Donaldson Coal Pty Limited

ABEL UNDERGROUND MINE PART 3A ENVIRONMENTAL ASSESSMENT

Appendix F

Surface Water Assessment and Outline Water Management Plan

Donaldson Coal

Abel Mine Project

Part 3A Assessment

Surface Water Assessment & Outline Water Management Plan

Revision 6

Date: 04/08/2006

VALIDITY STATEMENT

I certify that I have prepared the contents of this **Surface Water Assessment and Outline Water Management Plan** and to the best of my knowledge:

- it contains all available information that is relevant to the environmental assessment of the development to which the EA relates; and
- it is true in all material particulars and does not, by its presentation or omission of information, materially mislead.

Dr Stephen Perrens
Principal, Evans & Peck
4 August 2006

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1. INTRODUCTION

1.1 BACKGROUND

This Surface Water Assessment and Outline Water Management Plan has been prepared by Evans & Peck with assistance from Peter Dundon & Associates and Aquaterra Simulations. The Assessment addresses the issues associated with surface water and groundwater management for the Abel Underground Mine project's surface facilities which are located north of John Renshaw Drive. This report has been prepared as part of the Environmental Assessment required under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act)

1.2 PROJECT OVERVIEW

The Abel Underground Mine Project comprises the development of a new underground mine south from the high wall of the existing Donaldson Open Cut Mine. A map showing the layout of the project is contained in **Figure 1.1**.

Donaldson Coal currently owns and operates Donaldson Open Cut Mine, located approximately 23 km north-west of Newcastle. This open cut mine has approval to operate until 2012 at which point the economic reserves will be exhausted. Donaldson proposes to develop a new underground mine that will access coal reserves south of the Open Cut Mine.

The proposed Abel Underground Mine will have a maximum production capacity of approximately 4.5 million tonnes per annum run-of-mine (ROM) coal and an operating life of 21 years. The proposed method of extraction will be high productivity, continuous miner based bord and pillar systems, using pillar extraction techniques. This method allows the amount of coal being extracted to be varied so that subsidence can be controlled and a range of surface features protected.

The proposed underground lease area extends southwards from John Renshaw Drive towards George Booth Drive. It is bounded on the eastern side by the F3 Freeway and on the western side by a geological feature in the vicinity of Buttai Creek.

Abel Underground Mine will extract coal from the Upper Donaldson and Lower Donaldson coal seams. These seams dip downwards at approximately 5^o towards the south of the lease area. Therefore, as mining progresses southwards, mining will become deeper with the depth of cover ranging from 30 m in the northern area immediately adjacent to John Renshaw Drive, to 450 m at the southern boundary.

Access to the underground reserves will be from the Donaldson high wall north of John Renshaw Drive. Surface facilities will be placed within existing areas of disturbance in the Donaldson open cut. ROM coal will be transported via conveyor through the high wall to the stockpile areas located within the existing Donaldson lease area.

From the stockpiles, coal will be transported to the existing Bloomfield Coal Handling and Preparation Plant (CHPP), initially by truck and later by conveyor, where it will be processed and loaded onto rail. The Bloomfield CHPP also processes coal from its own open cut operation as well as from Donaldson Mine and, once production commences, Tasman Mine. Bloomfield's CHPP existing licensed capacity of 5 million tonnes per annum ROM will be required to cater for Bloomfield's existing production and the Abel coal. The required changes to Bloomfield's CHPP to accommodate the Abel coal, as well as the existing use of the CHPP by the Bloomfield Tasman Mines, forms part of the Environmental Assessment and are therefore included in this report.

1.3 REQUIREMENTS FOR PART 3A ENVIRONMENTAL ASSESSMENT

The Abel Underground Mine requires approval under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act) as it is classified as a "major project" under State Environmental Planning Policy (Major Projects). Part 3A of the Act requires this Project to undergo Environmental Assessment (EA) as part of the process for seeking approval of it.

An application for the project, including a Preliminary Assessment Report, was lodged with the Department of Planning (DOP) in December 2005. The Preliminary Assessment identified key issues which are to be the focus for the EA Report.

The Director-General's Key Assessment Requirements relevant to this WMP are those associated with Soil and Water. These comprise requirements for a detailed water balance and reference to:

- *Guidelines for Fresh and Marine Water Quality* (ANZECC);
- *Managing Urban Stormwater: Soils and Construction* (Landcom);
- *NSW State Rivers and Estuaries Policy;*
- *NSW Wetlands Management Policy*;
- the various State Groundwater Policy documents (Department of Natural Resources).

1.4 SCOPE OF THIS REPORT

This report deals with surface water issues in the vicinity of the surface workings for the Abel Project which include:

- Entrance and surface facilities for the Abel Underground Mine, to be located in a section of the Donaldson open cut pit.
- Sealed haul road for conveyance of coal from the Abel surface facilities to the existing Bloomfield CHPP. This haul road will subsequently be replaced by a conveyor.
- The use and upgrading of the Bloomfield CHPP to increase throughput and expansion of the associated stockpile facilities.
- Upgrading of the conveyor facilities within the stockpile areas surrounding the CHPP with connection to the existing conveyor from the Bloomfield processed coal stockpiles to the existing rail loading facilities.
- Stormwater pollution control facilities associated with the Abel surface workings, the transport corridor between Abel and the Bloomfield CHPP, and the Bloomfield CHPP and rail loader.
- Water supply and tailings disposal for the Bloomfield CHPP.

This report provides a water balance assessment to address the potential cumulative impacts from the combined operation of the three mines in the immediate vicinity of the Abel Project that lie within the catchment of Four Mile Creek (Abel, Donaldson and Bloomfield).

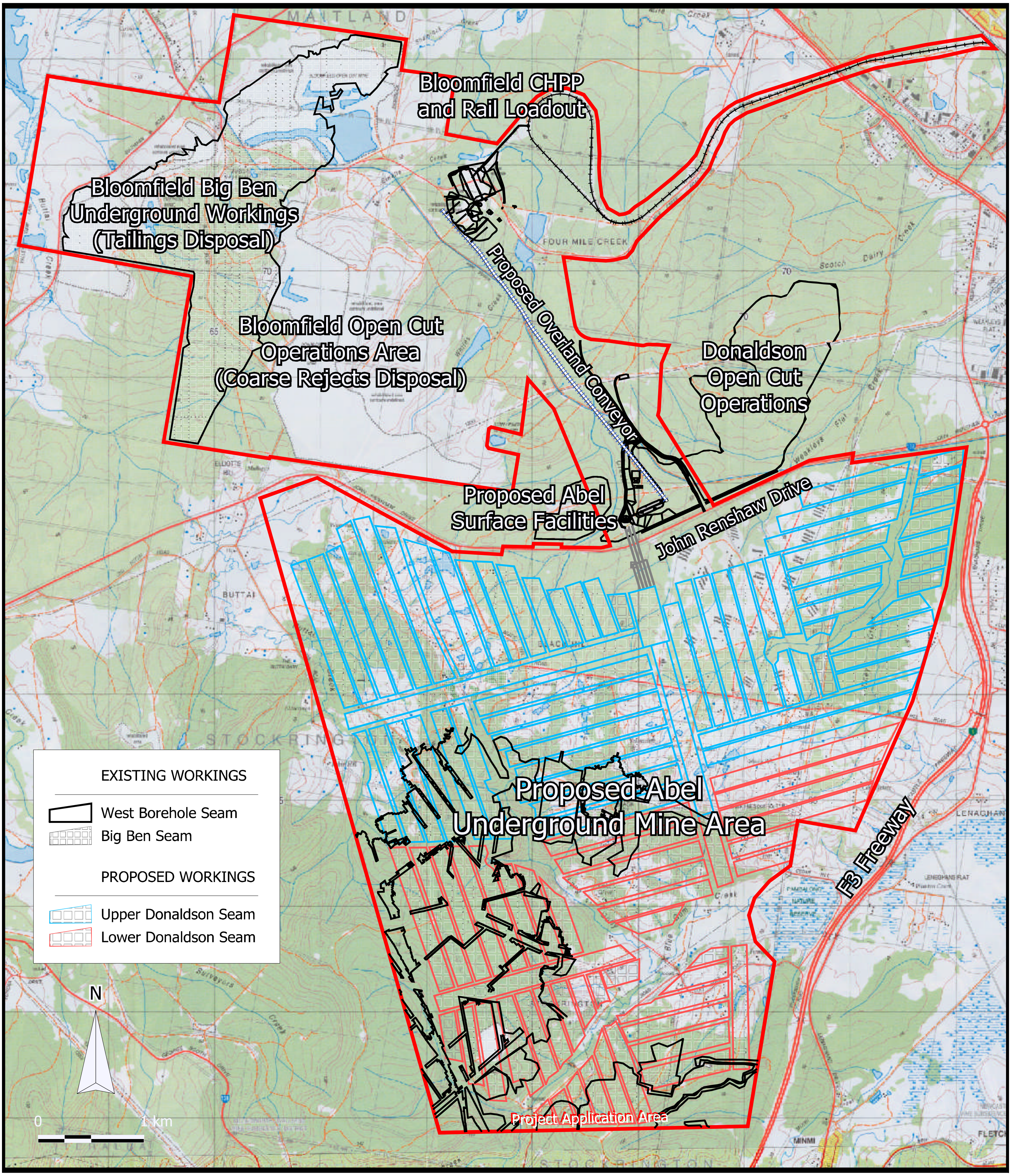
The analysis also takes account of the processing of coal from the Tasman mine at the Bloomfield CHPP and the option to accept excess water from, or supply water to, the Tasman Mine.

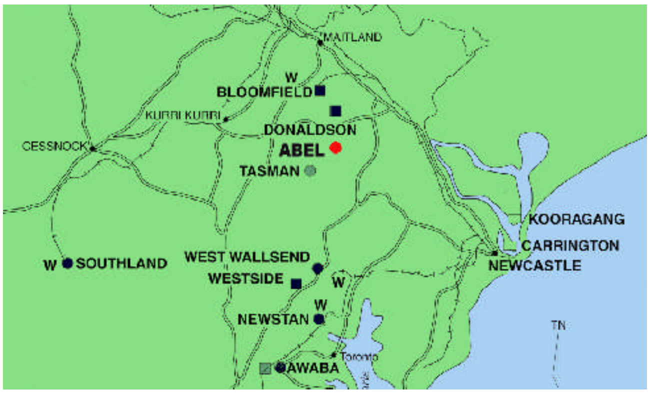
Chapter 2 of this report provides information on the existing mine operations and existing water management systems at the mines. A description of the surface water catchment and watercourses, including water quality, is provided. The existing groundwater regime and water quality is also described.

Chapters 3 and **4** describe the proposed surface facilities at the Abel Mine and the proposed expansion of the Bloomfield CHPP respectively. **Section 4.2** provides information on the predicted coal production, tailings production and water requirements for the proposed project.

Chapter 5 presents the assumptions, methodology and findings of the overall project water balance analysis.

Chapter 6 contains an outline draft Water Management Plan that provides information on the recommended operation of the mine surface water facilities based on the results of the water balance analysis to limit the occurrence of mine water discharges and the impact of saline discharges to Four Mile Creek. **Section 6.4** contains information on the recommended locations, parameters and frequency for surface water monitoring. **Section 6.5** provides an outline Surface Water Response Plan. **Section 6.6** contains an outline draft Erosion and Sediment Control Plan for the construction and operational phases of the project.





DONALDSON COAL

Abel Underground Mine Project
Project Overview

Appendix F

Figure 1.1

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2. EXISTING OPERATIONS AND WATER MANAGEMENT

2.1 EXISTING OPERATIONS

The Abel project includes a new underground mine as well as the use and expansion of the Bloomfield CHPP to process coal from the Abel, Bloomfield, Donaldson and Tasman mines. A short description of the operation and water management systems of each the existing mines is contained below.

Figure 2.1 is a schematic of the existing water management system for the Bloomfield and Donaldson Mines, into which the Abel Mine Project will contribute. All the elements of the systems depicted in **Figure 2.1** lie within, or adjoin, the catchment of Four Mile Creek.

2.1.1 Bloomfield Open Cut Mine and CHPP

Bloomfield Open Cut Mine currently delivers approximately 800,000 tonnes per annum of ROM to the Bloomfield CHPP. The mine has consent to operate until 2010. The areas of Bloomfield Mine that will be required for the Abel Underground Mine to operate include:

- enlarged facilities at the CHPP to allow for increased throughput and the related enlargement of the stockpile area;
- dams, channels, pipelines and pumping facilities for the provision of water to the CHPP;
- the underground workings and pit-top voids for tailings disposal;
- the existing private coal haul road from the Donaldson Mine;
- the existing rail loading facilities and rail loop.

The CHPP and rail loading facility will also handle coal from the existing Donaldson and Bloomfield Open Cut Mines and the Tasman Underground Mine (commencing mid-2006). Bloomfield currently has a licence under the *Protection of the Environment Operations Act 1997* to process 3.5 million tonnes per annum product coal (approximately 5 million tonnes per annum ROM coal).

Coarse and fine reject material is disposed of to facilities within the Bloomfield mine area. Coarse reject material is conveyed by truck to an old open cut referred to as the U Cut. Fine tailings are conveyed as a slurry by pipeline. Prior to 2003 the fine tailings were deposited into the U Cut and surface drainage water was returned to the supply for the CHPP. Since 2003 the fine tailings slurry has been deposited into the old underground workings. An estimated 1.2 million tonnes of fine tailings have been deposited between 2003 and June 2006.

The Bloomfield CHPP currently receives approximately 3.3 million tonnes of ROM coal per annum from the Bloomfield and Donaldson mines, of which about 2.3 million tonnes are product and 1 million tonnes are reject material. This reject material consists of around 580,000 tonnes of coarse tailings and 420,000 tonnes of fine tailings. Water requirements for operation of the CHPP are currently about 2,000 ML per year. This water is primarily drawn from old underground workings under the Bloomfield lease area via a series of holding dams which also store surface runoff from the surrounding catchments. The operation of this system is described in further detail in **Section 2.3.3**.

2.1.2 Donaldson Open Cut Mine

Donaldson Open Cut Mine currently delivers 2.5 million tonnes per annum ROM coal to the Bloomfield CHPP. The mine has consent to operate until 2012. The areas of Donaldson Mine that will be required for the Abel Underground Mine to operate include:

- existing private haul roads for coal haulage from the Donaldson Mine to the Bloomfield CHPP;
- the newly constructed haul road from John Renshaw Drive that connects to the existing Donaldson Mine haul road within the Donaldson Open Cut Mine lease area;
- selected areas of active and future mining that will be used for Abel surface facilities;
- elements of the existing Donaldson dirty water management system, particularly the main "Big Kahuna" storage dam and a pipeline for transfer of water between Donaldson and Bloomfield.

The existing Donaldson final landform and rehabilitation plans will be amended to address the required modifications to cater for the Abel Underground Mine.

2.1.3 Tasman Underground Mine

Tasman Underground Mine, located to the south of George Booth Drive and the Abel Underground Mine, was approved in 2004 for a maximum extraction of 960,000 tonnes per annum ROM coal. Coal from Tasman Underground Mine will be trucked to the Bloomfield CHPP for processing and delivery to the rail loading facility. Trucks will use George Booth Drive, John Renshaw Drive and the newly constructed private haul road through the Donaldson lease area.

Water balance analysis for the Tasman Mine indicates that the mine will progressively provide increasing water storage capacity in excess of the anticipated groundwater inflows. This storage capacity will be utilised to store groundwater inflows as well as any excess surface runoff that cannot be adequately handled by the surface water management system. In the event of there being an unanticipated excess or shortfall of water at the Tasman Underground Mine, water will be conveyed between Tasman and the "Big Kahuna" Dam by truck.

2.2 CLIMATE

Table 2.1 summarises the long term rainfall records for Bureau of Meteorology stations at Morpeth and East Maitland, together with data collected at the Bloomfield mine.

Table 2.1 presents a comparison of the annual rainfall records over the full period of record for each station and the concurrent periods of record for each station. The comparisons show that, over the concurrent periods, the average annual rainfall at Morpeth is around 3 - 4% higher that the average annual rainfall at East Maitland and Bloomfield. The biggest variation is in the minimum rainfall values.

Table 2.1
Long Term Rainfall Data (mm)

Station No Station Name	61046 Morpeth	61034 East Maitland	Bloomfield
Start Date	May 1884	August 1902	1989
End Date	February 2005	March 1990	2005
Missing	Aug 96 – Mar 97	Sep 68 – Dec 70	
Full record			
Mean	926	875	845
Standard Dev	280	248	200
Minimum	160	484	514
10 percentile	596	563	612
50 percentile	929	874	856
90 percentile	1,244	1,168	1,069
Maximum	1,994	1,673	1,278
Concurrent Records			
	1903 – 1968 1971 -1989	**1903 - 1968 1971 -1989**	
Mean	912	875	
Standard Dev	236	248	
Minimum	422	484	
10 percentile	583	563	
50 percentile	944	874	
90 percentile	1,192	1,168	
Maximum	1,586	1,673	
	1990-1995 1998-2004		**1990-1995 1998-2004**
Mean	896		870
Standard Dev	205		200
Minimum	649		514
10 percentile	696		636
50 percentile	851		911
90 percentile	1,124		1,084
Maximum	1,391		1,278

Average pan evaporation data for the three nearest evaporation stations are summarised in **Table 2.2.** The data shows that there is a general trend for increased evaporation nearer to the coast.

Table 2.2
Average Monthly Pan Evaporation Data (mm)

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Cessnock	177	140	124	90	62	48	56	81	108	136	112	183	1,351
Paterson	186	146	130	102	74	66	78	105	132	161	183	217	1,570
Williamtown	208	174	151	116	81	74	81	110	140	170	193	229	1,727

Because of the longer period of rainfall record available for East Maitland and the similarity between East Maitland and Bloomfield, the rainfall and earlier runoff modelling was carried out using East Maitland rainfall (Lyall & Macoun Consulting Engineers, 1998), the rainfall data for East Maitland, together with average monthly pan evaporation data for Williamtown, has been used for the water balance analysis (refer **Section 5**).

2.3 SURFACE WATER CATCHMENTS AND WATERCOURSES

The existing surface water catchments and water courses of relevance to the surface facilities for the Abel Project all lie within, or immediately adjoining, the catchment of Four Mile Creek. A complex system of natural and altered catchments, creeks, dams and pipelines form the water management "system" in the Four Mile Creek catchment. The complexity of this system is illustrated by the schematic diagram in **Figure 2.1**, which summarises the important surface water features within the catchment.

2.3.1 Four Mile Creek

With two minor exceptions, the surface facilities required for the operation of the Abel Project all lie within the catchment of Four Mile Creek. The exceptions are two small areas that will effectively become part of the Four Mile Creek catchment for water management purposes, namely the catchment of the "Big Kahuna" Dam (about 12 ha) and the remnant void that will contain the Abel box cut and surface facilities (additional 12 ha). Both of these areas adjoin the eastern boundary of the catchment.

The Four Mile Creek catchment drains some of the northern portion of the Abel underground mine area, located immediately south of John Renshaw Drive. The creek then drains north through the Donaldson and Bloomfield Mine lease areas. The tributary of Whites Creek discharges to Four Mile Creek within the Bloomfield Mine. Elwells Creek also drains through the Bloomfield Mine area and discharges to Four Mile Creek just near the Bloomfield lease northern boundary. After leaving the Bloomfield Mine lease area, Four Mile Creek drains northwards and then eastwards towards Ashtonfields and under the New England Highway. Further downstream the creek discharges to the Hunter River.

2.3.2 Donaldson Mine

The main watercourses draining the Donaldson Mine Lease area are Scotch Dairy Creek and Weakleys Flat Creek. These creeks drain in a north-easterly direction under the New England Highway and towards Beresfield, discharging to Woodberry Swamp. Woodberry Swamp, in turn, drains to the Hunter River. The open cut mining activities on Donaldson are now nearing completion within the Scotch Dairy Creek and Weakleys Flat Creek catchments and are starting to encroach into the eastern edge of the Four Mile Creek catchment immediately north of John Renshaw Drive. The approved Mine Operating Plan (MOP) for Donaldson includes mining a small section on the eastern side of Four Mile Creek, encroaching to within 40 m at the closest point. The MOP also includes a second pit of about 30 ha to be located to the west of Four Mile Creek.

The development of the Abel underground mine would utilise the void on the eastern side of Four Mile Creek to contain the box cut and all surface facilities required for the underground mine.

2.3.3 Bloomfield Including Supply for the CHPP

Much of the water management system shown in **Figure 2.1** is located within the Bloomfield mining lease area and is used to manage runoff from haul roads and stockpile areas as well as to provide water supply for the Bloomfield CHPP. **Figure 2.2** provides a schematic diagram of the Bloomfield CHPP coal and water handling processes within the immediate environs of the CHPP.

Coal Handling and Preparation Plant

As shown in **Figure 2.2** ROM coal from Bloomfield and Donaldson Mines is currently stored in stockpiles adjacent to the CHPP. After screening and crushing, the coal enters the washery. Water for processing in the washery is provided from Lake Foster.

Processed coal is then stored in stockpiles prior to being conveyed to the rail loader. Dust suppression sprays are applied to these stockpiles. Surface runoff and drainage from both the processed and ROM coal stockpiles is directed to a series of sediment traps that overflow to the Stockpile Dam (17 ML capacity). Water collected in the Stockpile Dam is currently used as needed for dust suppression on the stockpiles.

After processing, water from the CHPP is directed to the thickener, where anionic polyelectrolyte is applied to help separate tailings from water that is recycled through the plant. The tailings slurry (about 4.85 kL of water per tonne of tailings) is currently pumped to a disposal well that drains to the old underground workings within the Bloomfield lease area. The "clean" water from the thickener is redirected back into the washery. "Losses" of water from the vicinity of the CHPP and stockpiles include:

- Water used to convey the fine tailings (about 2,000 ML/year for current throughput of about 3 million tonnes of ROM);
- Water required for dust suppression on the stockpiles (approx 70 ML/year);
- Processed coal conveyed to the rail loader typically has 2% higher moisture content than the ROM coal received at the CHPP and accounts for about 40 ML/year;
- Coarse rejects from the washery have approximately 12% more water than ROM and account for about 70 ML/year.

Overall Water Management System

The characteristics of the main water facilities located within the Bloomfield Four Mile Creek catchment, shown on **Figure 2.1**, are described in **Table 2.3** below.

Table 2.3
Water Facilities

Name	Type	Capacity (ML)	Area (ha)	Discharges to
Abel Box Cut & surface facilities (future)	open cut	n/a	30	Pumped to Big Kahuna Dam
Donaldson Pit	open cut	n/a	21	Pumped to Big Kahuna Dam
Big Kahuna Dam	storage	400	3	Internal mine use only
S Cut & contributing catchment	open cut		55	Lake Kennerson via Whites Ck
Lake Kennerson	storage	200	4.9	Lake Foster or bypass channel
Creek Cut	open cut		68	Lake Foster
Tailings dams	tailings		65	Lake Foster
Lake Foster	storage	45	1.5	Four Mile Creek
Possums Puddle	storage	75	4.4	Four Mile Creek
Stockpile Dam	storage	17	0.5	Elwells Creek

The existing Donaldson open cut operations include a number of small storage dams that collect water from the mine pit and haul roads. Water is taken from these dams as required for dust suppression purposes. Excess water is pumped to the Big Kahuna Dam (400 ML) for storage. The capacity of this dam was selected to ensure that there was sufficient storage available to hold all dirty water generated within the operating areas of the mine, with the objective of ensuring that no discharge to the environment was required. To date no discharge has been required from the operating areas of the Donaldson mine.

Within the Bloomfield lease area, both groundwater and surface water drain into the S cut and is pumped to Whites Creek, which in turns drains to Lake Kennerson. Lake Kennerson also receives water pumped from the old underground mine workings (Big Ben seam) that underlie much of the Bloomfield lease area. There are three separate discharge/bypass systems associated with Lake Kennerson:

- A bypass channel that conveys water from Lake Kennerson around the western side of Lake Foster to the licensed discharge point immediately downstream of Lake Foster. This system is used to discharge relatively clean water held in Lake Kennerson without mixing with water in Lake Foster.
- A second bypass channel that runs around the eastern side of Lake Kennerson and Lake Foster. This channel collects runoff from catchment areas of about 57 ha, which is conveyed into Four Mile Creek and then flows into Possums Puddle.
- Discharge from Lake Kennerson to Lake Foster for purposes of maintaining water supply for the CHPP. Lake Foster also receives runoff from adjoining catchment areas totalling about 45 ha.

Water from Lake Foster is pumped to the washery for coal processing. Lake Foster has no natural discharge point of its own. In extremely wet conditions it is possible for the water level in Lake Foster to reach the level of the western bypass channel and mix with water discharged from Lake Kennerson. However, this is a rare event and normally any discharge only comprises water from Lake Kennerson conveyed to the licensed discharge point via the western bypass channel.

