussed above, there is no project description available for the Goonbri Project. EL7435 is not located within the Nagero Creek catchment. EL7435 is located in the Goonbri Creek and Bollol Creek catchments. Therefore there would be no surface water cumulative impacts on the Nagero Creek catchment.

Summary of cumulative impacts

The Continuation of Boggabri Coal Mine Project is located within the Nagero Creek catchment. The Nagero Creek catchment is approximately 4,250ha to the point where the creek meets the Namoi River floodplain, approximately 1km downstream of the Project Boundary (refer to Figure 1). Downstream of this point Nagero Creek flows west into the 'Slush Holes' on the floodplain. It is difficult to define the catchment boundary on the floodplain, however, it is estimated that the total catchment of Nagero Creek is around 8,000ha.

The Continuation of Boggabri Coal Mine Project will increase the catchment area contributing to the sites water management system from 683ha in Year 1 to 1,633ha in Year 21 of the Project. The water management system catchment of 1,633ha is equivalent to 20.4% of the total Nagero Creek catchment.

'Dirty' runoff captured in sediment dams at Boggabri Coal Mine will be reused onsite or released to Nagero Creek following treatment and testing to ensure water quality criteria are met. This will depend on the site water balance, stored water quality and receiving water quality. 'Contaminated' runoff (e.g. from the mining void and coal stockpile areas) will be reused onsite.

The onsite reuse and evaporation of water captured in the Boggabri Coal Mine water management system will result in a reduction in runoff volumes to Nagero Creek. Water balance modelling predicted that median runoff volumes at the point where Nagero Creek meets the floodplain will decrease by -16%, -19% and -7% for the Year 5, 10 and 21 landforms respectively as a result of the Project (compared to a runoff volume of 1,812ML/yr for Year 1). Note that modelling did not include the Other Projects (however the existing Tarrawonga Coal Mine was included). The water balance modelling methodology and assumptions are described in detail in the Continuation of Boggabri Coal Mine Surface Water Assessment (PB, June 2010).

The Tarrawonga Modification, Maules Creek Coal Project and Tarrawonga Extension would potentially capture runoff from an additional 170ha of the Nagero Creek catchment, further reducing runoff volumes to Nagero Creek. The additional area comprises an assumed 60ha for the Maules Creek Coal Project, 30ha for the Tarrawonga Modification, and 80ha for the Tarrawonga Extension. The combined area captured in water management systems of coal mines within the Nagero Creek catchment would increase from approximately 1,633ha (i.e. 20.4% of the total catchment) to 1,803ha (22.5% of the total catchment) if the Other Projects worst case cumulative impacts scenarios are included. The additional increase in the cumulative captured area of 2.1% associated with the Other Projects is not considered significant in the context of the overall impact.

On a regional level, it is difficult to assess cumulative impacts as project descriptions are not available for the Tarrawonga Extension or Goonbri Project (in particular, it is unknown if mining would be open cut or underground). The worst case combined footprint of the Continuation of Boggabri Coal Mine Project and Other Projects is around 10,515 ha (refer to Table 3). Note that this is a worst case footprint, and is likely to be very conservative as the full lease areas have been adopted for Tarrawonga Extension and Goonbri Project. The combined footprint is approximately 0.5% of the 22,600,000ha Namoi River catchment area to the town of Boggabri. The worst case mining scenario for surface water runoff cumulative impacts on the Namoi River is therefore considered to be minor based on the limited surface disturbance when compared to the size of the overall catchment. Impacts on surface water quantity from farm dams and irrigation channels and other water management structures which are widespread over the catchment area would contribute to cumulative impacts on the Namoi River.

Table 3 Project footprints

Project	Project footprint (ha)	Source
Continuation of Boggabri Coal Mine	Approximately 1,577ha	EA (July 2010)
Maules Creek Coal Project	Approximately 2,000 ha	EPBC Referral (July 2010)
Tarrawonga Modification / Extension	Unknown (ML1579: 656ha, EL5967: 5,298ha)^	NSW Department of Primary Industries - Coal Titles and Applications
Goonbri Project	Unknown (EL7435: 984ha)^	NSW Department of Primary Industries - Coal Titles and Applications
Total	**10,515 ha**	

Note. ^In the absence of project descriptions for the Tarrawonga Extension and Goonbri Project, the full lease area has been adopted as the footprint.

4.2 Water quality

All discharges from the Boggabri Coal Mine water management system would occur from a licensed discharge point in accordance with relevant Environment Protection License (EPL) discharge criteria. ‘Contaminated’ water stored in mine water dams will not be discharged to the creek system and will be reused onsite. It is assumed that the Other Projects would have similar water quality controls, as well as appropriate flood mitigation measures (where relevant). As such, there is unlikely to be any adverse cumulative impacts associated with water quality on the Namoi River from mining activities.

It should be noted that water discharge from mining activities is point source pollution which can be closely monitored and controlled. It is recognised that water quality in natural water systems, including the Namoi River, is heavily influenced from diffuse pollution sources that are more difficult to monitor and assess.