As noted above, the majority of the flow passing the licensed discharge point emanates from Lake Kennerson. The EPA licence requires that at times of discharge, a water sample be collected and tested, as well as an estimate made of the flow. Further details of the discharge flow and water quality are provided in **Section 2.4** below.

In 2000, a flow monitoring station was established on Four Mile Creek, downstream of the junction with Elwells Creek, near the Four Mile Creek workshop. The flow monitoring facilities comprise a 300 mm high v-notch weir plate located in the creek channel. At high flows the flow overtops the weir and the embankments on either side. A continuous water level recorder is located upstream of the v-notch weir. Flow is estimated based on a rating curve for a v-notch weir for the low flow range and Manning's equation for higher flows. Because of the non-standard upstream and downstream conditions, the flow estimates provided on the basis of the continuous water level measurements are considered to be indicative only.

2.4 SURFACE WATER DISCHARGE AND WATER QUALITY

2.4.1 EPA Licence Requirements – Bloomfield Mine

The EPA Licence Conditions for the Bloomfield Mine are summarised in **Table 2.4** and **Table 2.5** below. **Table 2.4** contains the location, type and description of the monitoring and discharge points, while **Table 2.5** contains the EPA Limit Conditions in terms of pollutant concentration and volume limits.

Table 2.4
Location of EPA Monitoring and Discharge Points – Bloomfield Mine

ID	Type of Monitoring Point	Type of Discharge Point	Description of Location
1	• Discharge to waters under wet weather conditions • Volume monitoring • Discharge quality monitoring	• Discharge to waters under wet weather conditions • Volume monitoring • Discharge quality monitoring	Lake Foster pipe outlet labelled as Discharge Point W001 on Bloomfield Colliery Water Management Plan dated 31/03/1999
2	• Ambient water quality monitoring		Four Mile Creek located 500 m upstream of the current NE Hwy culvert

Wet weather conditions are defined as 10 mm of rainfall or greater in 24 hours.

Table 2.5
EPA Limit Conditions – Bloomfield Mine

100th Percentile Concentration Limits				Volume
Conductivity (µS/cm)	**pH**	**TSS (mg/L)**	**Filterable Iron (mg/L)**	**Volume Limit (ML/day)**
6,000	6.5 - 8.5	30	1	40

2.4.2 Existing Surface Water Monitoring – Bloomfield Mine

Routine (monthly) ambient monitoring of 12 locations is carried out at and around the Bloomfield Mine, including the location required by the EPA licence. These locations are denoted WM1 to WM12 and are shown on **Figure 2.3**. (Note that WM1 is located outside the Four Mile Creek catchment). In addition, event based monitoring of any discharge from Lake Kennerson is carried out at W001 (same location as ambient monitoring location WM8).

Routine ambient monitoring is carried out for conductivity, pH, and TSS, as required by the EPA licence conditions. Wet weather discharge from Lake Kennerson is sampled for EC, pH, TSS and filterable iron, as required by the EPA licence conditions. A representative grab sample is taken of the discharge and within Four Mile Creek below the discharge location at the monitoring station (Four Mile workshops).

The system is designed and operated such that uncontrolled discharges should not occur. Should any uncontrolled discharge occur, either from Lake Foster or the Stockpile Dam, a grab sample would be taken and analysed for the same pollutants as for the controlled discharge events.

A continuous logger located on Four Mile Creek behind the Four Mile Creek workshop records flow depth and EC. As discussed in **Section 2.3.3**, flows estimated from the logger should be treated as indicative only due to the limitations and assumptions adopted in deriving the rating curve used to convert flow depths to discharges.

Appendix A contains statistics for the water quality data from each monitoring location. Monitoring commenced at the Bloomfield Mine in June 1996, therefore around 10 years of data is available. A summary of this data, averaged across all of the monitoring locations (except WM1, which is not located on Four Mile Creek) is contained in **Table 2.6** below.

Table 2.6
Summary of Water Quality Data for Bloomfield Mine
(averaged across all monitoring locations except WM1, 1996 – 2006)

	pH (monthly)	**EC (µS/cm)** (monthly)	**TSS (mg/L)** (discharge)
No. of Samples	254	231	76
Minimum	5	129	2
10 percentile	7	867	4
90 percentile	8	3,137	75
Maximum	9	5,180	1,071
Mean	7	1,890	43
Std deviation	1	986	139

Statistics for the annual flow data for the period 1999 to 2005 at the EPA discharge monitoring point (W001/WM8) are summarised in **Table 2.7**. The annual rainfall reported in the table is based on the daily rainfall measured at the Bloomfield mine.

Table 2.7
Discharge from Lake Kennerson

Year	No. of discharges	Daily Discharge (ML)			Annual Total (ML)	Annual Rain (mm)
		Min	Max	Average		
1999	42	1.7	40	22	915	997
2000	60	0.6	40	36	2,201	912
2001	30	15	40	36	1,126	941
2002	17	40	40	40	680	856
2003	6	40	40	40	240	701
2004	20	5	40	34	670	769
2005	6	35	40	38	229	775

It can be seen that in the early years of the records, particularly 2000, high levels of discharge occurred. This was because the base of the mine pit was below the water table and dewatering was required to control groundwater inflow. The groundwater pumped for dewatering purposes was directed to Lake Kennerson and subsequently discharged from the site. Similarly, a high level of discharge also occurred during 2004 because of increased pumping to Lake Kennerson for groundwater level control. As a result, throughout 2004 Lake Kennerson was very full (approximately 85%) and discharge was necessary to control water levels.

2.4.3 EPA Licence Requirements – Donaldson Mine

The EPA Licence Conditions for the Donaldson Mine require monthly grab samples to be analysed for conductivity, Total Suspended Solids (TSS) and pH. The monitoring point locations are:

- Site EM1 - upstream of Four Mile Creek
- Site EM2 - downstream of Four Mile Creek
- Site EM3 - upstream of Weakleys Flat Creek
- Site EM4 - downstream of Weakleys Flat Creek
- Site EM5 - upstream of Scotch Dairy Creek
- Site EM6 - downstream of Scotch Dairy Creek.

The surface water quality monitoring sites are indicated in Appendix 1 of the Water Monitoring Scope submitted to the EPA on 16 June 2000. These locations are shown on **Figure 2.3**.

Concentration and load limits were not specified in the EPA licence conditions as they were not considered applicable.

2.4.4 Existing Surface Water Monitoring – Donaldson Mine

Routine (monthly) monitoring of the six locations required by the EPA licence conditions commenced in June 2000. In July 2003, monitoring commenced at the following additional sites:

- Four Mile Creek at the New England Highway
- Scotch Dairy Creek at the New England Highway
- Weakleys Flat Creek at the New England Highway.

The parameters monitored include:

- pH (Lab)
- pH (in-situ)
- Electronic Conductance (Lab)
- Electronic Conductance (in-situ)
- Total Suspended Solids
- Total Dissolved Solids
- Alkalinity (total)
- Sulphates
- Chlorides
- Fluorides
- Nitrates
- Phosphates
- Acidity as $CaCO_3$
- Turbidity
- Aluminium
- Iron
- Manganese
- Calcium
- Magnesium
- Potassium
- Sodium
- Zinc
- Arsenic
- Barium
- Cadmium
- Cobalt
- Chromium
- Copper
- Lead
- Selenium
- Total Kjeldahl Nitrogen
- Nitrogen - Ammonia
- Nitrogen - oxidised
- Total Phosphorus
- Tot Petroleum Hydrocarbons
- TPH C6 - C9
- TPH C10 - C14
- TPH C15 - C28
- TPH C29 - C36
- Surfactants (MBAS)

Appendix A contains statistics for the available data for each monitoring location. A summary of this data, averaged across all of the monitoring locations, is contained in **Table 2.8**.

Table 2.8
Summary of Water Quality Data for Donaldson Mine
(averaged across all monitoring locations, 2000 – 2005)

	pH (lab)	EC (µS/cm)	TSS (mg/L)	TDS (mg/L)
No. of Samples	78	80	80	80
Minimum	4.8	101	1	56
10 percentile	6.0	210	7	135
90 percentile	7.0	902	2,779	577
Maximum	7.4	1,751	13,773	1,132
Mean	6.5	483	894	313
Std deviation	0.4	340	2,172	222

Macro-invertebrate sampling of Four Mile Creek above and below Donaldson Mine is also carried out twice per year.

2.5 GROUNDWATER AT BLOOMFIELD

The Bloomfield Mine is underlain by Permian Tomago Coal Measures. Seams currently mined include seams that equate to the Donaldson Seam and Big Ben Seam (also known as Ashtonfield Seam) that are also mined at Donaldson Open Cut mine. The deeper Rathluba Seam was formerly mined, but is stratigraphically deeper than the currently active seams.

Currently all mining at Bloomfield is from open cut mining, with one active pit near the southern boundary of the Lease.

Groundwater inflows typically occur from all main coal seams that are intersected by mining below the regional water table level. Groundwater inflow rates to the open cuts were estimated by Mackie (1998) at 0.1 ML/d.

Groundwater levels are currently depressed around the mine area, particularly on the southern (down dip) side of the lease, due to the cumulative effects of dewatering over many years of mining.

Former underground workings are currently used for the disposal of tailings from the CHPP. Tailings are discharged via a borehole into former underground workings in the Big Ben Seam. Water is recovered from a borehole (BH1) into the same workings, located about 2 km south and down dip from the tailings disposal point.

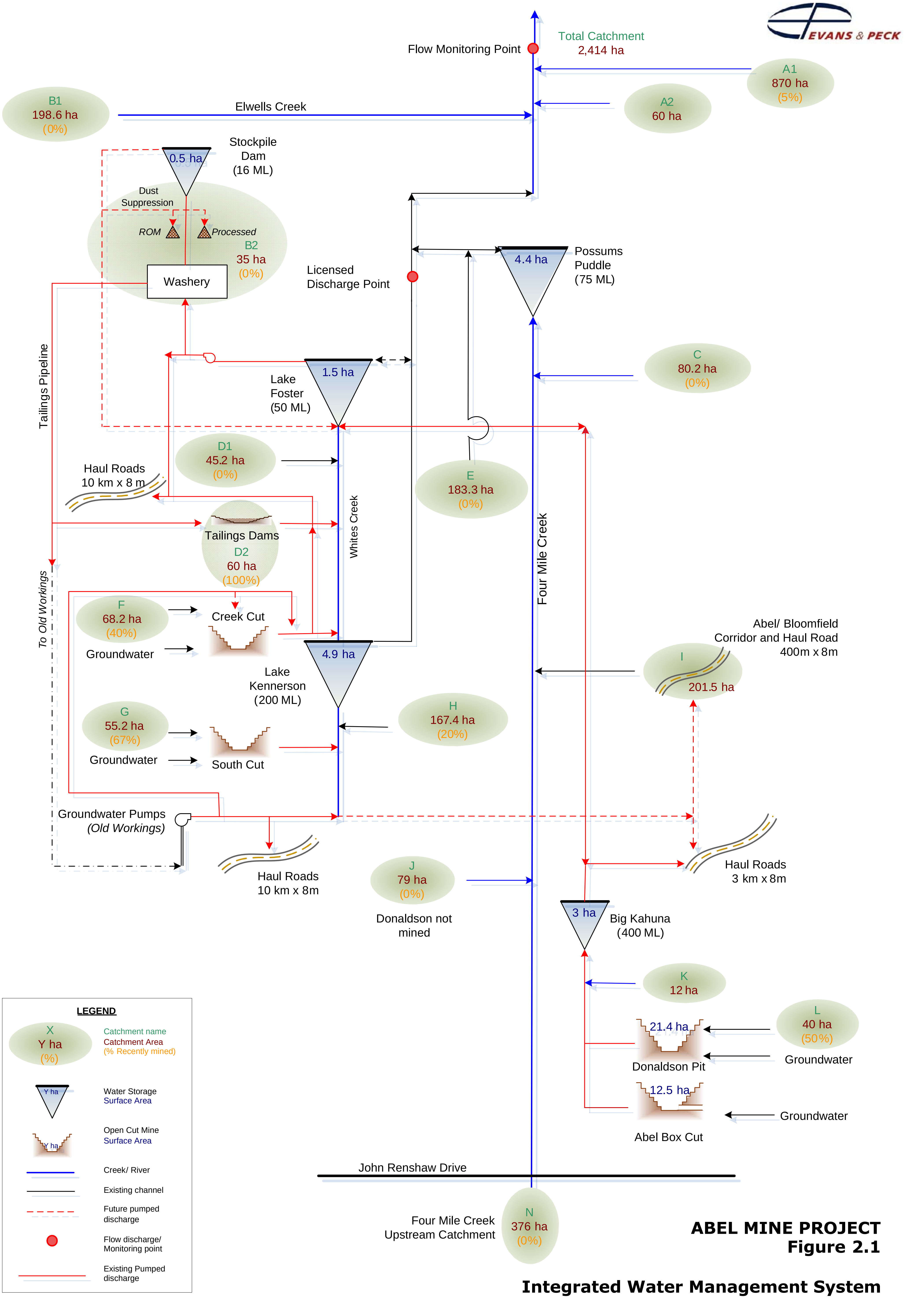
Groundwater levels were measured in May 2006 in nine bores and shafts around the Bloomfield lease area. The groundwater level was at -4.5 m AHD in a borehole close to the southern lease boundary, east of the current active pits. The groundwater levels in other bores near the southern end of the lease were between 10 and 20 m AHD. These are 10 - 20 m lower than groundwater levels measured in new Abel project piezometers nearby to the southeast and east.

The water level has been monitored regularly for some years in the borehole used for water recovery from the underground tailings disposal system. The hydrograph for this borehole is plotted on **Figure 2.4**. It shows that water level has been consistently below about -5 m AHD since at least 2001. It is clear that the recovery borehole represents a sink for groundwater in the vicinity, as well as for water segregating from the deposited tailings.

Groundwater quality has been measured at two bore sites on the Bloomfield lease area. Laboratory analysis results are presented in **Table 2.9**.

Table 2.9
Groundwater Quality – Bloomfield Mine

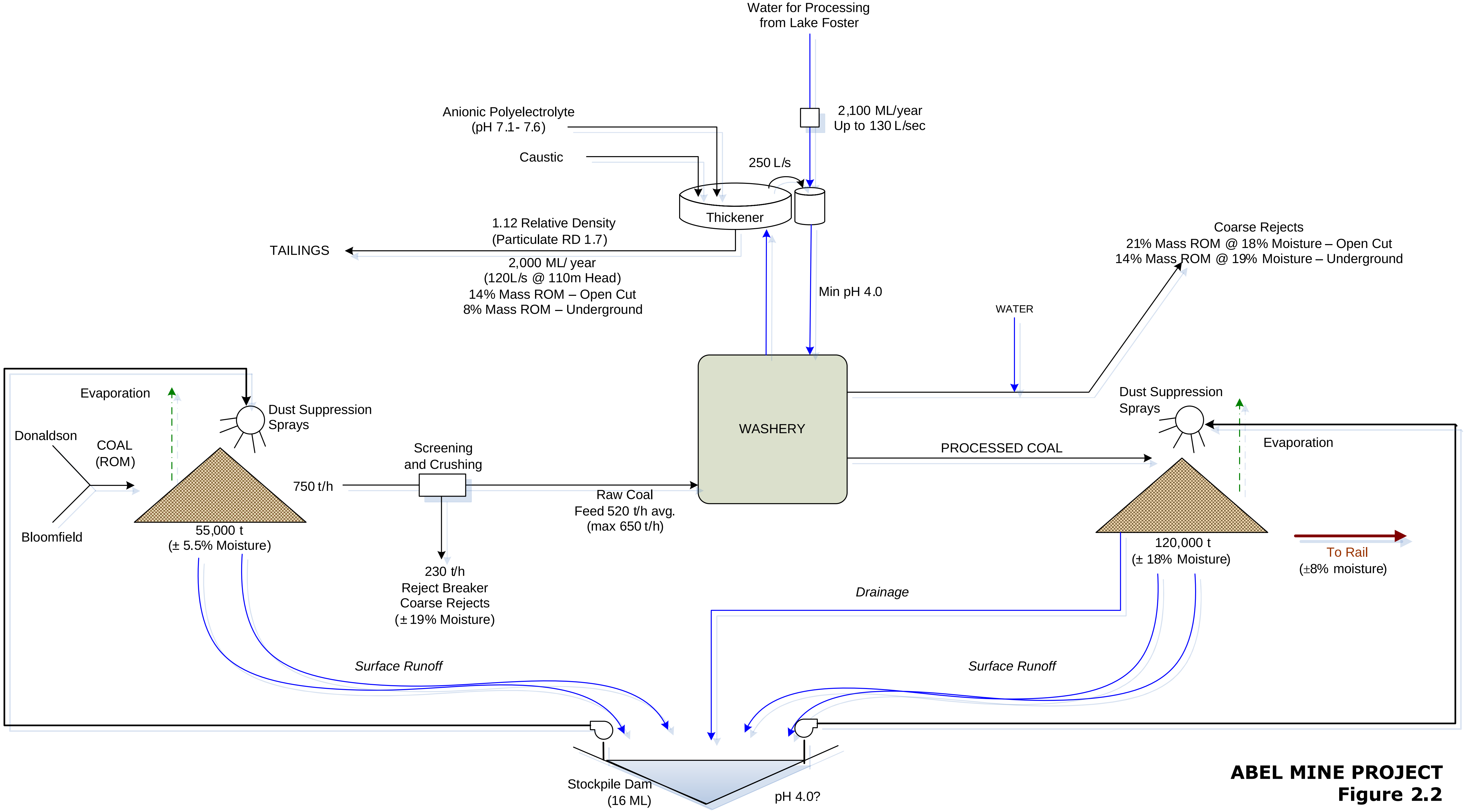
Parameter	Units	LOR	BL01	BL04
pH Value		0.01	6.58	7.11
Sodium Adsorption Ratio			13.22	13.72
Conductivity @ 25°C	µS/cm	1	2,700	2,970
Total Dissolved Solids (TDS)	mg/L	1	2,020	2,110
Calcium	mg/L	1	67	76
Magnesium	mg/L	1	41	61
Sodium	mg/L	1	557	662
Potassium	mg/L	1	11	19
Hydroxide Alk as $CaCO_3$	mg/L	1	<1	<1
Carbonate Alk as $CaCO_3$	mg/L	1	<1	<1
Bicarbonate Alk as $CaCO_3$	mg/L	1	288	753
Sulphate	mg/L	1	573	247
Chloride	mg/L	1	573	757



EVANS & PECK

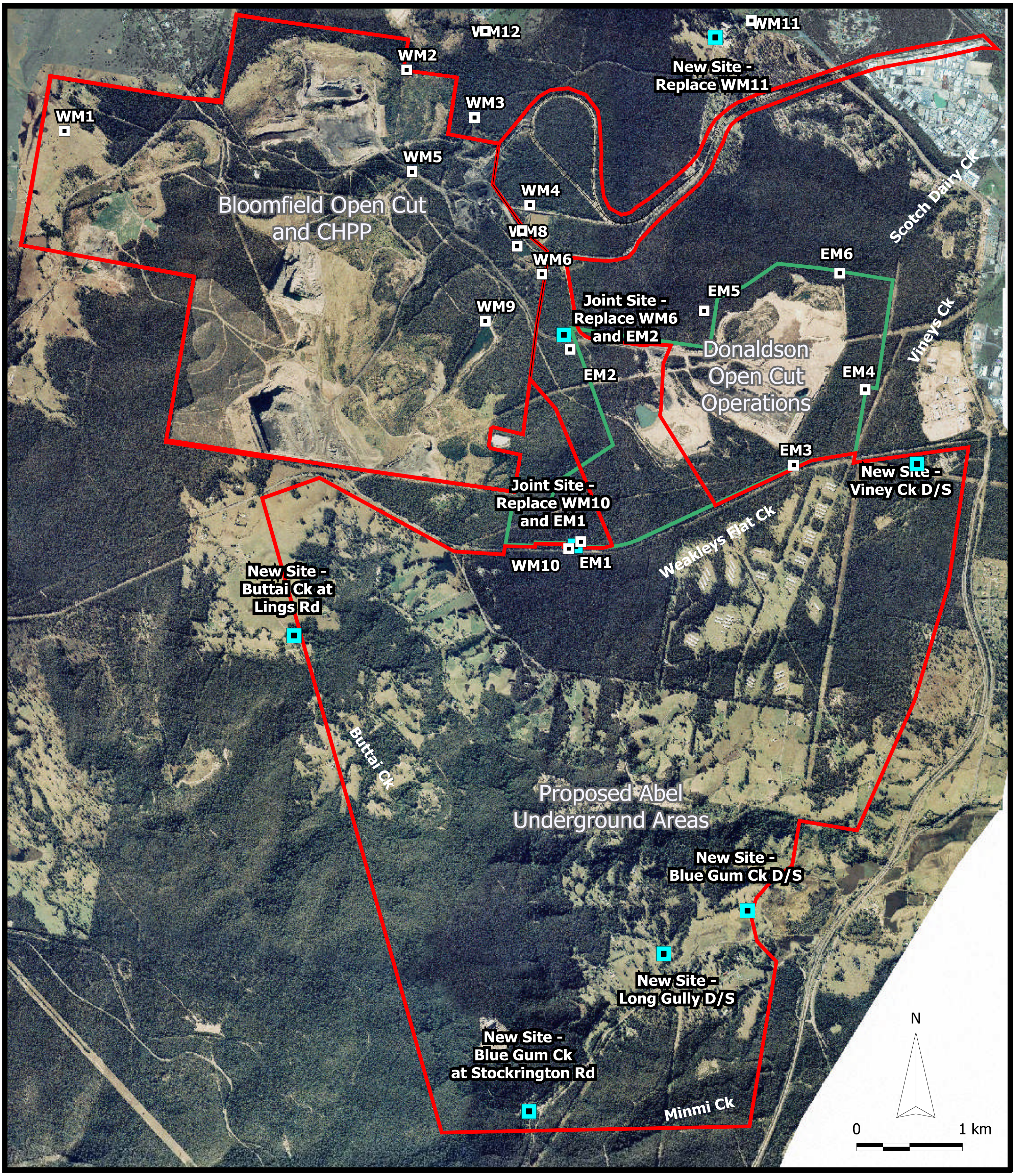
ABEL MINE PROJECT
Figure 2.1

Integrated Water Management System
Abel, Bloomfield and Donaldson Mines



ABEL MINE PROJECT
Figure 2.2

Bloomfield Washery Schematic
Existing Conditions



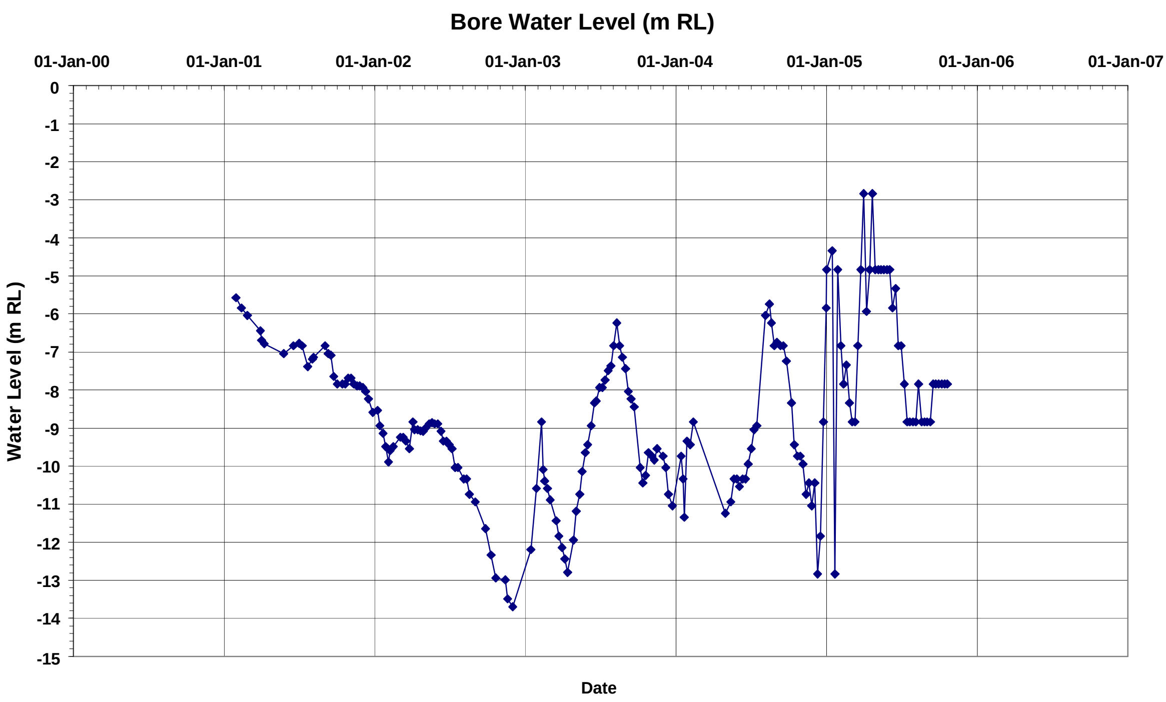
Abel Underground Mine Project

Existing Sampling Sites
Proposed Sampling Sites

DONALDSON COAL

Existing and Proposed Surface Water Monitoring Sites

Figure F-2.3 3/08/2006



ABEL MINE PROJECT
Figure 2.4
Groundwater Hydrographs – Bore BH1

3. PROPOSED ABEL MINE SURFACE FACILITIES

Production from the Abel Underground Mine will gradually increase, as production from Donaldson decreases, to a maximum of 4.4 million tonnes per annum of ROM coal (while operating concurrently Abel and Donaldson will not produce more than a combined total of 4.5 million tonnes per annum of ROM coal). All production from the Abel Underground Mine will be transferred to the Bloomfield CHPP for processing. Initially the coal will be conveyed to the Bloomfield CHPP by truck. Plans allow for the construction of a conveyor system to replace the trucks in the future.

3.1 SURFACE FACILITIES

Figure 3.1 shows the layout of the surface facilities for the Abel Underground Mine that will be developed in two stages:

- Temporary facilities will be established initially while open cut mining is completed in the area immediately adjacent to the Abel box cut entry to the underground mine. These facilities will comprise temporary amenities, employee parking and bath house located on the existing Donaldson mine area near the existing facilities (about 1.5 km north of the Abel site – not shown on **Figure 3.1**). In addition, temporary site office facilities will be established at an access point adjacent to the newly constructed internal haul road (on the north-eastern side of **Figure 3.1**).
- Once Donaldson's open cut mining has been completed on the eastern side of Four Mile Creek, permanent facilities for the Abel Underground Mine will be established within part of the remnant void. The remainder of the void will be back-filled and rehabilitated to leave an area of about 30 ha that drains into the remnant void (an increase of about 12 ha compared to pre-mining conditions).

As shown on **Figure 3.1**, the surface facilities to service the Abel Underground Mine will comprise:

- office, bath house and stores facilities;
- machinery workshop and washdown/refuelling facilities;
- car parking;
- ROM stockpile area.

3.2 DRAINAGE

As noted previously, all permanent facilities will be located within the remnant void after completion of open cut operations on the eastern side of Four Mile Creek. All runoff from external catchments will naturally drain away from the remnant void and there will, therefore, be no requirement for separate facilities for diversion of "clean" runoff away from the mine facilities. The grading of the base of the open cut will drain water in a south-easterly direction towards a location to the east of the 100,000 t ROM stockpiles shown on **Figure 3.1**. A sump will be established in this vicinity and provided with simple sedimentation and oil separation system to remove large sediment and oil. Water collected within the sump will be pumped to the Big Kahuna Dam from where it will be used for dust suppression within the underground and surface workings as well as on the stockpiles and haul roads. Excess water removed from the Abel underground workings will also be pumped into the Big Kahuna Dam.

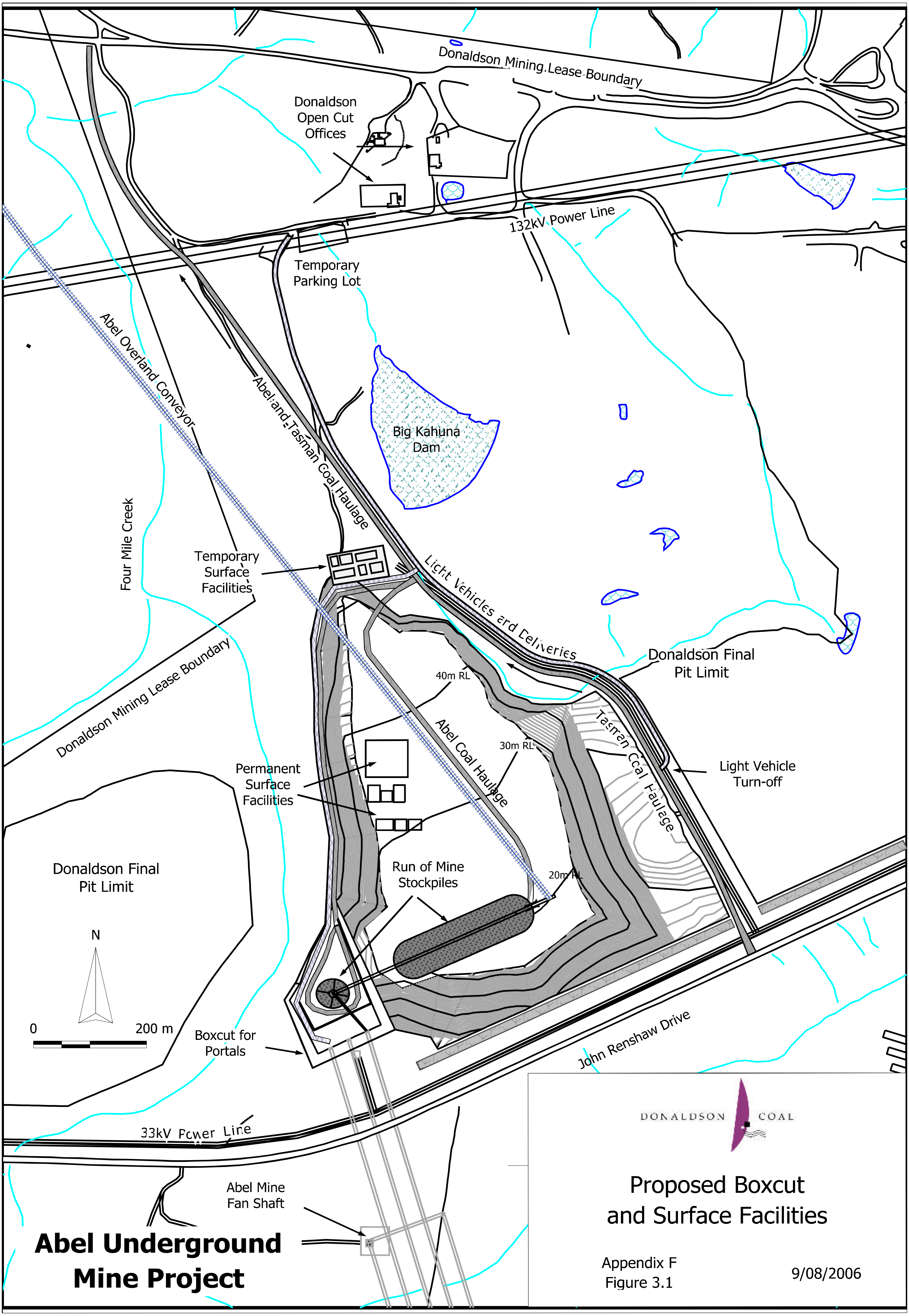
An existing pipeline between Big Kahuna Dam and the Bloomfield CHPP will be upgraded to permit transfer of water between the Big Kahuna Dam and Bloomfield. This pipeline will primarily be used to convey water from the Big Kahuna Dam to Bloomfield at sufficient rate to ensure that no overflow occurs from this dam. If necessary, this pipeline could also be used to convey water from Bloomfield to the Big Kahuna Dam. This pipeline has been provisionally sized to convey up to 10 ML/day.

3.3 Roadworks and Drainage

A separate short sealed haul road will be developed to service the Abel Underground Mine until such time as a conveyor system can be economically justified. This haul road will connect with the recently completed sealed section of haul road that provides access for coal trucks from the Tasman Mine through to the Bloomfield CHPP (as shown on **Figure 3.2**).

The existing haul roads that will also service the Abel mine (existing unsealed haul road from Donaldson to Bloomfield and the new sealed haul road from John Renshaw Drive) have existing approved stormwater pollution control systems. All runoff from the short section of haul road connecting the Abel surface work area to the new sealed haul road will drain back into the open cut void in which the Abel surface workings are located. Accordingly, no additional stormwater pollution control measures will be required for the haul road system that will be used to convey ROM from the Abel Underground Mine to the Bloomfield CHPP.

If and when a conveyor is installed to convey coal from the Abel Underground Mine to the Bloomfield CHPP, the conveyor will be located along the approximate alignment shown on **Figure 3.2**. Standard erosion and sediment control practices will be implemented during construction of the conveyor. Permanent drainage facilities will include table drains to direct all runoff to a series of pollution control ponds at each low point on the conveyor.

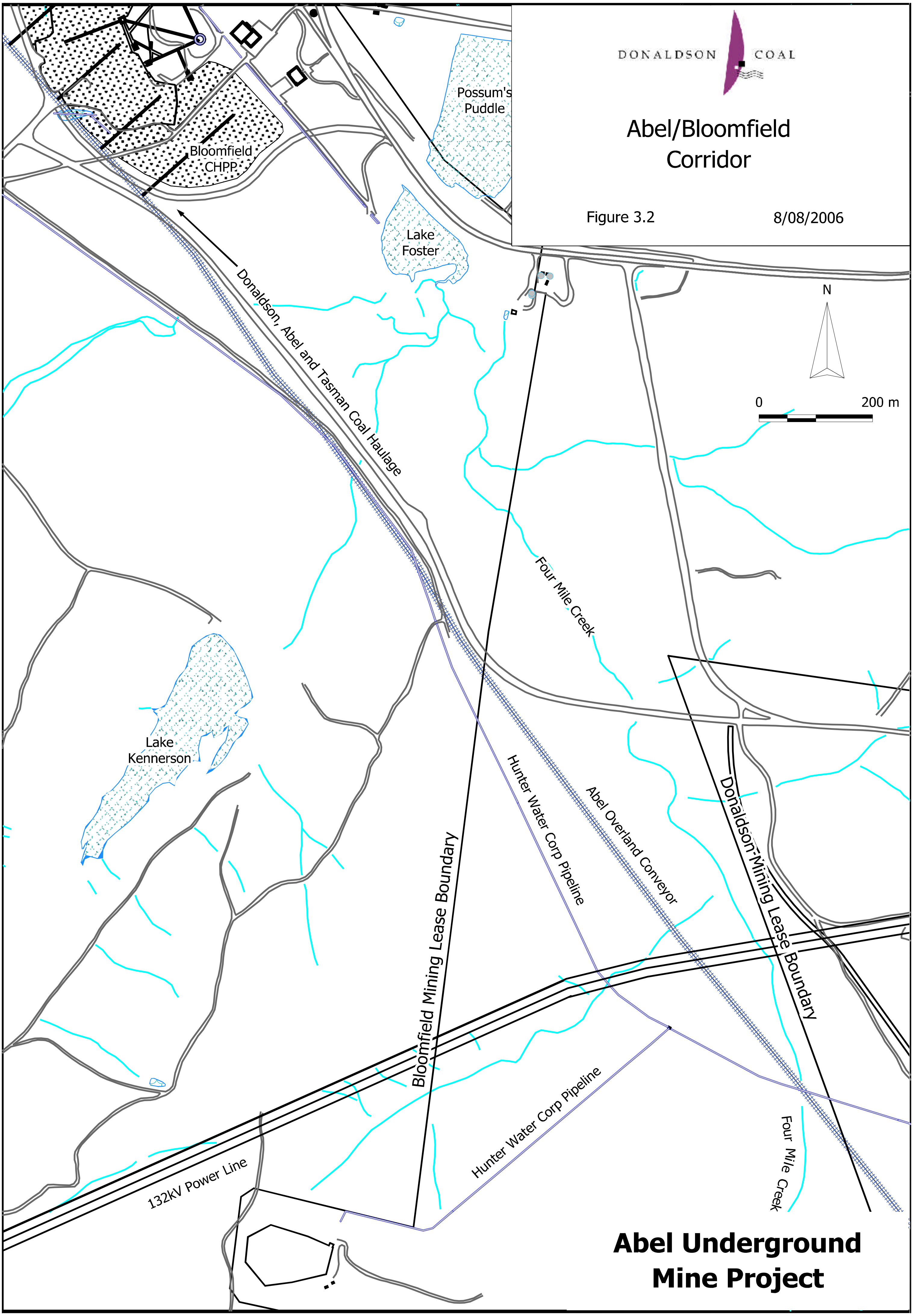


Abel Underground Mine Project

Proposed Boxcut and Surface Facilities

Appendix F
Figure 3.1

9/08/2006



Abel Underground Mine Project

4. BLOOMFIELD COAL HANDLING & PREPARATION PLANT

The Bloomfield CHPP will be expanded and continue to process coal from the Bloomfield, Donaldson and Tasman mines, as well as coal from the Abel Underground Mine and up to 1 million tonnes from other sources. The expansion requires the following surface water related matters to be considered:

- Increased stockpile areas for ROM and processed coal;
- Stormwater pollution control dams serving the CHPP and adjoining stockpile areas;
- Pipeline for conveying fine tailings slurry and the facilities for disposal of fine tailings, including the existing disposal well into the old underground workings as well as alternative disposal to existing voids;
- Haul roads for conveyance of coarse reject material for its disposal (currently the U Cut);
- Various facilities involved in the supply of water to the CHPP for processing of coal and the disposal of the fine tailings.

4.1 CHPP AND STOCKPILE AREA

Figure 4.1 is a layout of the expanded Bloomfield CHPP and adjoining stockpile facilities. A number of changes will be required within the CHPP itself to cater for an increased throughput but this will require no expansion of the building itself. The main changes in the facilities surrounding the CHPP, as shown on **Figure 4.1** will be:

- Expansion of the ROM stockpile area to provide sufficient capacity for 300,000 tonnes of ROM to be stacked in separate stockpiles for different quality of coal derived from the various mines contributing to the facility ;
- Provision for the installation of feed conveyors in the ROM stockpile area to distribute coal from the conveyor from Abel (once that conveyor is constructed);
- Expansion of the processed coal stockpile area including the extension of the two existing feed gantries and the installation of a third gantry to increase capacity to a maximum of 500,000 tonnes;
- Extension of the two existing reclaim tunnels and construction of a third reclaim tunnel to feed coal from the product stockpiles to the conveyor for transport to the rail loading facility;
- Minor re-arrangement of surface drainage facilities as described in **Section 4.3** below.

4.2 PROJECTED COAL PRODUCTION, TAILINGS DISPOSAL AND WATER REQUIREMENTS

An increase in capacity of about 50% of the Bloomfield CHPP (to 6.5 million tonnes per year of ROM) is required to cater for coal from the Abel Underground Mine and retain some residual capacity for other future sources. The Bloomfield CHPP currently relies on water supply primarily drawn from old underground workings within the Bloomfield lease area supplemented with surface runoff from parts of the Bloomfield open cut mine area.

With the expansion of the CHPP to accept coal from the Abel Underground Mine, the water supply system will be expanded to integrate with the water management systems for the Donaldson and Abel mines. This will allow any shortfall of water in any part of the associated mines to be drawn from the other mines. In addition, the water management system for the Tasman Underground Mine makes provision for excess water to be trucked to the Donaldson water supply system, if necessary.

Figure 4.2 is a schematic diagram that summarises the inputs (ROM and water) and outputs (coarse rejects, fine tailings and product coal) for the CHPP. **Table 4.1** and **Table 4.2** below summarise the annual ROM coal production, coarse and fine tailings production and water requirements for the CHPP for two different production scenarios:

- Target production from the Abel Underground Mine increasing from 1 million tonnes per year ROM coal in 2008 to 4.4 million tonnes per year in 2013 after which production would remain constant for the remainder of the life of the mine (**Table 4.1**) This scenario also includes 1 million tonnes of ROM from unidentified future sources commencing in 2011. This production scenario reflects conditions in which there would be the maximum demand for water for CHPP purposes.
- Provisional production based on the draft Abel mine plan which would involve gradually increasing production to a maximum of about 4.2 million tonnes of ROM coal in 2015 – 2017 followed by a gradual decline in production for the remainder of the life of the mine (**Table 4.2**). This production scenario reflects conditions in which there would be a relatively small water requirement for CHPP purposes at the end of the life of the Abel mine when the expected groundwater inflows to the mine are a maximum.

In **Table 4.1** and **Table 4.2** the percentage of coarse rejects and fine tailings varies depending on the source of the coal and the mining method. Based on experience at the Bloomfield CHPP and other mines, the estimated average proportions of coarse rejects and fine tailings are:

- Open cut ROM — 21% coarse rejects, 14% fine tailings;
- Underground coal — 12% coarse rejects, 8% fine tailings.

Both tables list the estimated volume of coarse rejects and fine tailings that will need to be disposed. Prior to 2003 all waste material was deposited in the U Cut void. Since 2003 the fine tailings slurry has been deposited via a borehole into the old underground workings of the Big Ben seam beneath the Bloomfield lease area. To date (June 2006) an estimated 1.2 million tonnes of fine tailings has been disposed in this manner. This is estimated to occupy about 1 million cubic metres of the estimated 4.8 million cubic metres of void space within the old underground workings (the "Big Ben" seam). Water is recovered from the same workings at a bore site approximately 2 km from the deposition point. This water is pumped to Lake Kennerson and subsequently used to supply make-up water to Lake Foster for use in the CHPP.

Table 4.1
Projected Annual Coal Production, Tailings Disposal and Water Requirements for the "Target Production" Scenario

Year	ROM Coal Production (t x 1,000)										
	Bloomfield O/C	Donaldson O/C	Other O/C	Tasman U/G	Abel U/G	Other U/G	Total	Coarse Rejects (t x 1,000)	Fine Tailings (t x 1,000)	C + F Tailings Cum'ive (m^3 x 1,000)	Annual Water Req'd (ML)
2005	800	2,250					3,050	641	427		2,170
2006	800	2,250		150			3,200	659	439	1,000	2,230
2007	800	2,250		800			3,850	737	491	2,000	2,500
2008	800	2,250		975	1,000		5,025	878	585	3,300	2,990
2009	800	2,250		975	1,400		5,425	926	617	4,700	3,160
2010	800	1,200		975	2,200		5,175	801	534	5,800	2,750
2011			800	975	2,900	200	4,875	657	438	6,800	2,270
2012			800	975	3,500	200	5,475	729	486	7,800	2,520
2013			800	975	4,400	200	6,375	837	558	9,100	2,900
2014			800	900	4,400	200	6,300	828	552	10,300	2,860
2015			800	760	4,400	200	6,160	811	541	11,400	2,810
2016			800	600	4,400	200	6,000	792	528	12,600	2,740
2017			800	450	4,400	200	5,850	774	516	13,700	2,680
2018			800		4,400	200	5,400	720	480	14,800	2,490
2019			800		4,400	200	5,400	720	480	15,800	2,490
2020			800		4,400	200	5,400	720	480	16,900	2,490
2021			800		4,400	200	5,400	720	480	17,900	2,490
2022			800		4,400	200	5,400	720	480	19,000	2,490
2023			800		4,400	200	5,400	720	480	20,000	2,490
2024			800		4,400	200	5,400	720	480	21,100	2,490
2025			800		4,400	200	5,400	720	480	22,100	2,490
2026			800		4,400	200	5,400	720	480	23,100	2,490
2027			800		4,400	200	5,400	720	480	24,200	2,490

Note: Years highlighted are those adopted for detailed water balance analysis (see Chapter 5).

Table 4.2
Projected Annual Coal Production, Tailings Disposal and Water Requirements for the "Provisional Production" Scenario

Year	ROM Coal Production (t x 1,000)								
	Bloomfield O/C	Donaldson O/C	Tasman U/G	Abel U/G	Total	Coarse Rejects (t x 1,000)	Fine Tailings (t x 1,000)	C + F Tailings Cum'ive (m^3 x 1,000)	Annual Water Req'd (ML)
2005	800	2,200			3,000	641	427		2,180
2006	800	2,250	150		3,200	659	439	1,000	2,240
2007	800	2,250	800		3,850	737	491	2,000	2,510
2008	800	2,250	975	224	4,249	784	523	3,200	2,680
2009	800	2,250	975	500	4,525	818	545	4,400	2,790
2010	800	1,200	975	1,091	4,066	668	445	5,300	2,290
2011			975	1,829	2,804	336	224	6,100	1,170
2012			975	2,567	3,542	425	283	6,700	1,480
2013			975	2,995	3,970	476	318	7,400	1,660
2014			900	3,769	4,669	560	374	8,200	1,950
2015			760	4,119	4,879	586	390	9,000	2,040
2016			600	4,119	4,719	566	378	9,900	1,970
2017			450	4,119	4,569	548	366	10,700	1,910
2018				3,919	3,919	470	314	11,400	1,640
2019				3,919	3,919	470	314	12,000	1,640
2020				3,919	3,919	470	314	12,700	1,640
2021				3,919	3,919	470	314	13,400	1,640
2022				3,285	3,285	394	263	14,000	1,370
2023				2,900	2,900	348	232	14,500	1,210
2024				2,514	2,514	302	201	14,900	1,050
2025				1,632	1,632	196	131	15,200	680
2026				750	750	90	60	15,300	310
2027				500	500	60	40	15,400	210

Table 4.3 summarises the estimated current available volumes for tailings disposal in the old underground workings and existing open cut voids. In addition to the void volume below the existing rim of the void the table shows the available volume above the surface of the voids assuming an average 10 m placement of coarse rejects. The volume for tailings disposal in the old underground workings of the Big Ben seam has been estimated from an analysis of the old mine plans which indicated that the total volume of void space is about 4.8 million m^3. Assuming that tailings could be injected into only 50% of this volume and that about 1 million m^3 has been deposited since 2003, there is an estimated 1.4 million m^3 capacity remaining in the underground workings of Big Ben seam.

Table 4.3
Estimated Available Volume for Tailings Disposal

Location	Void Volume (m^3 x 10^6)	Above Ground Volume[1] (m^3 x 10^6)
Old U/G Workings (Big Ben seam)	1.4	
U North open cut void	1.9	3.5
U South open cut void	0.8	3.0
Creek Cut void	5.3	2.0
S Cut void (final)	8.8	2.7
Total	**18.2**	**11.2**

Note; 1 Above ground volume based on an average depth of overtopping of each void with coarse rejects

Following the filling of the underground workings of the Big Ben seam it is proposed to discharge the tailings into the U North/U South open cut void, which has previously been used for that purpose, then the Creek Cut Void and the S Cut Void. The U North Cut and U South Cut voids will operate together as one void when tailings are discharged into the area.

Table 4.3 shows that there is an estimated capacity for deposition of about 18 million m^3 of coarse rejects and fine tailings within the existing Bloomfield operations. By comparison with the second last column of **Table 4.1** (24.2 million m^3), and **Table 4.2** (15.4 million m^3) it can be seen that there is sufficient capacity to accept all reject and tailings material over the anticipated life of all mines that contribute to the Bloomfield CHPP.

The final column of **Table 4.1** and **Table 4.2** lists the expected annual water requirements for the CHPP including fine tailings disposal and water lost in product and coarse tailings. The required volume of water has been estimated on the following basis:

- Water used to convey the fine tailings (4.85 m^3 per tonne of tailings) based on CHPP records;
- Processed coal conveyed to the rail loader typically has 2% higher moisture content than the ROM coal received at the CHPP;
- Coarse rejects from the washery have approximately 12% more water than ROM.

For the “Target Production” scenario (**Table 4.1**) it can be seen that the estimated water requirements increase from about 2,100 ML/year year under current operating conditions to about 3,200 ML/year in 2009 after which water requirements gradually decline as various mines cease production (Donaldson in 2010, Bloomfield in 2010 and Tasman in 2017). It can also be seen that from 2018 onwards, the water demand is expected to only 15% more than existing demand, despite greater ROM delivery. The reason for this is that from 2012, most ROM would be from underground sources which are expected to yield a lower proportion of fine tailings than open cut ROM (an average of 8% compared to 14%) which will require less water for transport.

For the “Provisional Production” scenario (**Table 4.2**) it can be seen that the estimated water requirements reach a peak of about 2,800 ML/year in 2009, decline to about 1,200 ML in 2011 before reaching a second peak of about 2,000 ML in 2015 after which water requirements gradually decline as coal production declines.

4.3 STORMWATER RUNOFF AND POLLUTION CONTROL

The existing stormwater pollution control facilities in the vicinity of the CHPP comprise a series of drains that direct runoff to a number of small sediment traps which, in turn, overflow to the Stockpile Dam (17 ML capacity).