4.3 Site water balance

Whilst the Other Projects would potentially impact upon the volume of clean runoff that is diverted around the Boggabri Coal Mine site, they would not impact upon the volume of runoff captured in the Boggabri Coal Mine water management system (i.e. in sediment dams and mine water dams). The Other Projects would therefore not impact upon the volume of surface water runoff available for onsite reuse at Boggabri Coal Mine (for use in coal processing, dust suppression and vehicle washdown etc).

However, there is the potential for the Other Projects to drawdown groundwater levels in the region and therefore to potentially reduce groundwater make into the mining void at Boggabri Coal Mine (compared to values predicted from groundwater modelling without Other Projects). This has the potential to reduce the volume of groundwater make available for reuse at Boggabri Coal Mine.

An analysis has been undertaken to assess the sensitivity of the Boggabri Coal Mine water balance to changes in groundwater make into the mining void. The analysis has been undertaken for the Year 5, 10 and 21 landforms. The analysis has not been undertaken for Year 1 as it is unlikely that the Other Projects would be active by this time.

In the absence of data from groundwater modelling incorporating the Other Projects, nominal groundwater make reductions of 10% and 20% have been adopted for the sensitivity analysis. Results of the analysis are provided in Table 4 for a 10th percentile (dry) rainfall year. The water balance modelling methodology and assumptions are described in detail in the Continuation of Boggabri Coal Mine Surface Water Assessment (PB, June 2010).

Table 4 Boggabri Coal Mine water balance for 10th percentile (dry) rainfall year - sensitivity analysis

		Base scenario		Scenario A (-10% g/w make)		Scenario B (-20% g/w make)	
Landform	**Annual site water demand (ML)**	**Ground water make^ (ML/yr)**	**Out-standing water deficit^^ (ML/yr)**	**Ground water make (ML/yr)**	**Out-standing water deficit^^ (ML/yr)**	**Ground water make (ML/yr)**	**Out-standing water deficit^^ (ML/yr)**
Year 5	1,309	250	750	225	775	200	800
Year 10	1,064	342	361	308	395	274	429
Year 21	1,075	410	384	369	425	328	466

Notes. ^Predicted groundwater make for base scenario sourced from *Continuation of Boggabri Coal Mine Groundwater Assessment* (Australasian Groundwater and Environmental Consultants, February 2010). ^^Existing water entitlements held by Boggabri Coal have been considered when calculating the outstanding water deficit.

Boggabri Coal has access to 194ML/yr from its existing groundwater licences. These existing water entitlements have been considered when calculating the outstanding water deficit in Table 4. For example, for the Year 5 Scenario B, there is a total water requirement of 994ML from external sources. It is assumed that 194ML would be supplied by existing groundwater licences, leaving an outstanding deficit of 800ML.

Table 4 shows that Boggabri Coal Mine experiences an annual water deficit in Years 5, 10 and 21 of the Project for 10th percentile (dry) rainfall years. The peak water deficit occurs during Year 5, when demands are highest. For a nominal 20% reduction in groundwater make, the outstanding water deficit during Year 5 would increase by 50 ML. The reduction in groundwater make would need to be made-up by securing additional water from external sources.

It is recommended that further water balance modelling be undertaken during detailed design when the Other Projects are better defined and groundwater modelling data incorporating the Other Projects becomes available.

4.4 Water use

Any extractions from the Namoi River or Groundwater Systems to supply the Other Projects would need to be in accordance with Water Access Licenses, the Water Sharing Plan (WSP) for the Upper Namoi and Lower Namoi Regulated River Water Sources 2003 and the WSP for the Upper and Lower Namoi Groundwater Sources 2003.

The WSPs establish rules for sharing water between the environmental needs of the river or aquifer and water users, and also between different types of water users such as town supply, rural domestic supply, stock watering, industry and irrigation. Any cumulative impacts associated with water use would be assessed, identified and managed under the WSPs.

There is potential that the long term average volume of water that may be diverted from these water sources in the future may be reduced as a result of the implementation of new sustainable diversion limits (SDLs) established under the Basin Plan for the Murray Darling Basin. The Basin Plan is currently being developed by the Murray Darling Basin Authority with a final plan to be adopted by Government in 2011. State WSPs will be required to comply with the Basin Plan and implement the new SDLs. The potential implications of these new SDLs on existing entitlements in the Naomi River and Groundwater Systems should be a key consideration when sourcing water from external sources to make up any water deficit to ensure the level of security of the entitlements will deliver the water required for the project.

5. Limitations

The Other Projects are constructed from a combination of published information and from the author’s speculation as described in Section 3.

The results of this assessment are therefore speculative, qualitative in nature and should not be relied upon to predict accurate environmental impacts.

This is not a fully quantitative report created using the normal scientific methodology for preparing formal environmental assessments in the context of a known, detailed project (because project descriptions of the Other Projects are speculative). Water balance modelling and hydrological modelling incorporating the Other Projects has not been undertaken as part of this assessment.

However, quantitative information has been used where possible. The methodology is sound. However, base data relies on assumptions (described in Section 3) and not on legal commitments inherent in approved conditions or obligations.