To cater for the increased throughput of the CHPP the stockpile area will be enlarged yielding a catchment of about 35 ha, as shown on **Figure 4.1**. This will require minor upgrading of the facilities and alteration of the water management regime, as follows:

- Construction of bunding around the southern and eastern side of the ROM stockpile area to direct all surface runoff to the Stockpile Dam.
- Upgrading of the existing drain that leads to the Dam F (1 ML capacity) located to the east of the conveyor that leads to the rail loader. This upgrading is required to ensure that no stormwater runoff from the product stockpile area can drain to Four Mile Creek.
- Dam F will be operated as a sediment trap and collection sump. Coarse sediment will be retained in the sump for removal as required. An automatic float operated pump will be used to transfer all water from the sump to the Stockpile Dam.
- The Stockpile Dam will be equipped with an automatic float operated pump to transfer water to Lake Foster. Further details of the capacity of the dam and the operating regime are set out below.
- Reconfigure both dams so that inlet and overflow occur at adjoining locations so as to achieve "first flush" capture in both dams. This will ensure that, in the event of extreme rainfall, any cleaner runoff that occurs after the dams are full will bypass the dams and not mix with earlier runoff contained in the dams.

The Stockpile Dam currently acts as a reservoir for water that is used for dust suppression in the vicinity of the CHPP. The capacity of the dam is intended to ensure that no discharge occurs except in extreme storm events. For the enlargement of the stockpile areas it is intended to alter the operation of the dam on the following basis without the need to enlarge the dam:

- To comply with current requirements for Type F sediment control basins (as set out in Chapter 6 of *Managing Urban Stormwater: Soils and Construction,* Landcom, 2004) a settlement zone storage capacity of 7 ML is required to accommodate runoff from a 90th percentile 2 day storm (see **Appendix B** for design calculations).
- For Type F sediment control basins, the settlement zone capacity of 7 ML is to be restored within 2 days of a storm (ie a minimum pump-out rate of 3.5 ML/day).
- Once drawn down to below the settlement zone, the remaining stored water will be utilised for dust suppression purposes on the stockpiles. (Because the processed coal leaves the CHPP at about 18% moisture content, it is anticipated that minimal water will be required for dust suppression on the processed coal stockpiles. The majority of the water required for dust suppression will be for the ROM stockpiles.)
- A sediment storage zone of 3 ML will be designated at the base of the Stockpile Dam. Once accumulated sediment reaches this level, it will be removed.

Note that the design capacity and operating regime to satisfy the requirements of *Managing Urban Stormwater: Soils and Construction* have been adopted as a **minimum** for this dam. Fulfilment of these requirements would achieve a system that could be expected to overflow in the event of rainfall greater than the 2 day 90th percentile rainfall (31.8 mm in 2 days). The frequency of overflow from the dam could be reduced further by adopting a higher pump-out rate and drawing down the water level below the 7 ML minimum capacity.

To assess the effectiveness of these options, water balance modelling has been undertaken (see **Chapter 5**). A specific output from this model is an estimate of the frequency and volume of overflow from this dam. In order to achieve zero overflow from the Stockpile Dam in average rainfall years, the modelling indicates that it would be necessary to operate the dam with a settlement storage capacity of 10 ML and a pump-out rate of 5 ML/day. As noted in **Chapter 5**, the water balance modelling indicates that such an operating regime would significantly reduce the frequency of overflow from the Stockpile Dam compared to that which would occur if the dam was operated strictly in accordance with the requirements set out in *Managing Urban Stormwater: Soils and Construction*. Further details of the proposed operating regime for the Stockpile Dam will be developed for the final Water Management Plan.

4.4 CHANGES TO WATER MANAGEMENT SYSTEM

The increased throughput of ROM and the changing composition of the sources of ROM (reduction of ROM from open cut mining and increasing quantities from underground) will lead to changes in the required volume of water supply for the CHPP as set out in **Table 4.1** and **Table 4.2**. In addition, as the Abel underground workings progress, groundwater inflow will increase from an estimated 0.0195 ML/day at the commencement of mining to a peak of 3.18 ML/day in year 2026. In the early years of the Abel Underground Mine it is anticipated that the inflow to the workings together with the surface runoff from the area of the surface workings will be stored in Big Kahuna and utilised for dust suppression within the underground workings, the surface facilities area and the haul road. As groundwater inflows progressively increase the available volume of water will exceed the requirements for dust suppression and excess water will be transferred to the Bloomfield water management system and substituted for water drawn from the underground workings.

For the "Provisional Production" scenario (**Table 4.2**), the decline in coal production in the later stages of the mine life coincide with the predicted increase in groundwater inflow. This would lead to an anticipated excess of water after 2025 which could be used for mine operational purposes and the Bloomfield CHPP. By the end of mining in 2027, about 2,500 ML of excess water could be produced. The mine plans indicate that by 2015 there would be capacity to store over 1,500 ML within mined out areas of the Abel Underground Mine and it is anticipated that sufficient capacity to store any excess underground water would be available if required after 2025.

For either of the production scenarios set out in **Table 4.1** and **Table 4.2** the majority of the current water for CHPP purposes is drawn from the Big Ben seam underground workings into which the tailings are deposited. Because water is extracted from the same workings, the majority of this water will be derived from the water used to transport the tailings. Once the tailings storage capacity of the underground workings is filled (estimated to be approximately the end of 2007), fine tailings will be deposited into surface voids. Once this occurs, approximately 80% of the water used for transport of fine tailings will be recoverable, with 20% retained within the deposited tailings or lost by evaporation and seepage.

The detailed water balance model (see **Chapter 5**) developed for the Four Mile Creek catchment represents the surface water processes depicted in **Figure 2.1**. This model has been used to assess the effectiveness of a range of operating rules for the various water sources and transfer systems within the water management system. The operating rules are primarily expressed in terms of target operating levels for the various storages and the pumping rates for transfer of water between sources. A range of operating rules were explored to demonstrate that, after accounting for inputs from the Abel Underground Mine (ROM and water), the water management system would be capable of operating in a manner that would achieve the following performance objectives:

- maintain water supply for the CHPP and dust suppression at all times;
- achieve zero discharge to the environment from Big Kahuna;
- minimise discharge from the Stockpile Dam;
- minimise discharge from Lake Foster and Lake Kennerson;
- where controlled discharge was necessary, preference would be given to Lake Kennerson.

A series of "trial and error" runs were made within the model for a range of mine production and climate scenarios. Once the adjustment of the model parameters indicated that the water management system could achieve satisfactory performance against the criteria listed above, a single set of target operating levels and water transfer pumping rates were adopted as an initial indicative set of operating parameters. It should be noted that these operating parameters represent one feasible set of operating rules that could be used to achieve the performance objectives listed above. In the process of finalising a Water Management Plan for the Abel Project, it is anticipated that further optimisation of the surface water operating rules will be undertaken. In addition, as further operating experience is gained, it is anticipated that there will be regular reviews of the water management plan involving further refinement of the operating rules.

As a result of the water balance modelling, the following changes to the existing arrangements are proposed:

- **Big Kahuna Dam**. Make the Big Kahuna Dam the focal point for water management for the Donaldson and Abel projects. Variations and enhancements to the existing system would include:
  - Upgrading the existing pipeline between the Big Kahuna Dam and Lake Foster to permit the transfer of up to 5 ML/day;
  - Establish a target operating level within the Big Kahuna Dam of 75% capacity (300 ML) above which water would be transferred to Lake Foster (subject to the water level in Lake Foster being below the target operating level).
- **Stockpile Dam**. Make minor adjustments to the Stockpile Dam and associated stormwater drainage facilities within the Bloomfield CHPP stockpile area:
  - Provide bunding and increase channel capacity to direct all runoff to the Stockpile Dam or Dam F;
  - Reconfigure both dams so that inlet and overflow occur at adjoining locations so as to achieve "first flush" capture in both dams. This will ensure that in the event of extreme rainfall any cleaner runoff that occurs after the dams are full will bypass the dams and not mix with earlier runoff contained in the dams;

  - Provide an automatic float operated pump to transfer all water from Dam F to the Stockpile Dam;
  - Provide an automatic float operated pump to transfer water from the Stockpile Dam to Lake Foster. Pump transfer rate to be a minimum of 3.5 ML/day to satisfy the requirements for operation of this dam in accordance with the requirements set out in *Managing Urban Stormwater: Soils and Construction* (Landcom, 2004).

- **Lake Foster**. As well as the source of water for supply to the CHPP, the functioning of Lake Foster as a "dirtier" water dam will be further differentiated by directing all feasible water from active mine areas into Lake Foster. This will include:
  - Pumping of water from the Stockpile Dam as described in **Section 4.3** above;
  - Transfer of excess water from Big Kahuna, including water from the Abel underground workings. Note that in later years of the Abel project, this will provide a significant contribution to the water supply for the CHPP (about 1,150 ML/year by 2027 which constitutes more than 60% of the water that would be required for the CHPP in that year under the "Target Production" scenario. As noted above, in the case of the "Provisional Production" scenario, there is expected to be an excess of groundwater available from about 2025 onwards);
  - Continue pumping water from the Creek Cut void and U Cut tailings disposal areas to Lake Foster when Lake Foster level is below a target operating level;
  - Increase the capacity of the bypass channel to convey controlled discharges from Lake Kennerson around the western side of Lake Foster. At high flows this channel can currently spill into Lake Foster or alternatively can receive overflow from Lake Foster.
  - Manage Lake Foster at a normal operating level of about 50% capacity to provide storage capacity for runoff events whilst minimising the frequency of discharge.

- **Lake Kennerson**. Retain Lake Kennerson as a primarily "clean" water dam that serves as a source of supply for Lake Foster when other sources are not available. Lake Kennerson would:
  - Continue to receive water from the Big Ben underground workings via the two existing pumps (9 ML/day and 7 ML/day capacity). Pumping from this source would be adjusted as necessary to achieve a normal operating level in Lake Kennerson of 50% capacity (100 ML);
  - Continue to receive water from S Cut and the natural and rehabilitated catchment areas of 167 ha.
  - Operate the discharge from Lake Kennerson so as to activate controlled discharge when the capacity exceeds 80% and wet weather condition occur in accordance with the existing EPA discharge licence (>10 mm in the previous 24 hours);

As a result of running the water balance model with a range of operating rules (target water levels and pumping or discharge rates), an indicative set of operating rules were identified (see **Table 4.4** below). These operating rules will be refined and submitted for review in the final Water Management Plan following approval of the project. The operating parameters set out below have only been used to demonstrate the capacity of the system to achieve improved performance against the stated water management objectives following introduction of ROM and coal from Abel.

Table 4.4
Indicative Target Operating Levels and Pumping / Discharge Rates

Storage/Source	Capacity (ML)	Target Operating Level (ML)	Controlled Discharge Rate (ML/day)	Pumping Rate (ML/day)	Pumping/ Discharge to:
Big Kahuna	400	300	-	5	Lake Foster
Stockpile Dam	16	6	-	5	Lake Foster
Lake Kennerson	200	160	Up to 40	-	Four Mile Creek
Lake Foster	45	22	0	0	No discharge

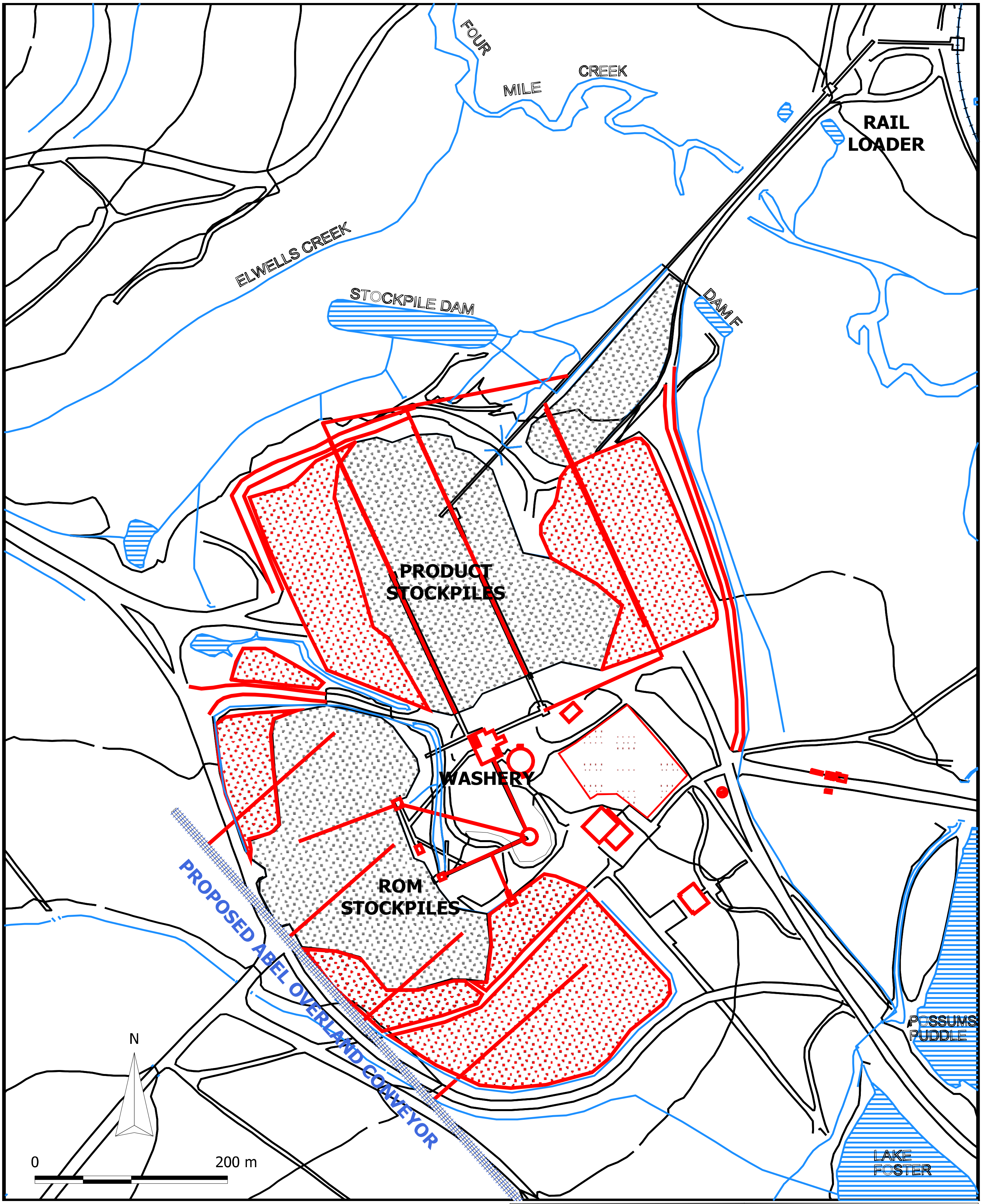
In addition to the pumping and discharge rates listed above, other significant water transfers that form part of the existing system include those set out in **Table 4.4**. The table also lists the proposed constraint on when pumping would occur.

Table 4.5
Indicative Pumping Rates from Sources

Storage/Source	Transfer Rate (ML/day)	Discharge To	Constraint
Old Workings	9	Pumped to L Kennerson	L Kennerson level <50%
Old Workings	7	Pumped to L Kennerson	L Kennerson level <40%
S Cut	2	Pumped to L Kennerson	L Kennerson level <80%
Lake Kennerson	Up to 16	Gravity flow to L Foster	L Foster < 50%
Tailings Dams (U Cut)	2	Pumped to L Foster	L Foster <50%
Creek Cut	2	Pumped to L Foster	L Foster <50%
S Cut	2	Pumped to L Foster	L Foster <50%

Compared to existing operating conditions, the main proposed changes to existing operating conditions are:

- Holding back on pumping from the Bloomfield underground workings until Lake Kennerson is less than 50% full. In the past pumping for groundwater level control purposes has maintained Lake Kennerson at over 80% full for extended periods;
- Transfer of water from the Stockpile Dam to Lake Foster. No transfer occurred in the past;
- Transfer water from Big Kahuna Dam to Lake Foster on a regular basis in order to maintain Big Kahuna at a target operating level of 75%. In the past, the existing pipeline was rarely used.



Abel Underground Mine Project

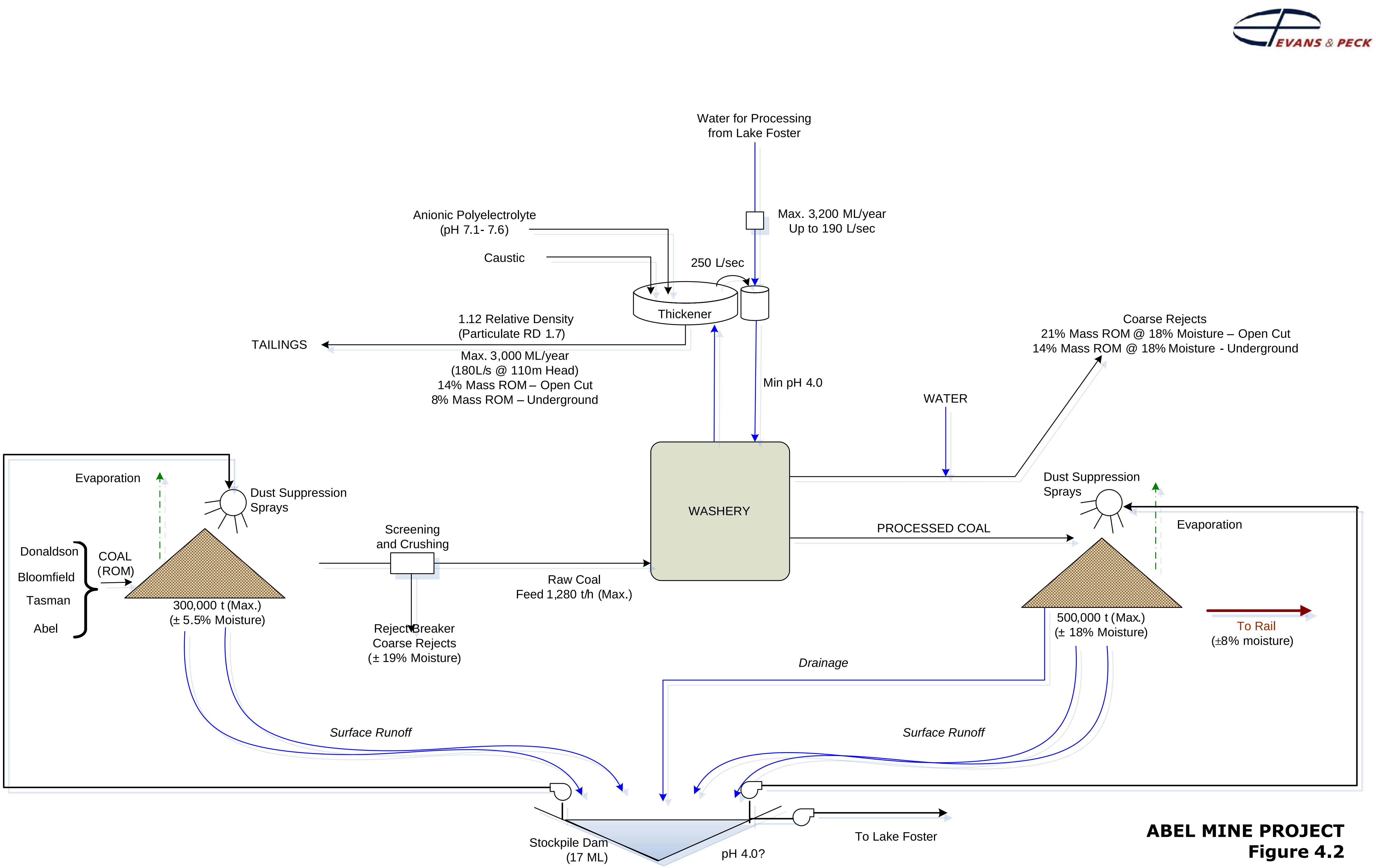
Existing Facilities
Proposed Expanded Facilities
Proposed New Parking Lot
Drainage and Dams
Proposed Abel Conveyor

DONALDSON COAL

Bloomfield Washery, Stockpiles, Conveyors and Rail Loader

Appendix F
Figure 4.1

9/08/2006



ABEL MINE PROJECT
Figure 4.2

Bloomfield Washery Schematic
Future Conditions

5. WATER BALANCE ANALYSIS

A detailed surface water management model has been developed to establish the overall performance of the water management systems associated with the Bloomfield, Donaldson and Abel mines. The model represents the runoff, flow, water storage and pumped transfer systems within the Four Mile Creek catchment, as shown in **Figure 2.1**.

The Tasman Mine does not have a common boundary with Abel, Bloomfield or Donaldson Mines. The interactions between Tasman and the operations depicted in **Figure 2.1** comprise the haulage of ROM to the Bloomfield CHPP and, if necessary (although highly unlikely), the transfer of water between sites by truck to cater for shortfall or excess of water at Tasman.

The water balance model has been configured to allow operation of the water storages and pumps to achieve the following objectives:

1. Maintain water supply for the CHPP and dust suppression at all times.
2. Achieve zero discharge to the environment from Big Kahuna.
3. Minimise discharge from the Stockpile Dam.
4. Reduce discharge from Lake Foster and Lake Kennerson. (Whilst a reduction in discharge from Lakes Kennerson and Foster is desirable for purposes of minimising potential salinity or TSS impacts on Four Mile Creek, some discharge from this system is required to maintain flows in the creek.)
5. Where controlled discharge is necessary, preference should be given to water from Lake Kennerson.

To achieve these objectives, the model allows the operation of each storage to be adjusted for:

- the target operating water level that provides capacity to capture and retain runoff from the contributing catchment;
- the transfer rate to/from the designated storage once the required target storage level is reached.

Details of the model setup and validation are contained in **Appendix C.** The main features of the model are:

- The model operates on a daily basis utilising historic daily records of rainfall and evaporation.
- The model incorporates a variety of catchments that have different runoff characteristics. These range from semi-natural bushland in the catchment to the south of John Renshaw Drive to urban residential areas at the northern end of the catchment adjacent to the New England Highway. Runoff characteristics for these different land uses have been derived from a detailed hydrologic study undertaken for catchments adjoining Four Mile Creek (Lyall & Macoun Consulting Engineers, 1998).
- Groundwater inflow to open cut pits and underground workings.
- Operation of key storages including runoff into the storage, pumped transfer into or out of the storage and rainfall on to, and evaporation from, the surface of the storage. (A pan factor of 0.8 was assumed for purposes of assessing evaporation loss from storages).
- Pumping of groundwater from old underground workings to supplement surface runoff to meet the water supply requirements of the Bloomfield CHPP.

- Extraction of water for dust suppression purposes (on haul roads, stockpiles and work areas).
- Water used for the disposal of fine tailings from the CHPP.
- Return of "excess" water from tailings deposition in open cut voids (after allowing for water retained within the deposited tailings and losses by evaporation and seepage).
- Controlled discharge from Lake Kennerson in the event that the maximum target water level is exceeded and conditions permit discharge in accordance with the requirements of the EPA licence.

The model uses daily historic climate data (rainfall and evaporation), keeps account of all daily inputs and outputs and provides annual summaries of the volume and frequency of pumped discharges and overflows.

The model has been run for a range of climatic scenarios at key stages in the life of the project, representing different stages of mine production and the associated groundwater inflow to the workings and requirements for water in the CHPP.

5.1 DATA SOURCES

Data sources used in the Four Mile Creek surface water balance model include:

- Catchment areas and characteristics derived from mine records and plans supplemented with catchment areas outside mine lease areas taken from the 1:25,000 topographic map.
- Storage characteristics of the key storages (depth, surface area and storage capacity) provided by Bloomfield and Donaldson mines.
- Daily rainfall data from Bloomfield Mine (1989 – 2005) supplemented with long term daily rainfall data provided by the Bureau of Meteorology for East Maitland (1902 – 1989) and Morpeth (1884 – 2005). These latter stations were used to assess the long term probability of wet (1 in 10 probability = 10 percentile exceedance probability), median and dry (1 in 10 probability = 90 percentile exceedance probability) climatic sequences up to 5 years duration.
- Daily evaporation provided by the Bureau of Meteorology data for Williamtown (1974 – 1989).
- Estimates of groundwater inflows to pits and underground workings based on historic observations and computer modelling as follows:
  - Abel Aquaterra Simulations, 2006
  - Donaldson Hughes Trueman / Peter Dundon & Associates, 2003
  - Bloomfield Mackie Environmental Research, 1998.
- Water use records for dust suppression at Donaldson and Bloomfield mines.
- Water use estimates for the Abel Underground Mine operations.
- Water requirements for operation of the CHPP provided by Bloomfield, including estimates of water requirements for the upgraded CHPP (1,400 t/h) and the future ROM from underground sources which are expected to yield a lower proportion of coarse rejects and fine tailings than the existing open cut sources of ROM.

Table 5.1 summarises the catchment areas and characteristics used in the Four Mile Creek water balance model.

Table 5.1
Catchment Areas Represented in the Four Mile Creek Water Balance Model

Catchments	Designation[1]	Not Mined (ha)	Previously Mined (ha)	Recently Mined (ha)	Total (ha)
Possums Puddle to Hwy	A1	724	84		809
Possums Puddle to Hwy (urban)	A2				60
Elwells Creek	B1	114	65	0	179
Washery Stockpile area	B2	35	0	0	35
Possums Puddle	C	59	28	0	87
Lake Foster	D1	30	15	0	45
Tailings Dams	D2	0	0	65	65
Clean Water Diversion Past Possums Puddle	E	75	109	0	183
Creek Cut Void	F	40	28		68
S Cut Void	G	5	14	37	55
Lake Kennerson catchment	H	0	132	36	167
4 Mile Catchment north of John Renshaw Dr outside Bloomfield & Donaldson Leases	I	202	0	0	202
Donaldson not mined	J	79	0	0	79
Catchment to Big Kahuna Dam	K	12	0	0	12
Donaldson mined and remnant void	L	0	21	11	32
Abel Surface Workings	M	0	0	13	13
South of John Renshaw Drive	N	376	0	0	376
Total					**2,467**

Note 1: Designation refers to the catchment lettering shown on **Figure 2.1**

5.2 MODEL CALIBRATION AND VALIDATION

The rainfall:runoff model used to generate runoff from natural and mined catchments utilised data derived from a previous more detailed hydrologic modelling study, using the AWBM model, for catchments adjoining the Four Mile Creek catchment (see **Appendix C** for further details). Results from the AWBM model (expressed as depth of daily runoff (mm) for different land uses) were used to estimate the runoff from the individual contributing sub-catchment types:

- semi-natural bushland areas located to the south of John Renshaw Drive;
- recently rehabilitated overburden dump area;
- previously rehabilitated overburden dump areas;
- low permeability open cut pits, haul roads and work areas;
- highly impermeable areas such as sealed roads and urban residential areas.

For validation purposes, the water balance model shown schematically in **Figure 2.1** was adjusted to reflect mining conditions as they existed within the Four Mile Creek catchment in 2004-5. The model was then run using rainfall for those years and the model results were checked against:

- Total discharge from the catchment as measured at the flow monitoring station at the rear of the Four Mile Workshops (about 500 m upstream of the New England Highway).

- Manual records of controlled discharge from Lake Kennerson into the bypass channel around Possums Puddle which discharges into Four Mile Creek upstream of the flow measuring point.

There is considerable uncertainty about the accuracy of the recorded flows at the flow monitoring station at the rear of the Four Mile Workshops. The depth:flow rating of this gauge is subject to a number of uncertainties. The gauge comprises a small V notch weir set into a low embankment across the creek. The V notch weir itself is only capable of measuring base flows in the creek. Also, the upstream and downstream conditions at the gauge do not fully comply with the requirements for operation of a V notch weir. In addition, only moderate flows above base flow conditions are required to drown out the weir. For these conditions, the depth:flow relationship has been derived using Manning's equation using estimates of the flood slope and average hydraulic roughness.

There is, however, a high level of confidence in the recorded volumes of discharge from Lake Kennerson. Bloomfield Mine has made extensive effort in surveying Lake Kennerson storage and discharge volumes. A level gauge has been installed in the lake wall to obtain accurate measurements of storage levels before and after any discharge. Discharge rates through the pipe outlets or pumping system are calculated and the discharge volume verified using a temporary v-notch weir.

In view of the limitations of the available flow records for the period 2004-5, especially the total flow from the catchment, the recorded flow shown in **Table 5.2** are considered to be **indicative only**.

Table 5.2
Comparison of Recorded and Modelled Flows 2004-5

	Recorded (ML)	Modelled (ML)
Total flow from catchment	13,170	4,235
Controlled discharge from Lake Kennerson	899	933

It can be seen that there is considerable discrepancy between the recorded flow at the flow gauge and that derived by the model. The recorded total flow is considered highly improbable because it represents approximately 39% runoff from the catchment during years in lower than average rainfall (769 mm and 675 mm respectively compared to the average at Bloomfield [1989-2004] of 855 mm and the long term record at East Maitland [1902-1985] of 875 mm).

Based on detailed recording of rainfall and runoff undertaken by Sydney Water (Sydney Water, 1995) for a number of catchments in Sydney, 39% runoff would represent runoff from an urban residential catchment rather than predominantly rural and mined catchments in which flow from a significant proportion of the catchment is controlled by mine water management systems.

As the original rainfall:runoff model used for this analysis was subject to calibration against recorded runoff from similar semi-rural catchments in a similar climate, the discrepancy between the total observed flow and the modelled is attributed to uncertainties in the flow rating at the flow gauging station.

5.3 MODEL SCENARIOS

The water balance model was run for a total of nine scenarios representing mining and operating conditions as they are expected to exist at the key milestone years summarised in **Table 5.3**.

Table 5.3
Summary of Conditions for Modelled Scenarios

Year	Operating Conditions	Bloomfield Open Cut	Donaldson Open Cut	Tasman Underground	Abel Underground[1]	Other Open Cut & Underground [1]	Fine Tailings Deposition	Abel Average Daily Inflow (ML/day)
2005	Historic	Full	Full	None	None	None	U/G	0
2005	Proposed	Full	Full	None	None	None	U/G	0
2008	Proposed	Full	Full	Full	Starting	None	U/G	0.02
2014	Proposed	Completed	Completed	Reducing	Target	Target	U/G	0.75
2014	Proposed	Completed	Completed	Reducing	Target	Target	U/G	0.75
2014	Proposed	Completed	Completed	Reducing	Provisional	None	Void	0.75
2020	Proposed	Completed	Completed	Completed	Target	Target	U/G	1.9
2020	Proposed	Completed	Completed	Completed	Target	Target	Void	1.9
2020	Proposed	Completed	Completed	Completed	Provisional	None	U/G	1.9
2027	Proposed	Completed	Completed	Completed	Target	Target	U/G	3.15
2027	Proposed	Completed	Completed	Completed	Target	Target	Void	3.15
2027	Proposed	Completed	Completed	Completed	Provisional	None	U/G	3.15

Note 1: "Target" production schedule as set out in **Table 4.1** and "Provisional" production as set out in **Table 4.2**

The scenarios set out in **Table 5.3** include two based on 2005 mining conditions with differing water management regimes representing historic regimes and the proposed future operation of the dams and water transfer systems. The purpose of these two scenarios is to provide a basis for discriminating between the effects of the proposed alterations in the water management regime from the effects of the Abel mine itself (increased water requirements for the CHPP and progressive increase in groundwater inflow to the Abel workings).

The other ten scenarios represent significant milestones in the development of the Abel Underground Mine for the "Target Production" and "Provisional Production" scenarios, as set out in **Table 4.1** and **Table 4.2**, the progressive increase in groundwater inflow to the Abel Underground Mine and the deposition of fine tailings either in underground voids or in open cut voids. Note that the inflow quoted in the last column is the **average** daily rate for that year, derived from the groundwater modelling results provided by Aquaterra Simulations.

For each project milestone scenario listed in **Table 5.3**, a number of climatic sequences were run to assess the impact of climate on the performance of the water management systems. The climatic sequences are summarised in **Table 5.4**.

Table 5.4
Climatic Scenarios Used in Water Balance Modelling

Duration	Rainfall Statistic	Average Annual Rainfall (mm)
5 year dry period	10 percentile	705
5 year median period	50 percentile	842
5 year wet period	90 percentile	1,039
1 year – dry	10 percentile	673
1 year – wet	90 percentile	1,198

5.4 WATER BALANCE MODEL RESULTS

Output from the water balance model comprises tables of statistics that summarise the behaviour of the various elements of the system including runoff, water transfers, groundwater pumping, dam water levels and dam discharges.

The combination of the 12 mining scenarios summarised in **Table 5.3** with the climatic sequences set out in **Table 5.4**, led to a total of 60 sets of results being generated by the water balance model. A series of tables in **Appendix C** provide the key input and output data for each of these scenarios.

The detailed water balance results in **Appendix C** demonstrate that the indicative operating rules set out in **Section 4.4** would achieve the following outcomes:

a) There will be adequate water available to meet all requirements for dust suppression and operation of the CHPP. Assuming tailings deposition to underground workings continued, the water balance model indicates that groundwater extraction from the Bloomfield underground workings would not exceed historic levels and would progressively decline as water from this source is substituted by groundwater inflow transferred from the Abel Underground Mine. Under these circumstances the discharge from Lake Kennerson would be significantly less than historic levels in 2000 and 2001 (2,200 ML and 1,130 ML respectively). Even in 2027 when there would be maximum groundwater inflow to the Abel Underground Mine the estimated discharge from Lake Kennerson would range from an average of 490 ML/year in a dry period to 955 ML/year in a wet period.

b) Conversely, under conditions in which tailings were deposited in open cut voids the excess water discharged from Lake Kennerson would be at rates comparable to those in 2000 and 2001. Under these conditions approximately 80% of the water discharged with the fine tailings would be returned for use in the CHPP. Water derived from the Abel underground workings would also contribute to the available supply. The model results indicate that by 2027 (the modelled year with maximum groundwater contribution from Abel – 1,150 ML) the surface water discharge would range from an average of 885 ML/year in a dry sequence of years to 1,370 ML/year in a wet sequence of years.

c) Zero discharge to the environment from Big Kahuna Dam could be achieved for all mine and climate scenarios. In the early stages of the project a target operating level of 75% would be appropriate. Based on operating experience this would need to be reviewed in later years and may need to be reduced to 70% to account for increased inflow from the Abel Underground Mine.

d) Proposed minor modifications to the Stockpile Dam together with an automatic pump to transfer water to Lake Foster would allow the performance of this dam to significantly exceed the requirements set out in Managing Urban Stormwater: Soils and Construction. There would only be a small risk of overflow in extreme wet weather conditions. Any pollution risk would be further reduced by configuring the dam as a "first flush" capture dam.

e) For all scenarios, controlled discharge volume and frequency from Lake Kennerson would be reduced significantly compared to historic conditions in the early years of the project. At the same time, the proposed operating levels for Lake Foster would ensure that any discharge at the EPA licence discharge point would primarily occur as controlled discharge from Lake Kennerson rather that overflow from Lake Foster.

f) In the later stages of mining there would be an excess of water generated from the Abel Underground Mine that could not be utilised for mine purposes or the CHPP. Under the "Provisional Production" scenario this would occur from 2025 onwards and by the end of the mine life as much as 2,500 ML of excess water could accumulate. The excess water could be discharged to the environment via Lake Kennerson (as outlined under a) and b) above or could be retained within the Abel underground workings. The Abel mine plan indicates that up to 2015 a total of about 1,600 ML would be available for water storage in worked out areas of the mine. Additional water storage capacity would become available as mining progresses after 2015.

The robustness of the water management system has been assessed by testing the sensitivity of the system to a range of assumptions:

- The water balance model results for the "Target Production" and "Provisional Production" scenarios indicate that the water management system is capable of being managed in a way that would achieve the stated water management objectives for significantly different coal production rates from the Abel Underground Mine.
- The water balance model results also indicate that for "Target Production" scenario and with 80% of water from fine tailings returned from use in the CHPP, the water management system is capable of being managed in a way that would achieve the stated water management without exceeding historic levels of surface water discharge to the environment from Bloomfield.
- The robustness of the water management system was also tested by examining the effect of different assumed evaporation pan coefficients on the overall water balance. Because the total water surface area of the main water storages (Big Kahuna Dam, Lake Kennerson and Lake Foster) is less than 10 ha, varying the pan coefficient between 0.7 and 0.9 only resulted in a minor difference in the overall water balance (+/- 40 ML/year).
- As a further test of the robustness of the water management system, a "worst case" analysis was undertaken by combining the "Provisional Production" scenario (reduced production towards the end of the mine life) with the "upper limit" estimates for groundwater inflow to the Able mine. These conditions would lead to low requirement for water at the end of the mine life at the same time as significantly increased groundwater inflow (approximately 50% increase). Under these conditions the excess of groundwater inflow would occur in 2023 (two years earlier than the base case) and the cumulative volume of excess groundwater by the end of the mine life would be about 5,000 ML. Given that this excess of water would occur towards the end of mining, by which time over 50 million tonnes of coal would have been extracted from the Abel Underground

Mine, providing sufficient storage to retain this water in the older underground workings is not expected to be a problem.

The analysis of a range of different scenarios indicates the robustness of the proposed surface water management system and its ability to achieve the stated objectives under a wide range of operating assumptions.

6. OUTLINE WATER MANAGEMENT PLAN

The outline Water Management Plan below provides indicative details of the requirements, in terms of capacity of storages, target operating levels and water transfer rates, based on water balance modelling described in **Chapter 5** above.

The water balance model has been used to explore the behaviour of the overall system and the way that the system can be managed to achieve a set of performance objectives. The operating parameters described in **Section 4.4** of this report (repeated in **Section 6.3** below) represent **one** feasible set of parameters that would achieve the stated objectives. In the course of preparing a final Water Management Plan for approval by the relevant authorities, it is proposed to explore further operating options (variation in target water levels and pumping rates, etc) that could also achieve the stated objectives.

6.1 OBJECTIVES

The proposed objectives for the management of an integrated surface water management system for the Bloomfield, Donaldson and Abel mines are to:

- Maintain water supply for the CHPP and dust suppression at all times
- Achieve zero discharge to the environment from Big Kahuna
- Minimise discharge from the Stockpile Dam
- Minimise discharge from Lake Foster and Lake Kennerson
- Where controlled discharge is necessary, preference is given to Lake Kennerson.

6.2 PROPOSED MODIFICATIONS TO WATER MANAGEMENT FACILITIES

Based on the water balance modelling (described in **Chapter 5** and **Appendix C**), the existing water management facilities within the Bloomfield and Donaldson lease areas would require minimal engineering modification. The main changes proposed are:

- Make the Big Kahuna Dam the focal point for water management for Donaldson and Abel. Retain Big Kahuna as a “zero discharge” dam;
- Upgrade the existing pipeline between the Big Kahuna Dam and Bloomfield to provide pump and pipeline capacity capable of transferring up to 10 ML/day to Lake Foster;
- Undertake minor earthworks to ensure that all runoff from the enlarged stockpile area adjacent the Bloomfield CHPP is directed to Dam F or the Stockpile Dam;
- Undertake minor earthworks to configure Dam F and the Stockpile Dam as “first flush” capture dams;
- Provide an automatic float controlled pump in Dam F to transfer all water to the Stockpile dam an a rate of 1 ML/day;
- Provide an automatic float controlled pump in the Stockpile Dam F to transfer all water to Lake Foster at a minimum rate of 3.5 ML/day;
- Upgrade the bypass channel around Lake Foster to ensure that flows in excess of 40 ML/day can be released from Lake Kennerson without the risk of overflow into Lake Foster.

6.3 PROPOSED WATER MANAGEMENT OPERATIONS

The water balance analysis has been used to establish a set of indicative operating parameters for the existing facilities within the Bloomfield and Donaldson lease areas. Compared to existing operating conditions, the main proposed changes to existing operating conditions are:

- Holding back on pumping from the Bloomfield underground workings until Lake Kennerson is less than 50% full. In the past, pumping for groundwater level control purposes has maintained Lake Kennerson at over 80% full for extended periods.
- Transfer of water from the Stockpile Dam to Lake Foster. No transfer occurred in the past.
- Transfer water from Big Kahuna Dam to Lake Foster on a regular basis to maintain Big Kahuna at a target operating level of 75%. In the past, the existing pipeline was rarely used.

The recommended target operating levels of various storages are set out in **Table 6.1.**

Table 6.1
Indicative Target Operating Levels and Pumping / Discharge Rates

Storage/Source	Capacity (ML)	Target Operating Level (ML)	Controlled Discharge Rate (ML/day)	Pumping Rate (ML/day)	Pumping/ Discharge To
Big Kahuna	400	340	-	5	Lake Foster
Stockpile Dam	16	6	-	5	Lake Foster
Lake Kennerson	200	160	Up to 40	-	Four Mile Creek
Lake Foster	45	22	0	0	No discharge

In addition to the pumping and discharge rates listed above, other significant pumps that form part of the existing water management system include those set out in **Table 6.2.** Note that the pumping rates specified in **Table 6.2** represent no change from existing operations. The main proposed change relates to the storage levels above which no pumping would occur.

Table 6.2
Indicative Pumping Rates from Sources and Target Water Levels

Storage/Source	Transfer Rate (ML/day)	Discharge To	Constraint
Old Workings	9	Pumped to L Kennerson	L Kennerson level <50%
Old Workings	7	Pumped to L Kennerson	L Kennerson level <40%
S Cut	2	Pumped to L Kennerson	L Kennerson level <80%
Lake Kennerson	Up to 16	Gravity flow to L Foster	L Foster < 50%
Tailings Dams (U Cut)	2	Pumped to L Foster	L Foster <50%
Creek Cut	2	Pumped to L Foster	L Foster <50%
S Cut	2	Pumped to L Foster	L Foster <50%

6.4 PROPOSED SURFACE WATER MONITORING

At present there is some duplication of monitoring in Four Mile Creek undertaken by Bloomfield and Donaldson (New England Highway, on the southern side of the Bloomfield lease area and a corresponding location on the northern side of the Donaldson lease area). It is proposed to relocate the existing water quality monitoring point at the New England Highway to the flow gauging site behind the Four Mile Workshops (about 500 m upstream) to provide an improved basis for assessing the interaction between flow and water quality.

An integrated overall monitoring program for the Abel, Donaldson and Bloomfield mines is proposed covering all potentially affected catchments including Four Mile Creek, Blue Gum Creek and other creeks on the land overlying the Abel underground lease area:

- Four Mile Creek at John Renshaw Drive (same as existing Donaldson site);
- Weakleys Flat Ck at John Renshaw Drive (same as existing Donaldson site);
- Viney Creek at John Renshaw Drive;
- Buttai Creek at Lings Road;
- Blue Gum Creek at Stockrington Road;
- Long Gully (downstream).

The proposed locations for surface water monitoring in the Bloomfield/Donaldson areas are shown on **Figure 2.3.**

Monitoring of surface water in the creeks that overlie the Abel Underground Mine will commence just prior to mining and continue until one year after mining has passed the contributing catchment. The following monitoring regime is proposed:

- Routine monthly baseline sampling;
- Daily water samples collected from the discharge point on any occasion when there is controlled discharge from Lake Kennerson. Water samples will also be collected at the flow gauging station behind the Four Mile Workshops;
- Daily water samples will be collected from any overflow from the Stockpile Dam. Water samples will also be collected at the flow gauging station behind the Four Mile Workshops.

These samples will be analysed for:

- non-filterable residue (NFR)
- turbidity
- pH
- conductivity.

6.5 PROPOSED SURFACE WATER RESPONSE PLAN

The procedure to be followed in the event of unforeseen surface or groundwater impacts being detected during the project is as follows:

1. The nature of the suspected impact and all relevant monitoring data will be immediately referred to an independent qualified hydrologist or hydrogeologist as appropriate for assessment.

2. An assessment will be made of the potential magnitude of the impact and the level of risk.

3. Alternative response and mitigation measures will be detailed for discussion with DNR, DEC and/or DPI-Minerals as appropriate.

4. A response/mitigation plan will be implemented to the satisfaction of DNR, DEC and/or DPI-Minerals.

6.6 DRAFT EROSION AND SEDIMENT CONTROL PLAN

This draft outline Erosion and Sediment Control Plan (ESCP) provides an outline of the measures that will be implemented to ensure that no undue pollution of receiving waters occurs during earthworks construction for the surface infrastructure facilities and the operation of the Abel Mine Project, including the operation of the Bloomfield CHPP.

The ESCP will be prepared in accordance with guidelines contained in *"Managing Urban Stormwater: Soils and Construction" (4th Edition)* (Landcom, 2004).

There are minimal activities associated with the project that will require erosion and sediment control works other than existing facilities. The following general measures are proposed:

- All works for the Abel box cut and subsequent construction of surface facilities will be undertaken within the boundaries of the existing Donaldson Mine lease area. These activities will be undertaken in accordance with the approved procedures for erosion protection and sediment control for the Donaldson Mine.
- The majority of works in the vicinity of the stockpile area for the Bloomfield CHPP will be undertaken within an area that reports to the existing Stockpile Dam and Dam F. These facilities provide adequate erosion and sediment control for those areas. For minor bunding works to be undertaken on the southern boundary of the enlarged stockpile area, standard erosion control practices such as silt fences will be used.
- For any earthworks associated with increasing the capacity of the bypass channel around Lake Foster, standard erosion control practices such as silt fences will be used.
- If a conveyor is eventually constructed between the Abel box cut and the Bloomfield CHPP, a separate Erosion and Sediment Control Plan will be prepared that takes account of the details of the conveyor, particularly the crossing of Four Mile Creek.

7. SUMMARY AND CONCLUSIONS

This Surface Water Assessment and Outline Water Management Plan has been prepared to address surface water and groundwater management issues associated with the Abel Underground Mine Project's surface facilities located north of John Renshaw Drive. This report has been prepared as part of the Environmental Assessment required under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act)

The following items are addressed/included in the Surface Water Assessment:

- Entrance and surface facilities for the Abel Underground Mine, to be located in a section of the Donaldson open cut pit.
- Sealed haul road (subsequently to be replaced by a conveyor) for conveyance of coal from the Abel surface facilities to the existing Bloomfield CHPP.
- Upgrading of the Bloomfield CHPP to increase throughput and expansion of the associated stockpile facilities.
- Upgrading of the conveyor facilities within the stockpile areas surrounding the CHPP with connection to the existing conveyor from the Bloomfield processed coal stockpiles to the existing rail loading facilities.
- Stormwater pollution control facilities associated with the Abel surface workings, the transport corridor between Abel and the Bloomfield CHPP, and the Bloomfield CHPP and rail loader.
- Water supply and tailings disposal for the Bloomfield CHPP.

This report contains a water balance assessment to address the potential cumulative impacts from the combined operation of the three mines in the immediate vicinity of the Abel Project that lie within the catchment of Four Mile Creek (Abel, Donaldson and Bloomfield Mines). The analysis also takes account of the processing of coal from the Tasman mine at the Bloomfield CHPP and the option to accept excess water from, or supply water to, the Tasman Mine.

The water balance model results indicate that, with minor adjustments to target operation water levels in the various storages and pumping rates to transfer water, the existing water management facilities within the Bloomfield and Donaldson mine areas can be operated in a manner that would achieve the following objectives:

- maintain water supply for the CHPP and dust suppression at all times;
- achieve zero discharge to the environment from the Big Kahuna Dam;
- minimise discharge from the Stockpile Dam;
- minimise discharge from Lake Foster and Lake Kennerson (with preference given to controlled discharge from Lake Kennerson).

The model results also indicate that the changes to the operating rules for the storages could achieve a reduction in surface water discharge to Four Mile Creek compared to historical levels.

The model results have been used to develop an outline Water Management Plan, containing a feasible set of operating rules for the water management facilities, to achieve these objectives. In the process of finalising the Water Management Plan for the Abel Project, further optimisation of the surface water operating rules will be undertaken. In addition, as further operating experience is gained, it is recommended that regular reviews of the Water Management Plan be undertaken to refine the operating rules.

The outline Water Management Plan also contains recommendations for surface water monitoring, an outline Surface Water Response Plan and an outline Erosion and Sediment Control Plan to ensure any impacts on existing surface water quality is minimised.

8. REFERENCES

Aquaterra Simulations (2006), *Groundwater Modelling of Impacts of Abel Underground Mining Operation*, Appendix E in *Abel Coal Project Groundwater Assessment*, prepared by Peter J Dundon for Newcastle Coal Pty Ltd, June 2006

Hughes Trueman / Peter Dundon & Associates (2003), *Donaldson Water Balance Review*, prepared for Donaldson Coal Pty Ltd.

Landcom (2004), *Managing Urban Stormwater: Soils and Construction*

Lyall & Macoun Consulting Engineers (1998), *Catchment Management Study: Morpeth-Tenambit, Woodberry and Millers Forest Catchments*, prepared for the Maitland Landcare Group.

Mackie Environmental Research (1998), *Water Management Studies*, prepared for Bloomfield Colliery Pty Ltd.

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Sydney Water (1995), Stormwater Monitoring Project, 1994 Annual Report. Sydney Water Corporation Limited.