The assessment has considered future mining by open cut methods. Potential surface water impacts associated with possible future underground mining have not been considered.

Should you require any additional information, please don't hesitate to contact the undersigned on 02 4929 8300.

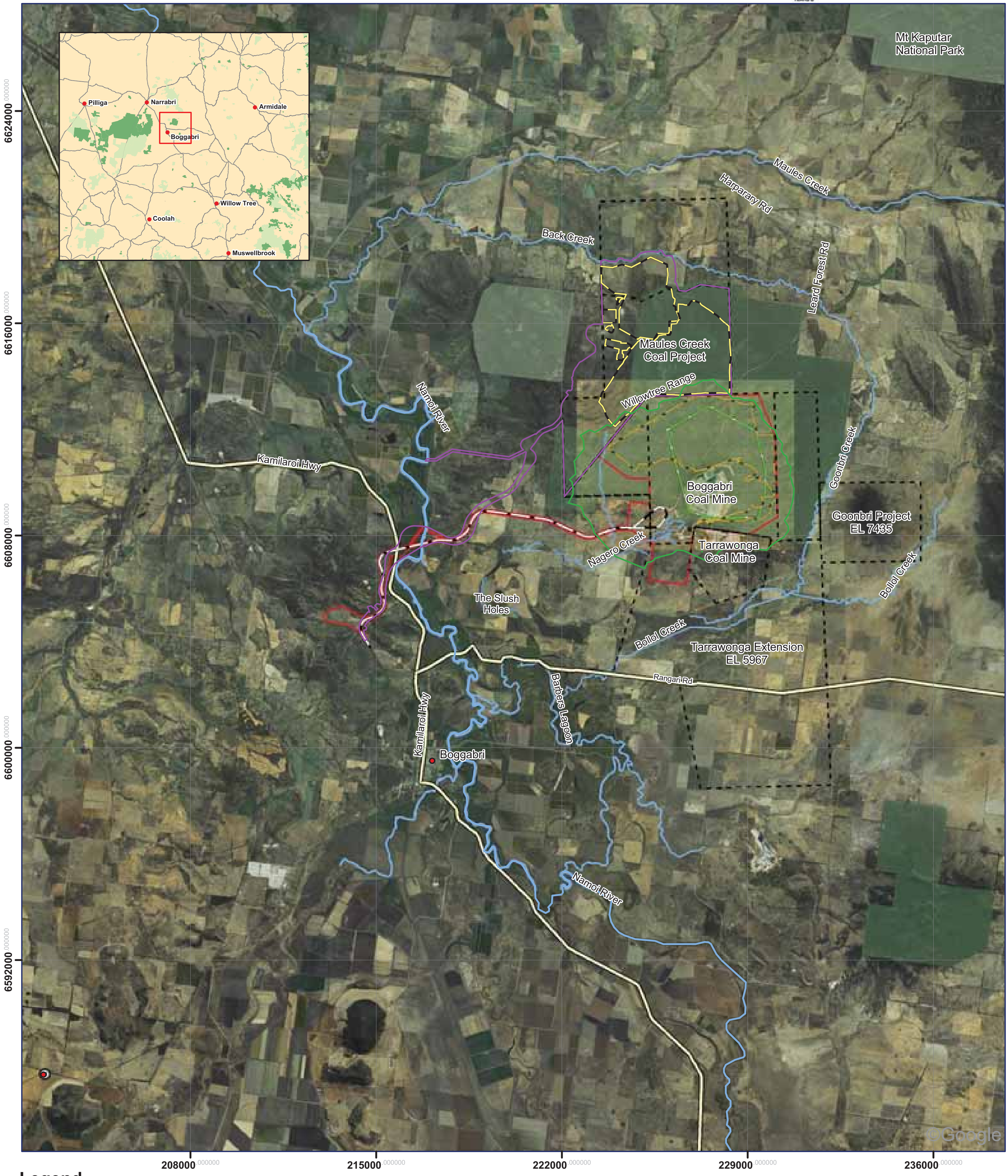
Yours sincerely

Leigh Tickle
Senior Environmental Engineer
Sustainable Communities and Water
Parsons Brinckerhoff Australia Pty Limited

Attachments:
Figure 1

CLIENT: HANSEN BAILEY PTY LTD
PROJECT: CONTINUATION OF BOGGABRI COAL MINE, CUMULATIVE IMPACT ASSESSMENT

PARSONS BRINCKERHOFF



Legend

- Town Location
- River / Creek
- Study Catchment (Nagero Creek to floodplain)
- Mine Tenement
- EIS Mine Disturbance (Boggabri Existing)
- Project Boundary (Boggabri Extension)
- Proposed Disturbed Limit (Boggabri Extension)
- Maules Creek EA Boundary
- Maules Creek Disturbance Area

0 2.5 5
Kilometers

GDA 1994 MGA Zone 56

FIGURE 1 LOCALITY PLAN

\\AUNCLF\proj\H\Hansen_Bailey\2123173_EMA_BOGGABRI_COAL_EA\05_WrkPapers\GIS\Output\Maps