Appendix A Water Quality Data

SUMMARY OF EXISTING WATER QUALITY AT BLOOMFIELD MINE													
Location	**WM1 (not in 4 MileCk)**	**WM2**	**WM3**	**WM4**	**WM5**	**WM6**	**WM7**	**WM8**	**WM9**	**WM10**	**WM11**	**WM12**	**Total Mean**
Data period													
Start Date	17/6/96	12/6/96	12/6/96	12/6/96	12/6/96	12/6/96	12/6/96	12/6/96	12/6/96	12/6/96	12/6/96	12/6/96	
End Date	3/11/05	1/10/05	4/10/06	4/10/06	1/4/06	4/10/06	4/10/06	4/10/06	4/10/06	6/12/05	4/10/06	6/12/05	
Length of record (y)	9.4	9.3	10.3	10.3	9.8	10.3	10.3	10.3	10.3	9.5	10.3	9.5	**10**
No# of observations	181	148	230	242	195	229	230	433	233	214	438	331	**259**
Avg frequency of obs (days)	19	23	16	16	18	16	16	9	16	16	9	10	**15**
pH													
No# of Samples	96	71	227	242	171	225	224	430	226	421	421	140	**241**
Minimum Value	2.7	3.9	4.2	6.4	3.4	5.8	6.0	6.7	5.6	5.7	5.7	4.1	**5.0**
10% Percentile	2.8	4.5	6.7	6.9	5.1	6.4	6.6	7.5	7.9	6.7	6.7	6.8	**6.2**
90% Percentile	4.0	7.0	7.6	8.2	7.8	7.2	8.0	8.2	8.4	7.7	7.7	7.6	**7.4**
Maximum Value	4.8	7.6	8.1	8.7	8.4	8.5	9.3	8.8	9.0	8.7	8.7	8.1	**8.2**
Mean	3.4	5.9	7.1	7.5	6.7	6.8	7.2	7.9	8.1	7.2	7.2	7.2	**6.9**
Standard deviation	0.5	0.9	0.5	0.5	1.0	0.4	0.6	0.3	0.4	0.4	0.4	0.5	**0.5**
Specific Conductance (μSiemens/cm)													
No# of Samples	98	71	229	242	171	225	225	430	225	187	398	140	**220**
Minimum Value	265	211	230	150	9	121	9	12	300	50	12	310	**140**
10% Percentile	1,117	460	370	220	450	166	197	3,199	3,140	200	587	546	**888**
90% Percentile	6,774	2,300	2,784	3,414	3,970	326	1,228	6,010	6,312	650	4,686	2,829	**3,440**
Maximum Value	8,770	2,750	6,080	7,360	6,620	2,100	3,320	7,970	8,020	1,080	5,930	5,750	**5,479**
Mean	2,888	1,224	1,444	1,376	1,969	239	519	4,914	5,049	427	2,063	1,567	**1,973**
Standard deviation	2,255	682	1,125	1,565	1,407	216	570	1,196	1,372	197	1,515	1,000	**1,092**
Total Suspended Solids (mg/L)													
No# of Samples	12	12	122	130	74	47	13	123	19	22	220	54	**71**
Minimum Value	1.0	14.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	2.0	1.0	1.0	**2.2**
10% Percentile	1.0	15.0	2.0	1.0	4.0	1.6	2.0	1.0	1.0	8.0	2.9	1.6	**3.4**
90% Percentile	40	50	36	51	80	67	218	19	20	107	75	98.5	**71.7**
Maximum Value	90	50	140	310	470	370	250	4,220	50	180	5470	270	**989**
Mean	18.5	28.0	18.5	23.4	39.5	29.0	62.3	77.4	9.6	45.4	94.5	40.8	**40.6**

SUMMARY OF EXISTING WATER QUALITY AT BLOOMFIELD MINE													
Location	**WM1 (not in 4 MileCk)**	**WM2**	**WM3**	**WM4**	**WM5**	**WM6**	**WM7**	**WM8**	**WM9**	**WM10**	**WM11**	**WM12**	**Total Mean**
Standard deviation	26.6	14.1	26.2	43.6	78.9	57.0	88.1	531.1	13.3	45.6	576.9	52.2	**129.5**
Rainfall (mm)													
No# of Samples								162			157	161	**160**
Minimum Value								20			20	20	**20**
10% Percentile								0			0	0	**0**
90% Percentile								44			45	45	**45**
Maximum Value								110			110	110	**110**
Mean								18			18	18	**18**
Standard deviation								0			0	0	**0**
Discharge Volume (ML)													
No# of Samples								183					**183**
Minimum Value								0.6					**0.6**
10% Percentile								1.7					**1.7**
90% Percentile								40					**40**
Maximum Value								40					**40**
Mean								33					**33**
Standard deviation								13					**13**
Flow from Logger (kL/day)													
No# of Samples											29		**29**
Minimum Value											19,570		**19,570**
10% Percentile											35,181		**35,181**
90% Percentile											299,836		**299,836**
Maximum Value											428,400		**428,400**
Mean											135,696		**135,696**
Standard deviation											104,470		**104,470**

SUMMARY OF WATER QUALITY AT DONALDSON MINE										
	4 Mile Creek @ Hwy	**Scotch Dairy Creek @ Hwy**	**Weakleys Flat Creek @ Hwy**	**EM1**	**EM2**	**EM3**	**EM4**	**EM5**	**EM6**	**Total Mean**
Data period										
Start date	15/7/2003	15/7/2003	12/6/2003	21/6/2000	10/7/2000	21/6/2000	21/6/2000	21/6/2000	21/6/2000	
End date	26/10/2005	26/10/2005	26/10/2005	26/10/2005	26/10/2005	26/10/2005	26/10/2005	26/10/2005	26/10/2005	
Length of record (y)	2.3	2.3	2.4	5.4	5.3	5.4	5.4	5.4	5.4	**4.3**
No observations	28	27	29	80	98	124	105	133	114	**82.0**
Avg freq of obs (days)	29.8	30.9	29.9	24.4	19.7	15.8	18.6	14.7	17.1	**22.3**
pH (Lab)										
No# of Samples	28	27	29	75	92	118	99	129	109	**78**
Minimum value	6.4	5.5	6.2	5.7	5.8	4.2	4.0	0.0	5.5	**4.8**
10% Percentile	6.9	6.2	6.3	6.0	6.1	5.4	5.3	5.7	6.2	**6.0**
90% Percentile	7.2	7.2	7.0	7.0	7.3	6.3	6.3	7.0	7.2	**7.0**
Maximum value	7.4	7.7	7.1	7.2	7.8	7.0	6.8	7.8	7.7	**7.4**
Mean value	7.1	6.7	6.6	6.6	6.8	5.9	5.8	6.4	6.7	**6.5**
Std deviation	0.2	0.5	0.3	0.4	0.4	0.4	0.5	1.0	0.4	**0.4**
pH (in-situ)										
No# of Samples	27	27	29	76	84	98	90	110	88	**70**
Minimum value	5.7	5.9	6.2	4.8	5.2	4.7	4.7	4.8	4.0	**5.1**
10% Percentile	6.1	6.2	6.5	5.8	5.7	5.2	5.3	5.8	6.2	**5.9**
90% Percentile	7.3	8.0	8.3	7.6	7.7	6.7	6.9	7.2	7.5	**7.5**
Maximum value	7.9	8.5	8.6	7.9	8.0	7.4	7.8	7.9	8.3	**8.0**
Mean value	6.8	7.2	7.3	6.8	6.8	6.0	6.0	6.5	6.8	**6.7**
Standard deviation	0.5	0.7	0.7	0.7	0.7	0.6	0.6	0.6	0.6	**0.6**
Electronic Conductance (Lab) - uS/cm										
No# of Samples	28	27	29	77	94	121	102	128	112	**80**
Minimum value	300	175	260	80	85	0	0	6	0	**101**
10% Percentile	415	198	418	123	127	185	96	202	130	**210**
90% Percentile	1197	397	1552	622	264	955	528	1486	1118	**902**

SUMMARY OF WATER QUALITY AT DONALDSON MINE										
	4 Mile Creek @ Hwy	**Scotch Dairy Creek @ Hwy**	**Weakleys Flat Creek @ Hwy**	**EM1**	**EM2**	**EM3**	**EM4**	**EM5**	**EM6**	**Total Mean**
Maximum value	2100	600	2600	905	380	1240	1800	2930	3200	**1751**
Mean value	753	290	899	343	172	518	256	636	479	**483**
Standard deviation	455	95	539	194	59	314	231	559	618	**340**
Electronic Conductance (in-situ) - uS/cm										
No# of Samples	26	27	29	74	81	100	91	109	91	**70**
Minimum value	210	145	255	80	90	0	0	95	0	**97**
10% Percentile	385	210	319	128	120	130	90	200	145	**192**
90% Percentile	950	394	1556	608	215	951	300	1462	1230	**852**
Maximum value	2170	585	2660	895	400	7025	1930	2960	3480	**2456**
Mean value	653	298	918	344	163	577	222	616	518	**479**
Standard deviation	409	93	558	191	54	733	220	563	635	**384**
Total Suspended Solids (mg/L)										
No# of Samples	28	27	29	77	94	121	104	129	113	**80**
Minimum value	2	2	2	1	1	0	0	1	0	**1**
10% Percentile	2	4	8	6	1	19	13	3	2	**7**
90% Percentile	19	145	100	207	683	14120	4290	3360	2092	**2779**
Maximum value	49	200	408	388	6430	50300	30240	26110	9830	**13773**
Mean value	11	49	48	66	240	4081	1693	1225	634	**894**
Standard deviation	11	61	78	86	745	9371	4392	3387	1421	**2172**
Total Dissolved Solids (mg/L)										
No# of Samples	28	27	29	77	94	122	104	129	113	**80**
Maximum value	1370	316	1750	520	240	960	1130	1880	2020	**1132**
Mean value	496	188	578	226	110	340	167	413	302	**313**
Standard deviation	323	63	348	122	39	212	152	361	376	**222**
Minimum value	170	16	175	55	55	0	0	29	0	**56**
10% Percentile	276	131	251	83	80	121	62	129	85	**135**
90% Percentile	838	277	952	390	166	600	361	916	698	**577**
Alkalinity (total) (mg/L)										
No# of Samples	7	6	6	32	39	49	49	62	50	**33**

SUMMARY OF WATER QUALITY AT DONALDSON MINE										
	4 Mile Creek @ Hwy	**Scotch Dairy Creek @ Hwy**	**Weakleys Flat Creek @ Hwy**	**EM1**	**EM2**	**EM3**	**EM4**	**EM5**	**EM6**	**Total Mean**
Minimum value	53	21	7	0	0	0	0	0	0	**9**
10% Percentile	54	28	17	0	0	0	0	0	0	**11**
90% Percentile	171	105	65	72	50	31	27	72	72	**74**
Maximum value	260	134	80	90	70	174	68	160	129	**129**
Mean value	104	67	41	36	28	16	10	34	41	**42**
Standard deviation	72	40	25	30	20	26	14	32	32	**32**
Sulphates (mg/L)										
No# of Samples	28	27	29	77	94	122	104	129	113	**80**
Minimum value	15	6	2	1	1	-1	-1	1	-1	**3**
10% Percentile	34	10	16	1	2	2	1	5	1	**8**
90% Percentile	312	52	96	34	19	125	91	109	52	**99**
Maximum value	600	68	200	136	1250	157	1226	265	115	**446**
Mean value	150	26	54	13	22	60	49	48	19	**49**
Standard deviation	155	17	42	20	128	45	159	45	25	**71**
Chlorides (mg/L)										
No# of Samples	7	6	6	32	35	48	48	63	49	**33**
Minimum value	30	28	78	0	0	0	0	0	0	**15**
10% Percentile	46	28	96	1	6	0	0	4	0	**20**
90% Percentile	122	50	376	127	42	183	73	390	105	**163**
Maximum value	145	50	454	206	85	256	156	30500	639	**3610**
Mean value	79	39	222	56	26	89	41	607	62	**136**
Standard deviation	37	10	141	48	17	70	38	3830	107	**478**
Fluorides (mg/L)										
No# of Samples	6	6	6	32	35	48	48	62	49	**32**
Minimum value	0.7	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	**0.1**
10% Percentile	0.7	0.3	0.2	0.0	0.1	0.0	0.0	0.0	0.0	**0.1**
90% Percentile	1.0	24.7	0.6	0.6	1.0	0.6	0.7	0.8	0.9	**3.4**
Maximum value	1.1	49	0.7	1.3	1.1	120	1.1	348	35	**61.9**
Mean value	0.9	8.5	0.4	0.4	0.6	4.4	0.2	7.4	1.3	**2.7**

SUMMARY OF WATER QUALITY AT DONALDSON MINE										
	4 Mile Creek @ Hwy	**Scotch Dairy Creek @ Hwy**	**Weakleys Flat Creek @ Hwy**	**EM1**	**EM2**	**EM3**	**EM4**	**EM5**	**EM6**	**Total Mean**
Standard deviation	0.1	19.9	0.2	0.3	0.3	20.7	0.3	44.6	5.1	**10.2**
Nitrates (mg/L)										
No# of Samples	6	7	6	27	31	42	42	56	41	**29**
Minimum value	0.2	0.0	0.2	0.0	0.0	0.0	0.0	-0.1	0.0	**0.0**
10% Percentile	0.3	0.1	0.3	0.4	0.1	0.2	0.0	0.0	0.1	**0.2**
90% Percentile	0.5	3.1	0.8	1.6	0.8	1.2	2.0	1.2	1.2	**1.4**
Maximum value	0.6	6.0	0.8	3.2	7.0	50	105	47	5.1	**25.0**
Mean value	0.4	1.2	0.5	0.9	0.5	1.8	3.2	1.4	0.7	**1.2**
Standard deviation	0.1	2.2	0.2	0.6	1.2	7.6	16.1	6.2	0.9	**3.9**
Phosphates (mg/L)										
No# of Samples	6	7	6	27	31	42	42	55	41	**29**
Minimum value	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
10% Percentile	0.1	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.1	**0.1**
90% Percentile	0.4	14.6	0.3	0.5	0.4	1.1	0.7	0.9	2.4	**2.4**
Maximum value	0.5	28	0.4	2.1	4	16	20	2.6	4.9	**8.7**
Mean value	0.2	5.0	0.2	0.3	0.3	0.8	0.7	0.4	0.8	**1.0**
Standard deviation	0.2	10.4	0.1	0.4	0.7	2.5	3.1	0.5	1.2	**2.1**
Acidity as $CaCO_3$										
No# of Samples	28	27	29	40	55	75	52	69	69	**49**
Minimum value	5.0	2.0	4.0	4.0	2.0	0.1	5.0	0.5	0.1	**2.5**
10% Percentile	6.0	6.6	7.6	10.0	4.0	6.0	8.0	5.8	6.0	**6.7**
90% Percentile	16.5	26.4	20.0	47.1	12.0	41.6	38.0	24.4	28.0	**28.2**
Maximum value	23	52	30	83	18	192	620	226	55	**144**
Mean value	10.5	15.3	13.5	24.6	7.3	22.0	29.8	15.2	15.2	**17.1**
Standard deviation	4.9	10.0	6.2	17.2	3.9	31.4	84.2	26.9	10.2	**21.6**
Turbidity (NTU)										
No# of Samples	28	27	29	40	54	74	51	68	69	**49**
Minimum value	8	14	14	7	1	30	10	7	3	**10**
10% Percentile	17	23	20	56	7	127	92	21	15	**42**

SUMMARY OF WATER QUALITY AT DONALDSON MINE										
	4 Mile Creek @ Hwy	**Scotch Dairy Creek @ Hwy**	**Weakleys Flat Creek @ Hwy**	**EM1**	**EM2**	**EM3**	**EM4**	**EM5**	**EM6**	**Total Mean**
90% Percentile	80	234	480	327	591	19885	8250	1548	2524	**3769**
Maximum value	120	1015	1005	445	12300	45250	31250	21000	12950	**13926**
Mean value	36	137	190	168	402	5664	3176	889	789	**1272**
Standard deviation	28	195	244	107	1682	10574	6973	2859	1775	**2715**
Aluminium (mg/L)										
No# of Samples	6	6	6	32	37	48	48	63	50	**33**
Minimum value	0.05	0.15	0.12	0.00	0.00	0.00	0.00	0.00	0.00	**0.04**
10% Percentile	0.09	0.18	0.13	0.01	0.00	0.00	0.00	0.01	0.00	**0.05**
90% Percentile	0.5	2.0	5.6	8.0	8.9	25.0	77.8	26.0	23.0	**19.6**
Maximum value	0.5	2.1	8.4	14	37	170	370	1400	38	**227**
Mean value	0.3	1.0	2.4	2.7	3.1	10.8	31.8	32	5.8	**10.0**
Standard deviation	0.2	0.9	3.1	3.4	7.5	25.8	73.3	177.6	9.6	**33.5**
Iron (mg/L)										
No# of Samples	6	6	6	32	37	48	48	63	50	**33**
Minimum value	0.2	0.7	0.3	0.0	0.0	0.0	0.0	0.0	0.0	**0.1**
10% Percentile	0.3	0.7	0.5	0.1	0.0	0.0	0.0	0.0	0.0	**0.2**
90% Percentile	0.8	4.6	6.0	7.2	7.0	23.5	47.4	16.6	14.0	**14.1**
Maximum value	1.0	4.7	8.6	13	22	100	606	83	30	**96.5**
Mean value	0.5	3.0	2.7	3.7	2.4	10.5	28.4	6.7	5.0	**7.0**
Standard deviation	0.3	1.8	3.1	2.9	4.4	19.7	87.8	14.6	6.9	**15.7**
Manganese (mg/L)										
No# of Samples	6	6	6	33	38	50	49	65	51	**34**
Minimum value	0.03	0.02	0.04	0.00	0.00	0.00	0.00	0.00	0.00	**0.01**
10% Percentile	0.03	0.04	0.06	0.00	0.00	0.00	0.00	0.00	0.00	**0.01**
90% Percentile	0.75	0.62	0.33	0.57	0.13	0.73	0.75	0.60	0.41	**0.54**
Maximum value	1.20	0.69	0.34	0.98	0.83	4.40	1.70	1.20	1.70	**1.45**
Mean value	0.30	0.28	0.18	0.17	0.06	0.38	0.25	0.24	0.17	**0.23**
Standard deviation	0.45	0.28	0.13	0.24	0.14	0.66	0.35	0.28	0.30	**0.32**
Calcium (mg/L)										

SUMMARY OF WATER QUALITY AT DONALDSON MINE										
	4 Mile Creek @ Hwy	**Scotch Dairy Creek @ Hwy**	**Weakleys Flat Creek @ Hwy**	**EM1**	**EM2**	**EM3**	**EM4**	**EM5**	**EM6**	**Total Mean**
No# of Samples	6	6	6	32	37	48	48	62	49	**33**
Minimum value	15.0	5.5	1.0	0.0	0.0	0.0	0.0	0.0	0.0	**2.4**
10% Percentile	15.5	7.4	3.3	0.1	0.0	0.0	0.0	0.2	0.0	**2.9**
90% Percentile	53.5	33.0	15.5	10.9	19.4	11.3	7.3	20.9	25.0	**21.9**
Maximum value	71.0	42.0	16.0	14.0	22.0	16.0	32.0	65.0	36.0	**34.9**
Mean value	33.2	20.6	9.8	5.9	11.1	6.0	3.5	12.0	13.1	**12.8**
Standard deviation	20.4	13.0	5.8	4.0	7.4	4.2	5.4	9.9	9.5	**8.8**
Magnesium (mg/L)										
No# of Samples	6	6	6	32	37	48	48	62	49	**33**
Minimum value	9.9	5.0	10.0	0.0	0.0	0.0	0.0	0.0	0.0	**2.8**
10% Percentile	10.5	5.1	10.0	0.1	0.0	0.0	0.0	0.1	0.0	**2.9**
90% Percentile	46.0	7.0	29.0	12.0	3.4	14.0	7.6	33.9	13.2	**18.5**
Maximum value	66.0	7.2	31.0	21.0	6.3	19.0	15.0	59.0	52.0	**30.7**
Mean value	27.2	6.0	19.7	6.3	2.1	7.4	3.5	12.8	6.5	**10.2**
Standard deviation	20.4	0.9	9.4	4.9	1.4	4.9	3.6	13.1	8.4	**7.4**
Potassium (mg/L)										
No# of Samples	6	6	6	32	37	48	48	62	49	**33**
Minimum value	3.1	3.0	4.4	0.0	0.0	0.0	0.0	0.0	0.0	**1.2**
10% Percentile	3.2	3.0	4.6	0.2	0.0	0.0	0.0	0.1	0.0	**1.2**
90% Percentile	7.0	4.2	7.7	8.0	3.8	7.0	4.9	9.0	9.1	**6.7**
Maximum value	8.6	4.2	7.9	9.0	4.9	9.7	6.1	14.0	12.0	**8.5**
Mean value	4.9	3.6	6.1	4.8	1.7	4.2	2.4	4.9	3.7	**4.0**
Standard deviation	2.0	0.6	1.6	2.6	1.3	2.3	1.8	3.3	3.3	**2.1**
Sodium (mg/L)										
No# of Samples	6	6	6	32	37	48	48	62	49	**33**
Minimum value	41.0	19.0	58.0	0.0	0.0	0.0	0.0	0.0	0.0	**13.1**
10% Percentile	41.5	20.0	61.5	1.1	0.0	0.0	0.0	1.4	0.0	**13.9**
90% Percentile	150.0	29.0	200.0	63.5	19.8	120.0	57.1	215.0	75.2	**103.3**
Maximum value	190.0	34.0	260.0	120.0	45.0	200.0	97.0	420.0	320.0	**187.3**

SUMMARY OF WATER QUALITY AT DONALDSON MINE										
	4 Mile Creek @ Hwy	**Scotch Dairy Creek @ Hwy**	**Weakleys Flat Creek @ Hwy**	**EM1**	**EM2**	**EM3**	**EM4**	**EM5**	**EM6**	**Total Mean**
Mean value	91.8	24.0	121.3	35.3	11.2	62.8	26.9	74.6	35.4	**53.7**
Standard deviation	55.2	5.2	76.1	26.9	9.4	48.5	25.5	85.6	53.5	**42.9**
Zinc (mg/L)										
No# of Samples	6	6	6	33	38	50	49	64	50	**34**
Minimum value	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
10% Percentile	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
90% Percentile	0.02	0.19	0.10	0.36	0.30	1.22	1.34	0.99	0.54	**0.6**
Maximum value	0.02	0.27	0.12	0.93	0.92	64.00	5.50	2.50	1.40	**8.4**
Mean value	0.01	0.09	0.05	0.11	0.08	1.70	0.44	0.34	0.19	**0.3**
Standard deviation	0.01	0.09	0.04	0.22	0.18	9.01	0.97	0.49	0.30	**1.3**
Arsenic (mg/L)										
No# of Samples	6	6	6	32	37	48	48	62	50	**33**
Minimum value	0.0010	0.0010	0.0010	-0.0010	-0.0010	0.0000	-0.0010	-0.0010	-0.0010	**-0.0002**
10% Percentile	0.0010	0.0010	0.0010	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	**0.0003**
90% Percentile	0.0015	0.0055	0.0030	0.0030	0.0024	0.0073	0.0166	0.0059	0.0040	**0.0055**
Maximum value	0.0020	0.0060	0.0030	0.0040	0.0040	0.0130	0.0330	0.0150	0.0150	**0.0106**
Mean value	0.0012	0.0028	0.0020	0.0016	0.0011	0.0035	0.0055	0.0028	0.0022	**0.0025**
Standard deviation	0.0004	0.0022	0.0009	0.0011	0.0011	0.0034	0.0080	0.0029	0.0024	**0.0025**
Barium (mg/L)										
No# of Samples	6	6	6	32	37	48	48	62	49	**33**
Minimum value	0.009	0.025	0.033	0.000	0.000	0.000	0.000	0.000	0.000	**0.007**
10% Percentile	0.011	0.032	0.034	0.003	0.000	0.000	0.000	0.002	0.000	**0.009**
90% Percentile	0.034	0.096	0.083	0.067	0.100	0.400	0.534	0.206	0.240	**0.196**
Maximum value	0.042	0.096	0.091	0.450	0.450	3.100	2.000	0.490	0.420	**0.793**
Mean value	0.021	0.066	0.059	0.065	0.043	0.198	0.220	0.085	0.086	**0.094**
Standard deviation	0.012	0.031	0.023	0.097	0.080	0.470	0.403	0.104	0.106	**0.147**
Cadmium (mg/L)										
No# of Samples	6	6	6	32	36	48	48	63	50	**33**
Minimum value	0.00005	0.00005	0.00005	-0.00005	-0.00005	-0.00005	-0.00005	-0.00005	-0.00005	**-0.00002**

SUMMARY OF WATER QUALITY AT DONALDSON MINE										
	4 Mile Creek @ Hwy	**Scotch Dairy Creek @ Hwy**	**Weakleys Flat Creek @ Hwy**	**EM1**	**EM2**	**EM3**	**EM4**	**EM5**	**EM6**	**Total Mean**
10% Percentile	0.00005	0.00005	0.00005	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	**0.00002**
90% Percentile	0.00005	0.00036	0.00017	0.00017	0.00017	0.00085	0.00094	0.00162	0.00050	**0.00054**
Maximum value	0.00005	0.00044	0.00018	0.00033	0.00050	0.00400	0.00340	0.01100	0.00340	**0.00259**
Mean value	0.00005	0.00018	0.00010	0.00008	0.00008	0.00040	0.00039	0.00074	0.00022	**0.00025**
Standard deviation	0.00000	0.00016	0.00006	0.00008	0.00011	0.00085	0.00070	0.00177	0.00050	**0.00047**
Cobalt (mg/l)										
No# of Samples	6	6	6	33	38	50	49	65	51	**34**
Minimum value	0.0007	0.0005	0.0020	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	**0.0004**
10% Percentile	0.0009	0.0007	0.0035	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	**0.0006**
90% Percentile	0.0034	0.0044	0.0115	0.0046	0.0041	0.0337	0.0458	0.0626	0.0090	**0.0199**
Maximum value	0.0050	0.0050	0.0130	0.0240	0.0100	0.3300	0.1400	0.5600	0.0350	**0.1247**
Mean value	0.0019	0.0023	0.0076	0.0026	0.0014	0.0182	0.0144	0.0279	0.0034	**0.0089**
Standard deviation	0.0016	0.0018	0.0039	0.0042	0.0024	0.0482	0.0272	0.0741	0.0066	**0.0189**
Chromium (mg/L)										
No# of Samples	6	6	6	33	38	50	49	64	50	**34**
Minimum value	0.0010	0.0010	0.0010	-0.0050	-0.0020	-0.0050	-0.0050	-0.0050	-0.0050	**-0.0027**
10% Percentile	0.0010	0.0010	0.0010	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	**0.0003**
90% Percentile	0.0020	0.0040	0.0040	0.0078	0.0093	0.0230	0.0820	0.0114	0.0161	**0.0177**
Maximum value	0.0020	0.0040	0.0060	0.0140	0.0350	0.1900	0.3300	0.1200	0.0340	**0.0817**
Mean value	0.0013	0.0023	0.0022	0.0029	0.0036	0.0106	0.0297	0.0083	0.0055	**0.0074**
Standard deviation	0.0005	0.0014	0.0019	0.0037	0.0071	0.0280	0.0644	0.0214	0.0085	**0.0152**
Copper (mg/L)										
No# of Samples	6	6	6	32	36	48	48	63	50	**33**
Minimum value	0.001	0.004	0.002	0.000	-0.001	0.000	0.000	-0.001	-0.001	**0.001**
10% Percentile	0.002	0.005	0.002	0.000	0.000	0.000	0.000	0.000	0.000	**0.001**
90% Percentile	0.002	0.024	0.005	0.096	0.059	0.246	0.265	0.115	0.160	**0.108**
Maximum value	0.002	0.025	0.007	0.320	0.170	0.830	0.630	0.370	0.310	**0.296**
Mean value	0.002	0.013	0.003	0.030	0.017	0.093	0.080	0.044	0.041	**0.036**
Standard deviation	0.000	0.009	0.002	0.066	0.037	0.145	0.138	0.067	0.068	**0.059**

SUMMARY OF WATER QUALITY AT DONALDSON MINE										
	4 Mile Creek @ Hwy	**Scotch Dairy Creek @ Hwy**	**Weakleys Flat Creek @ Hwy**	**EM1**	**EM2**	**EM3**	**EM4**	**EM5**	**EM6**	**Total Mean**
Lead (mg/L)										
No# of Samples	6	6	6	33	37	50	49	64	50	**33**
Minimum value	0.0002	0.0015	0.0003	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	**0.0002**
10% Percentile	0.0003	0.0015	0.0008	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	**0.0003**
90% Percentile	0.0036	0.0455	0.0093	0.0488	0.0296	0.1310	0.1500	0.0945	0.1250	**0.0708**
Maximum value	0.0060	0.0520	0.0150	0.0760	0.1400	0.4700	0.3700	0.2300	0.4200	**0.1977**
Mean value	0.0015	0.0199	0.0040	0.0139	0.0102	0.0462	0.0511	0.0307	0.0454	**0.0248**
Standard deviation	0.0022	0.0214	0.0055	0.0204	0.0266	0.0806	0.0927	0.0529	0.0861	**0.0432**
Selenium (mg/L)										
No# of Samples	6	6	6	10	13	24	17	27	26	**15**
Minimum value	0.0010	0.0010	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0000	**0.0004**
10% Percentile	0.0010	0.0010	0.0010	0.0009	0.0010	0.0010	0.0010	0.0010	0.0010	**0.0010**
90% Percentile	0.0020	0.0020	0.0040	0.0020	0.0020	0.0047	0.0070	0.0040	0.0030	**0.0034**
Maximum value	0.0020	0.0020	0.0040	0.0020	0.0020	0.0070	0.0110	0.0050	0.0060	**0.0046**
Mean value	0.0017	0.0017	0.0023	0.0014	0.0014	0.0024	0.0030	0.0020	0.0017	**0.0020**
Standard deviation	0.0005	0.0005	0.0014	0.0007	0.0006	0.0017	0.0031	0.0012	0.0012	**0.0012**
Total Kjeldahl Nitrogen										
No# of Samples				3	3	3	12	9	3	**6**
Nitrogen - Ammonia										
No# of Samples				3	3	3	12	9	3	**6**
Nitrogen - oxidised										
No# of Samples				3	3	3	12	9	3	**6**
Total Phosphorus										
No# of Samples				3	3	3	12	9	3	**6**
Total Petroleum Hydrocarbons (mg/L)										
No# of Samples				11	13	13	20	19	13	**15**
TPH C6 - C9										
No# of Samples				3	3	3	12	9	3	**6**
TPH C10 - C14										

SUMMARY OF WATER QUALITY AT DONALDSON MINE										
	4 Mile Creek @ Hwy	**Scotch Dairy Creek @ Hwy**	**Weakleys Flat Creek @ Hwy**	**EM1**	**EM2**	**EM3**	**EM4**	**EM5**	**EM6**	**Total Mean**
No# of Samples				3	3	3	12	9	3	**6**
TPH C15 - C28										
No# of Samples				3	3	3	12	9	3	**6**
TPH C29 - C36										
No# of Samples				3	3	3	12	9	3	**6**
Surfactants (MBAS) (mg/L)										
No# of Samples				11	13	13	20	19	13	**15**

Appendix B Stormwater Pollution Control for CHPP & Stockpiles

The environmental approvals for the expansion of the washery will require the stormwater pollution control systems to comply with current requirements. The current requirements are based on a risk management approach that defines the design criteria for pollution control dams in terms of the probability of overflow occurring depending on the nature of the pollutants involved, the sensitivity of the downstream environment and the duration of the project. As set out in Chapter 6 of *Managing Urban Stormwater: Soils and Construction* (Landcom, 2004), the "baseline" criteria for urban land development require sufficient capacity in the dam to capture all runoff from a 75th percentile rainfall event lasting 5 days (2, 10 or 20 days can also be considered depending on the operating conditions). The operating requirements stipulate that the runoff capture capacity of the dam must be restored within a further period equal to the duration of the design storm. This can be achieved by either by utilising the water within the site, transferring the water to a holding dam or by treating the water to a standard suitable for discharge (usually < 50 mg/L TSS).

In the case of coal stockpile areas there is no adopted rainfall probability for design purposes, but 90th percentile is usually adopted to reflect the fact that the facility will be operating for many years. The selection of the duration of the design storm duration is then a matter of choice depending on how fast the collected runoff can be utilised or transferred out of the pollution control dam.

Table B-1 sets out the required dam capacity for storms of 2, 5, 10 and 20 days duration at Bloomfield based on rainfall data presented *Managing Urban Stormwater: Soils and Construction.* The table also sets out the required pumping rate to empty the dam after a storm.

Table B-1
Required Pollution Control Dam Capacity
for Different Duration Design Storms (90th Percentile)

Storm Duration (days)	Rainfall (mm)	Runoff Coeff	Runoff (m^3/ha)	Required Dam Cap (ML)	Required Pumping Rate (ML/day)	Required Pumping Rate (L/s)
2	31.8	0.64	204	7	3.5	40
5	51.8	0.74	383	13	2.6	30
10	83.3	0.79	658	23	2.3	27
20	139.5	0.79	1102	39	1.95	22

Table B-1 shows that the required dam capacity to retain runoff from the 90th percentile storm ranges from 7 ML for a 2 day storm to 39 ML for a 20 day storm.

The existing Stockpile Dam has a capacity of 17 ML which exceeds the required capacity for a 2 day storm. Accordingly, the proposed operating regime that would comply with the requirements of *Managing Urban Stormwater: Soils and Construction* would be to ensure that within 2 days of the end of a storm the water level was drawn down to 10 ML (ie to provide 7 ML storage capacity).

Appendix C Water Balance Modelling

C-1 BACKGROUND

A detailed surface water management model has been developed to assess the overall performance of the water management systems associated with the Bloomfield, Donaldson and Abel mines. The model has been developed to represent the runoff, flow, water storage and pumped transfer systems within the Four Mile Creek catchment as shown in **Figure C-1**.

The Tasman mine does not have a common boundary with Abel, Bloomfield or Donaldson. The interactions between Tasman and the operations depicted in **Figure C-1** will comprise the haulage of ROM to the Bloomfield CHPP and, if necessary (although highly unlikely), the transfer of water between sites by truck to cater for shortfall or excess of water at Tasman.

The model for assessment of water balance for the Abel Mine project includes:

- surface runoff from the contributing catchments into the various storages;
- groundwater inflow to open cut pits and underground workings;
- rainfall onto, and evaporation from, the surface of the various storages;
- extraction and recycling of water for use in the Bloomfield CHPP;
- extraction of water for dust suppression purposes (on haul roads and stockpiles);
- pumped discharge between storages and channels;
- disposal of tailings;
- controlled discharge from Lake Kennerson in the event that the maximum target water level is exceeded and conditions permit discharge in accordance with the requirements of the EPA licence.

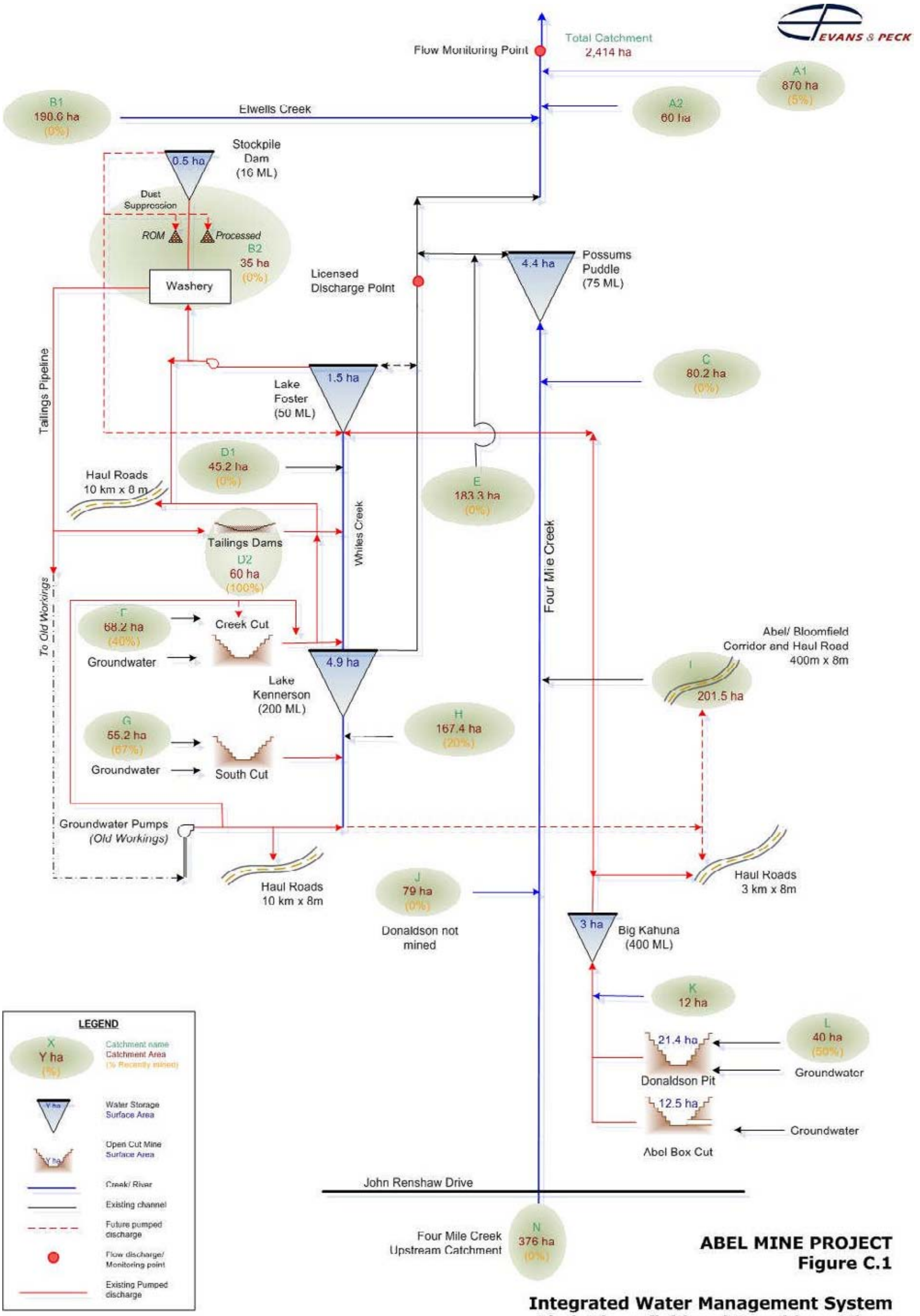
The model uses daily historic climate data (rainfall and evaporation), keeps account of all daily inputs and outputs and provides annual summaries of the volume and frequency of pumped discharges and overflows. Further details of the main elements of the model are set out below.

The model is operated for a range of climatic scenarios at key stages in the life of the project, representing different stages of mine production and the associated groundwater inflow to the workings and requirements for water in the CHPP.

C-2 SURFACE RUNOFF

Lyall & Macoun Consulting Engineers (1998) prepared a catchment management study of the Morpeth-Tenambit, Woodberry and Millers Forest catchments on behalf of the Maitland Landcare Group. The catchments studied by Lyall & Macoun in 1998 adjoin the Four Mile Creek catchment and contain a similar range of land uses. The study utilised a well recognised Australian daily rainfall:runoff model (AWBM) that was calibrated against catchment runoff data for small local catchments (<100 km^2).

AWBM is a catchment water balance program, developed for Australian conditions, that uses rainfall and evaporation data to generate catchment daily runoff. The program represents a catchment as three surface moisture stores with different storage and runoff characteristics. Each of the three surface stores is assigned with a surface storage capacity value as well as partial area which are adjusted as part of the calibration process. Runoff from each store calculated independently of the other two stores.



ABEL MINE PROJECT
Figure C.1

Integrated Water Management System
Abel, Bloomfield and Donaldson Mines

At each time step (daily in this case), rainfall is added to each of the three surface moisture stores and evapotranspiration is subtracted from the stores. Runoff then occurs when there is excess moisture in any of the stores. The resulting surface runoff in the AWBM model is then stored as current moisture in the surface runoff store and its rate of depletion to the outlet is defined by the surface runoff recession constant.

The program also models baseflow as a function of baseflow storage and a baseflow recession constant. Baseflow storage recharge is a function of runoff and a baseflow recharge index. The base flow recharge index and baseflow recession constant are both determined from calibration of the model.

For the Lyall & Macoun (1998) study, calibration involved the comparison between recorded historical streamflow and the modelled daily runoff for a small local catchment. The selection of the appropriate catchments for calibration was based on the proximity of the catchment to the Maitland area and the quality of the streamflow data. Daily streamflow records for four stations (supplied by the then Department of Land and Water Conservation) were examined. The longest and most complete dataset (Station 210068 – Pokolbin Creek) was selected for model calibration purposes. For model calibration purposes the closest available daily rainfall data were obtained from Cessnock Post Office while evaporation data came from the RAAF, Williamtown. The periods selected for calibration were ones that had continuous good quality streamflow and climate data. The main limitation on the calibration period was the quality of the streamflow data. This restricted the calibration period to 1974-1980 and 1983-1986, a total of 11 years.

Calibrations with and without baseflow were attempted and it was found that modelling with baseflow gave a much better account of the historical low runoff events, and therefore, baseflow was included in the model. Preliminary estimates of the model's parameters were calculated using the BASE5 and NEWFLOW calibration programs. The goodness of fit between model and historical data was assessed in terms of runoff hydrograph, flow duration, double mass curves and total volume of runoff. The parameters in the model were then refined using trial and error until the flow duration curves for the two sets of data and the total volume of runoff agreed.

For modelling of the Morpeth-Tenambit, Woodberry and Millers Forest catchments, the AWBM model was run using rainfall data from East Maitland and evaporation data from Williamtown. The study period (1974-1989) was restricted by the availability of concurrent and consistent the rainfall and evaporation data. Using the model parameters derived for Pokolbin Creek as a starting point, model parameters (principally percentage impervious area) were adjusted to reflect a range of land use types, including those listed in **Table C-1**.

Table C-1
Land Use and Runoff Data from the AWBM Model

Land Use Type	Impervious (%)	Average Runoff (% of rainfall)
1	0	12
2	5	15
3	10	21
4	35	29
5	90	58

Table C-1 also indicates the average annual runoff expressed as a percentage of average annual rainfall. The model results for urban and industrial land uses with a high proportion of impervious surfaces were validated against runoff data collected by Sydney Water for a variety of urban catchments in the Sydney area.

C-3 WATER BALANCE MODEL

C-3.1 Climate Data

For the Four Mile Creek water balance model depicted in **Figure C-1**, the daily rainfall and climatic data utilised in the Lyall & Macoun (1998) study were adopted, namely:

- daily rainfall data for East Maitland (1902 – 1995)
- daily evaporation data for Williamtown (1974 – 1989).

A summary of the statistics for the rainfall data is contained in **Section 2.2** of the main report.

C-3.2 Catchment Runoff

Results from the AWBM model (expressed as depth of runoff (mm) for different land uses) were used to estimate the runoff from the contributing sub-catchment areas within the Four Mile Creek catchment. The contributing sub-catchments contain a wide range of land use components for which that appropriate runoff characteristics were selected in the water balance model:

- semi-natural bushland areas located to the south of John Renshaw Drive;
- recently rehabilitated overburden dump area;
- previously rehabilitated overburden dump areas;
- low permeability open cut pits, haul roads and work areas;
- highly impermeable areas such as sealed roads and urban residential areas.

Table C-2 summarises the catchment areas and characteristics used in the Four Mile creek water balance model.

Table C-2
Catchment Areas Represented in the Four Mile Creek Water Balance Model

Catchments	Designation[1]	Not Mined (ha)	Previously Mined (ha)	Recently Mined (ha)	Total (ha)
Possums Puddle To Highway	A1	724	84		809
Possums Puddle To Highway (urban)	A2				60
Elwells Creek	B1	114	65	0	179
Washery Stockpile area	B2	35	0	0	35
Possums Puddle	C	59	28	0	87
Lake Foster	D1	30	15	0	45
Tailings Dams	D2	0	0	65	65
Clean Water Diversion Past Possums Puddle	E	75	109	0	183
Creek Cut Void	F	40	28		68
S Cut Void	G	5	14	37	55
Lake Kennerson catchment	H	0	132	36	167

Table C-2
Catchment Areas Represented in the Four Mile Creek Water Balance Model

Catchments	Designation[1]	Not Mined (ha)	Previously Mined (ha)	Recently Mined (ha)	Total (ha)
Four Mile Catchment north of John Renshaw Drive outside Bloomfield & Donaldson Leases	I	202	0	0	202
Donaldson not mined	J	79	0	0	79
Catchment to Big Kahuna Dam	K	12	0	0	12
Donaldson mined and remnant void	L	0	21	11	32
Abel Surface Workings	M	0	0	13	13
South of John Renshaw Drive	N	376	0	0	376
Total					**2,467**

Note 1: Designation refers to the catchment lettering shown on Figure C-1

C-3.3 Water Storages

The model includes four key water storages that form part of the Bloomfield, Donaldson and Abel water management systems. For modelling purposes, a number of small storages that fed to the key storages have been ignored. The characteristics of these storages have been derived from data provided by each mine and are summarised in **Table C-3**.

Table C-3
Water Storages Represented in the Four Mile Creek Water Balance Model

Water Dam/Storages	Surface Area (ha)	Depth (m)	Capacity (ML)
Possums Puddle	4.4	5.0	75
Lake Foster	1.5	10.0	45
Lake Kennerson	4.9		200
Stockpile Dam	0.5	3.5	16
Big Kahuna	3.0		400

As noted above, the Four Mile Creek water balance model also allows for:

- rainfall onto the surface of the storages,
- evaporation from the surface of the storages,
- seepage from the storages.

C-3.4 Water Use

Water requirements for mine operations principally comprise water use for dust suppression on haul roads, work areas and stockpiles and the water required for coal processing.

Estimates of water use for dust suppression on haul roads and work areas have been derived from records kept by the individual mines. For modelling purposes this requirement was factored proportionally to allow for changes in the area of active haul road at the particular state of mine development represented in the model (2005, 2008, 2014, 2020 and 2027 – see **Section C-4** below). In the model, the assessed water demand for dust suppression is only taken into account on days on which there is less than 10 mm of rainfall.

Tables C-4 and **C-5** below summarise the annual ROM coal production, coarse and fine tailings production and water requirements for the CHPP for two different production scenarios:

- Target production from the Abel Underground Mine and other mines feeding the Bloomfield CHPP increasing from 1 million tonnes per year ROM coal in 2008 to 4.4 million tonnes per year in 2013 from Abel after which production would remain constant for the remainder of the life of the mine (**Table C-4**);
- Provisional production based on the draft mine plan which would involve gradually increasing production to a maximum of about 4.2 million tonnes of ROM coal in 2015 – 2017 followed by a gradual decline in production for the remainder of the life of the mine (**Table C-5**).

Table C-4
Projected Annual Coal Production, Tailings Disposal and Water Requirements for the "Target Production" Scenario

Year	ROM Coal Production (t x 1,000)										
	Bloomfield O/C	Donaldson O/C	Other O/C	Tasman U/G	Abel U/G	Other U/G	Total	Coarse Rejects (t x 1,000)	Fine Tailings (t x 1,000)	C + F Tailings Cum'ive (m^3 x 1,000)	Annual Water Req'd (ML)
2005	800	2,250					3,050	641	427		2,170
2006	800	2,250		150			3,200	659	439	1,000	2,230
2007	800	2,250		800			3,850	737	491	2,000	2,500
2008	800	2,250		975	1,000		5,025	878	585	3,300	2,990
2009	800	2,250		975	1,400		5,425	926	617	4,700	3,160
2010	800	1,200		975	2,200		5,175	801	534	5,800	2,750
2011			800	975	2,900	200	4,875	657	438	6,800	2,270
2012			800	975	3,500	200	5,475	729	486	7,800	2,520
2013			800	975	4,400	200	6,375	837	558	9,100	2,900
2014			800	900	4,400	200	6,300	828	552	10,300	2,860
2015			800	760	4,400	200	6,160	811	541	11,400	2,810
2016			800	600	4,400	200	6,000	792	528	12,600	2,740
2017			800	450	4,400	200	5,850	774	516	13,700	2,680
2018			800		4,400	200	5,400	720	480	14,800	2,490
2019			800		4,400	200	5,400	720	480	15,800	2,490
2020			800		4,400	200	5,400	720	480	16,900	2,490
2021			800		4,400	200	5,400	720	480	17,900	2,490
2022			800		4,400	200	5,400	720	480	19,000	2,490
2023			800		4,400	200	5,400	720	480	20,000	2,490
2024			800		4,400	200	5,400	720	480	21,100	2,490
2025			800		4,400	200	5,400	720	480	22,100	2,490
2026			800		4,400	200	5,400	720	480	23,100	2,490
2027			800		4,400	200	5,400	720	480	24,200	2,490

Note: Years highlighted are those adopted for detailed water balance analysis (see Section C-4).

Table C-5
Projected Annual Coal Production, Tailings Disposal and Water Requirements for the "Provisional Production" Scenario

Year	ROM Coal Production (t x 1,000)								
	Bloomfield O/C	Donaldson O/C	Tasman U/G	Abel U/G	Total	Coarse Rejects (t x 1,000)	Fine Tailings (t x 1,000)	C + F Tailings Cum'ive (m^3 x 1,000)	Annual Water Req'd (ML)
2005	800	2,200			3,000	641	427		2,180
2006	800	2,250	150		3,200	659	439	1,000	2,240
2007	800	2,250	800		3,850	737	491	2,000	2,510
2008	800	2,250	975	224	4,249	784	523	3,200	2,680
2009	800	2,250	975	500	4,525	818	545	4,400	2,790
2010	800	1,200	975	1,091	4,066	668	445	5,300	2,290
2011			975	1,829	2,804	336	224	6,100	1,170
2012			975	2,567	3,542	425	283	6,700	1,480
2013			975	2,995	3,970	476	318	7,400	1,660
2014			900	3,769	4,669	560	374	8,200	1,950
2015			760	4,119	4,879	586	390	9,000	2,040
2016			600	4,119	4,719	566	378	9,900	1,970
2017			450	4,119	4,569	548	366	10,700	1,910
2018				3,919	3,919	470	314	11,400	1,640
2019				3,919	3,919	470	314	12,000	1,640
2020				3,919	3,919	470	314	12,700	1,640
2021				3,919	3,919	470	314	13,400	1,640
2022				3,285	3,285	394	263	14,000	1,370
2023				2,900	2,900	348	232	14,500	1,210
2024				2,514	2,514	302	201	14,900	1,050
2025				1,632	1,632	196	131	15,200	680
2026				750	750	90	60	15,300	310
2027				500	500	60	40	15,400	210

The estimated water requirements for the CHPP are based on the following assumptions (derived from operating experience and records at the CHPP):

- Open cut ROM — 21% coarse rejects, 14% fine tailings
- Underground coal — 12% coarse rejects, 8% fine tailings
- Water required for fine tailings disposal — 4.85 m^3/t
- Water increase from ROM to product — 2%
- Water increase from ROM to coarse reject — 12%

C-3.5 Groundwater Inflows

Groundwater inflows to open cut pits and underground workings have been derived from a variety of sources including mine records and computer modelling as set out below.

C-3.5.1 Abel Underground Mine

The average inflows quoted in **Table C-6** below are the **average** daily rates for each year, derived from the groundwater modelling results provided by Aquaterra Simulations.

Table C-6
Estimated Groundwater Inflow into Abel Underground Workings

Calendar Year	Average Inflow (ML/day)	Annual Inflow (ML/year)
2008	0.02	3.6
2009	0.02	7.2
2010	0.10	21.3
2011	0.17	49.4
2012	0.35	95.3
2013	0.52	158.1
2014	0.75	230.8
2015	0.97	313.1
2016	1.19	393.5
2017	1.40	472.1
2018	1.56	540.7
2019	1.72	600.0
2020	1.90	661.3
2021	2.07	724.0
2022	2.19	777.9
2023	2.32	824.1
2024	2.56	890.5
2025	2.79	976.7
2026	2.97	1,052.7
2027	3.15	1,118.2

(Source - Aquaterra Simulations, June 2006)

C-3.5.2 Donaldson Open Cut Mine

Table C-7
Estimated Groundwater Inflow into Donaldson Open Cut

Date	Inflow (ML/day)
Feb-03	0.16
Feb-05	0.23
Feb-07	0.27
Feb-08 (interpolated)	0.275
Feb-09	0.28
Feb-11	0.3

(Source: Donaldson Water Balance Review:
Hughes Trueman + Peter Dundon & Associates, 2003)

C-3.5.3 Bloomfield Open Cut Mine

Mackie Environmental Research (1998) estimated inflow to each of the Bloomfield pits at 0.1 ML/day.

C-3.5.4 Groundwater Pumping

In addition to inflows to the pits and underground workings, the model takes account of the two existing groundwater pumps that extract water from old underground workings on Bloomfield. These pumps have the capacity to pump 9 ML/day and 7 ML/day respectively. Both pumps deliver water to Lake Kennerson for eventual delivery to the CHPP.

C-3.6 System Operation

The water balance model has been configured to allow the water storages to operate to achieve the following objectives:

- Maintain water supply for the CHPP and dust suppression at all times;
- Achieve zero discharge to the environment from Big Kahuna;
- Minimise discharge from the Stockpile Dam;
- Reduce discharge from Lake Foster and Lake Kennerson. Whilst a reduction in discharge from Lakes Kennerson and Foster is desirable for purposes of minimising potential salinity or TSS impacts on Four Mile Creek, some discharge from this system is required to maintain flows in the creek;
- Where controlled discharge is necessary, preference should be given to Lake Kennerson.

To achieve these objectives, the model allows the storage operation to be adjusted for:

- The target operating water level that provides capacity to capture and retain runoff from the contributing catchment;
- The transfer rate to/from the designated storage once the required target storage level is reached.

C-4 MODEL VALIDATION

For validation purposes, the water balance model shown schematically in **Figure C-1** was adjusted to reflect mining conditions as they existed within the Four Mile Creek catchment in 2004-5. The model was then run using rainfall for those years and the model results checked against:

- total discharge from the catchment as measured at the flow monitoring station at the rear of the Four Mile Workshops (about 500 m upstream of the New England Highway);
- manual records of controlled discharge from Lake Kennerson into the bypass channel around Possums Puddle which discharges into Four Mile Creek upstream of the flow measuring point.

It should be noted that there is considerable uncertainty about the accuracy of the recorded flows at the flow monitoring station at the rear of the Four Mile Workshops. The depth:flow rating of the gauge the rear of the Four Mile Workshops is subject to a number of uncertainties. The gauge comprises a small V notch weir set into a low embankment across the creek. The V notch weir itself is only capable of measuring base flows in the creek. Also, the upstream and downstream conditions at the gauge do not fully comply with the requirements for operation of a V notch weir. In addition, only moderate flows above base flow conditions are required to drown out the weir. Under these conditions, the depth:flow relationship has been derived using Manning's equation using estimates of the flood slope and average hydraulic roughness.

There is, however, a high level of confidence in the recorded volumes of discharge from Lake Kennerson. Bloomfield Mine has made extensive effort in surveying Lake Kennerson storage and discharge volumes. A level gauge has been installed in the lake wall to obtain accurate measurements of storage levels before and after any discharge. Discharge rates through the pipe outlets or pumping system are calculated and the discharge volume verified using a temporary v-notch weir.

In view of these limitations of the available flow records for the period 2004-5, the records are considered to be **indicative only**.

Table C-8 summarises the total flow for the two years as recorded (see above) and as estimated by the model.

Table C-8
Comparison of Recorded and Modelled Flows 2004-5

	Recorded (ML)	Modelled (ML)
Total flow from catchment	13,170	4,235
Controlled discharge from Lake Kennerson	899	933

It can be seen that there is considerable discrepancy between the recorded flow at the flow gauge and that derived by the model. The recorded total flow is considered highly improbable because it represents approximately 39% runoff from the catchment during years in lower than average rainfall (769 mm and 675 mm respectively compared to the average at Bloomfield [1989-2004] of 855 mm and the long term record at East Maitland [1902-1985] of 875 mm). Based on detailed recording of rainfall and runoff in a number of catchments in Sydney, 39% runoff would represent runoff from highly urbanised catchments rather than predominantly rural and mined catchments in which flow from a significant proportion of the catchment is controlled by mine water management systems.

In view of the fact that the original rainfall:runoff model use for this analysis was subject to calibration against recorded runoff from similar catchments in a similar climate, the discrepancy between the total observed flow and the modelled is attributed to uncertainties in the flow rating at the flow gauging station.

C-5 MODEL SCENARIOS

To assess the overall performance of the water management systems in the Four Mile Creek catchment and the effect of the proposed Abel Underground Mine, the water balance model was run for a total of nine scenarios representing mining and operating conditions as they are expected to exist at key milestone years that are summarised in **Table C-9**.

Table C-9
Summary of Conditions for Modelled Scenarios

Year	Operating Conditions	Bloomfield Open Cut	Donaldson Open Cut	Tasman Underground	Abel Underground[1]	Other Open Cut & Underground [1]	Fine Tailings Deposition	Abel Average Daily Inflow (ML/day)
2005	Historic	Full	Full	None	None	None	U/G	0
2005	Proposed	Full	Full	None	None	None	U/G	0
2008	Proposed	Full	Full	Full	Starting	None	U/G	0.02
2014	Proposed	Complete	Complete	Reducing	Target	Target	U/G	0.75
2014	Proposed	Complete	Complete	Reducing	Target	Target	U/G	0.75
2014	Proposed	Complete	Complete	Reducing	Provisional	None	Void	0.75
2020	Proposed	Complete	Complete	Complete	Target	Target	U/G	1.9
2020	Proposed	Complete	Complete	Complete	Target	Target	Void	1.9
2020	Proposed	Complete	Complete	Complete	Provisional	None	U/G	1.9
2027	Proposed	Complete	Complete	Complete	Target	Target	U/G	3.15
2027	Proposed	Complete	Complete	Complete	Target	Target	Void	3.15
2027	Proposed	Complete	Complete	Complete	Provisional	None	U/G	3.15

Note 1: "Target Production" schedule as set out in **Table C-4** and "Provisional Production" as set out in **Table C-5**

The scenarios set out in **Table C-9** include two based on 2005 mining conditions with differing water management regimes representing historic regimes and the proposed operation of the dams and water transfer systems. The purpose of these two scenarios is to provide a basis for discriminating between the effects of the proposed alterations in the water management regime from the effects of the Abel mine itself (increased water requirements for the CHPP and progressive increase in groundwater inflow to the Abel workings). Note that the inflows quoted in the last column of **Table C-9** above are the **average** daily rates for each year, derived from the groundwater modelling results provided by Aquaterra Simulations.

The other 10 scenarios represent significant milestones in the development of the Abel Underground Mine for the "Target Production" and "Provisional Production" scenarios (as set out in **Tables C-4** and **C-5**) and the progressive increase in groundwater inflow to the Abel Underground Mine to a maximum average of 3.15 ML/day at the scheduled end of the project.

For each milestone scenario listed in **Table C-9** a number of climatic sequences were run to assess the impact of climate on the performance of the water management systems. The climatic sequences are summarised in **Table C-10**.

Table C-10
Climatic Scenarios Used in Water Balance Modelling

Duration	Rainfall Statistic	Average Annual Rainfall (mm)
5 year dry period	10 percentile	705
5 year median period	50 percentile	842
5 year wet period	90 percentile	1,039
1 year dry period	10 percentile	673
1 year wet period	90 percentile	1,198

C-6 MODEL RESULTS

Having adopted runoff characteristics for the various catchments based on catchment land use characteristics, the water balance model was configured to represent the mining conditions at each of the milestone years as described in **Section C-5** (2005, 2008, 2014, 2020 and 2027). The main factors that changed for each milestone year were:

- The status of open cut pits in terms of active pit area, contributing catchment and time since initial rehabilitation occurred;
- The coal produced from the different mines, principally to account for the different characteristics of open cut and underground coal, the tonnage from each source and the resulting water requirements for the CHPP as set out in **Tables C-4** and **C-5**;
- Changes in groundwater inflows to open cut pits and underground workings (as set out in **Section C-4** above) to reflect the status of the mines at that time.

For each milestone date the operational parameters of the water balance model (target operating water levels and pumping rates) were adjusted to explore the response of the system to these factors and to identify a set of operating parameters that would, for a wide range of climatic conditions, achieve the objectives set out in **Section C-3.6**, namely:

- Maintain water supply for the CHPP and dust suppression at all times;
- Achieve zero discharge to the environment from Big Kahuna;
- Minimise discharge from the Stockpile Dam;
- Minimise discharge from Lake Foster and Lake Kennerson;
- Where controlled discharge is necessary, preference is given to Lake Kennerson.

Once the adjustment of the model parameters indicated that the water management system could achieve satisfactory performance against the criteria listed above, a single set of target operating levels and water transfer pumping rates were adopted as an initial indicative set of operating parameters (**Table C-11**) that were applied to all scenarios (to provide a common basis for comparison of the possible impacts of mining). It should be noted that these operating parameters represent one feasible set of operating rules that could be used to achieve the performance objectives listed above. In the process of finalising a Water Management Plan for the Abel Project, it is anticipated that further optimisation of the surface water operating rules will be undertaken. In addition, as further operating experience is gained, it is anticipated that there will be regular reviews of the water management plan involving further refinement of the operating rules.

Table C-11
Indicative Proposed Operating Conditions for Storages and Water Sources

Storage/Source	Target Operating Level (% of full capacity)	Transfer Rate (ML/day)	Transfer To	Transfer From
Big Kahuna	75%	5	L Foster	Abel Mine
Stockpile Dam	25%	7	L Foster	na
Lake Kennerson	80%	9	na	Groundwater
Lake Foster	50%	9	na	L Kennerson

The combination of the 12 mining scenarios summarised in **Table C-9** with the climatic sequences set out in **Table C-10**, led to a total of 60 sets of results being generated by the water balance model. **Tables C-12** to **C-16** below provide consolidated summaries of the model results of overflows from various key storage dams and flow in Four Mile creek at the flow monitoring station for each of the scenarios set out in **Table C-9**. Note that all climatic sequences as set out in **Table C-10** are summarised on each table.

Table C-12 summarises the annual average overflow that would be achieved from the Big Kahuna Dam under the operating conditions and climatic sequences described above. The main aspects of the indicative proposed future operating rules for Big Kahuna are:

- Target maximum operating level 75% of capacity above which water would be transferred to Lake Foster and serve as the "first call" source of water for maintaining water level in Lake Foster provided Lake Foster was not above its target operating level (50% capacity).
- Pumping rate from Big Kahuna to Lake Foster 5 ML/day (55 L/s) when the water level criteria are satisfied.

The results show that the historic and proposed operating rules for Big Kahuna lead to minimal risk of overflow until the Abel mine reaches 2020 conditions (daily groundwater inflow to Abel of 1.9 ML/day) when there is a small chance of an overflow occurring during a 5 year wet climate sequence. The detailed model results show that this overflow (average of 1.1 ML/year) is attributable to a single wet weather event in one year. It is noticeable that the model indicates no overflow occurring in a single wet year. The apparent discrepancy between the results for a single year and the results for a 5 year sequence are attributable to short term events embedded within the rainfall records.

The last three rows of **Table C-12** shows that by 2027 (Abel average daily groundwater inflow of 3.15 ML/day) there would be a slightly increased risk of overflow from Big Kahuna. However, given the large capacity of this dam, a reduction of the target operating level to 70% capacity would be likely to eliminate this risk.

Table C-12
Big Kahuna Overflow (ML/year)

Year	Operating Conditions [1]	Mine Scenario [2]	Tailings Disposal [3]	5 y Dry Period	5 y Median Period	5 y Wet Period	1 y Dry Period	1 y Wet Period
Ave Rain (mm/y)				705	842	1,039	673	1,198
2005	H	H	U/G	0.0	0.0	0.0	0.0	0.0
2005	P	H	U/G	0.0	0.0	0.0	0.0	0.0
2008	P	P & T	U/G	0.0	0.0	0.0	0.0	0.0
2014	P	T	U/G	0.0	0.0	0.0	0.0	0.0
2014	P	T	Void	0.0	0.0	0.0	0.0	0.0
2014	P	P	U/G	0.0	0.0	0.0	0.0	0.0
2020	P	T	U/G	0.0	0.0	1.1	0.0	0.0
2020	P	T	Void	0.0	0.0	1.1	0.0	0.0
2020	P	P	U/G	0.0	0.0	0.2	0.0	0.0
2027	P	T	U/G	0.0	1.4	3.4	0.0	0.0
2027	P	T	Void	0.0	1.4	3.4	0.0	0.0
2027	P	P	U/G	0.0	0.4	0.6	0.0	0.0

Note **1:** H = Historic water management operating conditions
P = Proposed water management operating conditions
2: H **=** Historic production rate
P = Provisional production rate
T = Target production rate
3: U/G = Underground placement of fine tailings
Void = Placement of fine tailings in open cut void

Table C-13 summarises the modelled annual average overflow from the Stockpile Dam. The results indicate that, under 2005 historic production conditions and operating rules (dust suppression in the Bloomfield CHPP stockpile area), there is a significant chance of overflow from this dam particularly in periods of extended wet weather (second line of data in the table). However, with the implementation of the proposed operating changes listed below, the chance of overflow will be significantly reduced for all climatic conditions. The indicative proposed operating rules for the Stockpile Dam are:

- target maximum operating level 25% of capacity above which water would be transferred to Lake Foster;
- pumping rate from Stockpile Dam to Lake Foster 7 ML/day (80 L/s), which is twice the rate required to satisfy the criteria for operating stormwater pollution control dams as set out in *Managing Urban Stormwater: Soils and Construction* (Landcom 2004).

Table C-13
Stockpile Dam Overflow (ML/year)

Year	Operating Conditions [1]	Mine Scenario [2]	Tailings Disposal [3]	5 y Dry Period	5 y Median Period	5 y Wet Period	1 y Dry Period	1 y Wet Period
Rain (mm/y)				705	842	1,039	673	1,198
2005	H	H	U/G	7.7	16.4	27.8	14.4	10.6
2005	P	H	U/G	0.0	0.0	1.9	0.0	0.0
2008	P	P & T	U/G	0.0	0.0	1.9	0.0	0.0
2014	P	T	U/G	0.0	0.0	1.9	0.0	0.0
2014	P	T	Void	0.0	0.0	1.9	0.0	0.0
2014	P	P	U/G	0.0	0.0	1.9	0.0	0.0
2020	P	T	U/G	0.0	0.0	1.9	0.0	0.0
2020	P	T	Void	0.0	0.0	1.9	0.0	0.0
2020	P	P	U/G	0.0	0.0	1.9	0.0	0.0
2027	P	T	U/G	0.0	0.0	1.9	0.0	0.0
2027	P	T	Void	0.0	0.0	1.9	0.0	0.0
2027	P	P	U/G	0.0	0.0	1.9	0.0	0.0

Note **1, 2, 3:** See Table C-12 for definitions

Table C-14 summarises the modelled controlled discharge volumes from Lakes Foster and Kennerson while **Table C-15** summarises the average annual number of discharge events. Compared to current conditions, the main proposed operating changes to these storages would involve lowering the target operating water level to allow the capture and retention of runoff from the contributing catchments. The indicative target operating levels are 80% and 50% capacity for Lake Kennerson and Lake Foster respectively.

In the model, discharge from Lake Foster and Lake Kennerson is amalgamated to reflect actual conditions at the EPA discharge monitoring point in the discharge channel downstream of Possums Puddle. In practice, in the past, controlled discharge from Lake Kennerson has been undertaken prior to Lake Foster reaching full supply level. (Lake Foster can only discharge under gravity when it is allowed to reach full supply level and its overflow mixes with any flow from Lake Kennerson to drain via a common exit point.) Therefore, under historic operating procedures any discharge at the monitoring point has come almost exclusively from Lake Kennerson. This arrangement will be further enhanced by the proposed future operating rules.

Table C-14
Combined Discharge from Lake Kennerson and Lake Foster (ML/year)

Year	Operating Conditions[1]	Mine Scenario [2]	Tailings Disposal [3]	5 y Dry Period	5 y Median Period	5 y Wet Period	1 y Dry Period	1 y Wet Period
Rain (mm/y)				705	842	1,039	673	1,198
2005	H	H	U/G	600	775	960	670	940
2005	P	H	U/G	65	140	225	140	135
2008	P	P & T	U/G	65	140	195	115	110
2014	P	T	U/G	70	145	210	125	125
2014	P	T	Void	220	400	560	320	410
2014	P	P	U/G	100	185	280	150	155
2020	P	T	U/G	145	95	260	145	180
2020	P	T	Void	385	605	790	485	770
2020	P	P	U/G	145	260	380	215	260
2027	P	T	U/G	115	205	305	185	190
2027	P	T	Void	485	745	955	605	965
2027	P	P	U/G	885	1,150	1,365	995	1,385

Note **1, 2, 3:** See Table C-12 for definitions

Table C-15
Lakes Kennerson and Foster Discharge (Days/Year)

Year	Operating Conditions[1]	Mine Scenario [2]	Tailings Disposal [3]	5 y Dry Period	5 y Median Period	5 y Wet Period	1 y Dry Period	1 y Wet Period
Rain (mm/y)				705	842	1,039	673	1,198
2005	H	H	U/G	82	90	98	85	100
2005	P	H	U/G	4	8	13	6	10
2008	P	P & T	U/G	4	10	10	5	8
2014	P	T	U/G	5	10	12	5	10
2014	P	T	Void	26	46	60	30	57
2014	P	P	U/G	7	13	16	7	13
2020	P	T	U/G	9	7	15	9	13
2020	P	T	Void	55	76	97	61	114
2020	P	P	U/G	9	18	24	11	28
2027	P	T	U/G	8	15	20	11	22
2027	P	T	Void	95	131	159	104	177
2027	P	P	U/G	241	256	268	245	277

Note **1, 2, 3:** See Table C-12 for definitions

Both **Table C-14** and **Table C-15** show that under 2005 historic operating conditions, significant discharge (average annual volume and number of days) can be expected from Lake Kennerson in all climatic sequences, especially during wet climate sequences. The tables also show that by altering the target operating levels of these two storages, a significant reduction in controlled discharge could be achieved (compare second line of data [2005 processing rates with historic water level rules] with the third line in **Table C-14**). The results show that for all scenarios up to 2020, the discharge from Lake Kennerson would be less than it would be under 2005 operating conditions. Even with tailings directed to an open cut void and water returned for reuse in the CHPP, the discharge from Lake Kennerson would be of the order of 60-80% of that which would occur under 2005 operating conditions. The results also show that even with 2027 mine conditions for the "Target Production" scenario (ie maximum average daily groundwater inflow to Abel of 3.15 ML/day and 5.4 million tonnes ROM production) and placement of tailings in an open cut void, the discharge from Lake Kennerson could be managed to achieve a reduction compared to historic operating conditions except in the wettest of years. On the other hand, because of the reduced requirement for water for the CHPP under the "Provisional Production" scenario (500,000 tonnes ROM with groundwater inflow to Abel of 3.15 ML/day average) there would be increased discharge from Lake Kennerson (by about 50%) compared to historic conditions unless the surplus water was stored elsewhere within the water management system.

The water balance model does not account for any underground storage of water within the Abel mine. Accordingly, in the model any excess water that cannot be used within the mine operations or the CHPP is "lost" from the system as overflow from Lake Kennerson. In practice, the mine plan for the "Provisional Production" scenario indicates that about 1,600 ML of underground storage would become available by 2015 and additional storage would subsequently become available before it would be required in about 2023. Under these circumstances, rather than sending excess water from the Abel mine to the Bloomfield water management system, excess water could be stored underground.

Table C-16 summarises the modelled flows at the flow monitoring station behind the Four Mile workshops. The model results in the table indicate that under future operating conditions, the flow in Four Mile Creek would be restored to a more natural regime as a result of the reduction in the controlled discharge from Lake Kennerson. In the past significant flows have been discharged from Lake Kennerson (2,200 ML in 2000) largely as a result of groundwater pumping to control groundwater levels and minimise seepage into the active open cut pit. Based on the current mine plan, the modelling assumes that in future, any groundwater pumping from the old underground workings on Bloomfield will be for purposes of water supply to the CHPP only.

The model results show that the effect of changes in mining conditions over the years can be expected to have negligible impact on the flow regime in Four Mile Creek. The most significant impacts would occur as a result of either discharging fine tailings to open cut voids or the reduction in projected ROM production in 2027 under the "Provisional Production" scenario. In either case, the flow in Four Mile Creek would not be significantly different from those that would occur under 2005 mining and operating conditions.

Table C-16
Four Mile Creek Flow (ML/year)

Year	Operating Conditions [1]	Mine Scenario [2]	Tailings Disposal [3]	5 y Dry Period	5 y Median Period	5 y Wet Period	1 y Dry Period	1 y Wet Period
Rain (mm/y)				705	842	1,039	673	1,198
2005	H	H	U/G	3,235	4,679	6,048	3,814	5,755
2005	P	H	U/G	2,658	3,955	5,182	3,204	4,836
2008	P	P & T	U/G	2,655	3,952	5,152	3,178	4,812
2014	P	T	U/G	2,663	3,959	5,167	3,186	4,826
2014	P	T	Void	2,812	4,213	5,517	3,384	5,111
2014	P	P	U/G	2,689	4,000	5,239	3,210	4,857
2020	P	T	U/G	3,210	2,685	5,221	3,210	3,996
2020	P	T	Void	2,975	4,421	5,748	3,545	5,472
2020	P	P	U/G	2,738	4,072	5,342	3,277	4,962
2027	P	T	U/G	2,706	4,021	5,268	3,246	4,891
2027	P	T	Void	3,076	4,560	5,917	3,667	5,666
2027	P	P	U/G	3,475	4,965	6,328	4,059	6,085

Note **1, 2, 3:** See Table C-12 for definitions

C-7 CONCLUSIONS

The water balance model results presented above indicate that with minor adjustments to target operation water levels in the various storages and pumping rates to transfer water, the existing water management facilities within the Bloomfield and Donaldson mine areas can be operated in a manner that would achieve the following objectives:

- Maintain water supply for the CHPP and dust suppression at all times.
- Achieve zero discharge to the environment from the Big Kahuna Dam.
- Minimise discharge from the Stockpile Dam.
- Minimise discharge from Lake Foster and Lake Kennerson. Where controlled discharge is necessary, preference should be given to Lake Kennerson.

The model has been used to develop a feasible set of operating rules that demonstrate the adequacy of the water management facilities to achieve these objectives. In the process of finalising a Water Management Plan for the Abel Project, it is anticipated that further optimisation of the surface water operating rules will be undertaken and reported in the approved Water Management Plan. In addition, as further operating experience is gained, it is anticipated that there will be regular reviews of the water management plan involving further refinement of the operating rules.