DONALDSON COAL

Abel Coal Project

Water Management Plan

Prepared in accordance with the Project Approval issued under Section 75J of the *Environmental Planning and Assessment Act 1979*

March 2008

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Abel Coal Project

Water Management Plan

REPORT SECTIONS

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PART A GENERAL

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PART A GENERAL

A1. INTRODUCTION

This Water Management Plan deals with the surface and groundwater issues related to the Abel Coal Project including:

- The underground mining areas
- The portal, surface facilities and surface water management facilities associated with the Abel Underground Mine; and
- The facilities associated with the expansion of the existing Bloomfield Coal Handling and Preparation Plant (CHPP) including enlargement of the stockpile area, facilities for the supply of water to the CHPP from surface and groundwater sources and the facilities necessary fro the disposal of coarse reject and fine tailings from the CHPP.

The Plan is structured in three parts that reflect the separate responsibilities of Donaldson Coal and Bloomfield Colliery for particular aspects of the project and the shared responsibility for monitoring of surface and groundwater within the geographical area covered by the Abel project. The three sections of the document are:

- Part A Project overview and areas of shared responsibility;
- Part B Abel Underground Coal Mine;
- Part C Bloomfield Coal Handling and Preparation Plant.

A2. BACKGROUND

Donaldson Coal Pty Ltd (Donaldson) received approval on 7 June 2007 for the Abel Coal Project. The project involves the development of an underground mine and the expansion of an existing coal preparation facility. The mine has approval to extract up to 4.5 million tonnes per year over 21 years. Mine access and associated surface infrastructure will be located within the existing Donaldson Mine open cut void, with transfer of coal to the existing Bloomfield CHPP for coal washing and rail transport to the Port of Newcastle. To cater for the output from the Able underground mine as well as meeting existing commitments, the CHPP will be expanded to handle an annual throughput of 6.5 million tonnes of run-of-mine coal.

This Water Management Plan for the Abel Coal Project has been prepared by Evans & Peck with assistance from Peter Dundon & Associates, GSS Environmental and Robyn Tuft & Associates in accordance with the Project Approval issued under Section 75J of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

The Abel Coal Project is located within Newcastle, Cessnock and Maitland Local Government Areas (LGAs). The majority of the underground mine and surface infrastructure area is within the Cessnock LGA.

The underground mine is to be located south of John Renshaw Drive, approximately 23 km north-west of Newcastle. The approved project area, including the underground mine area and surface facilities, is shown in **Figure A1.1**.

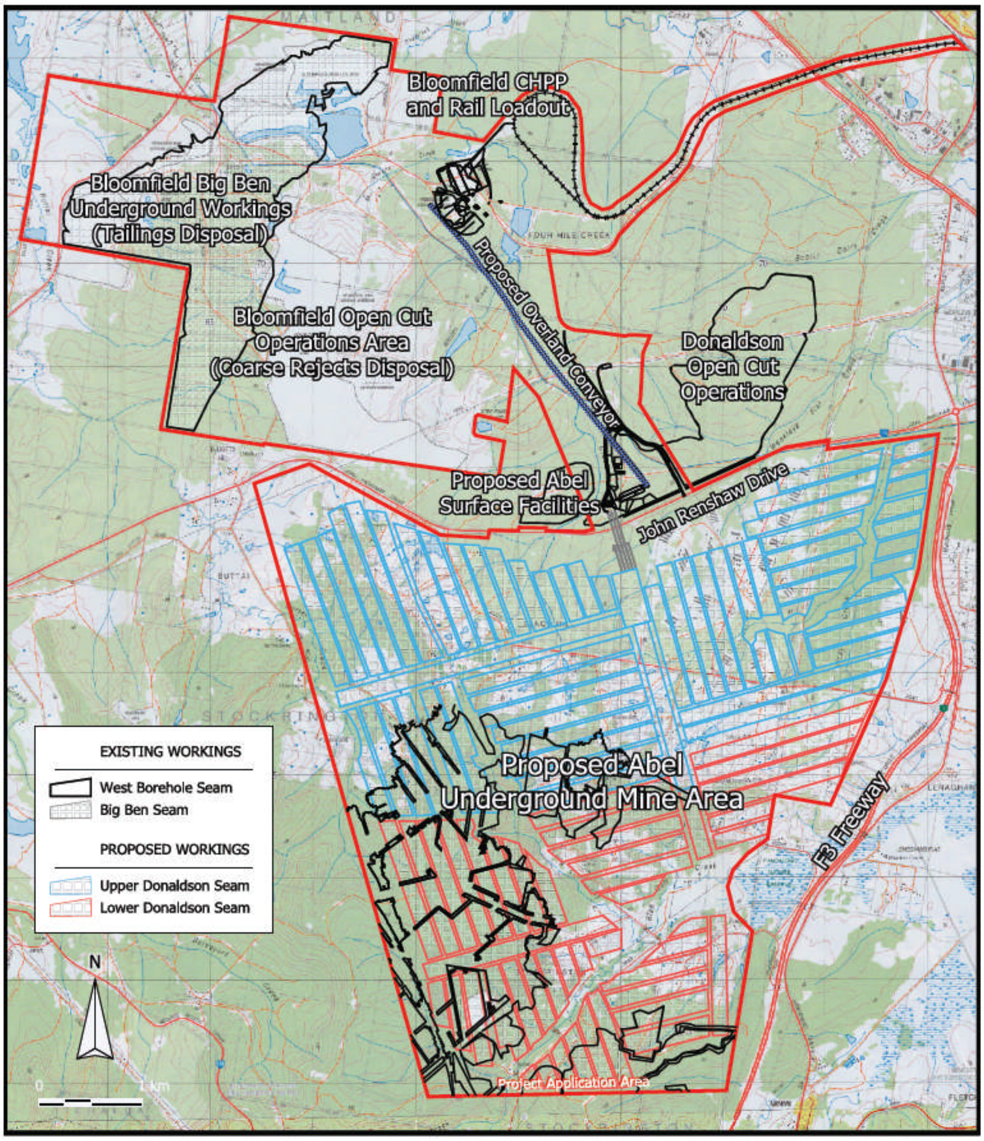
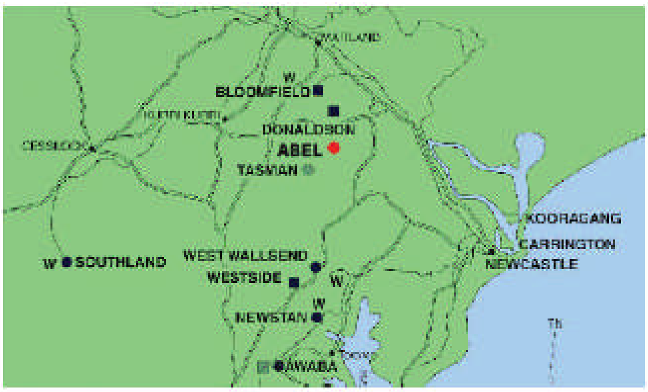


Figure A1.1

Project Location Layout



A3. COLLABORATIVE MANAGEMENT

A key feature of the Abel Coal Project is that it involves both current and proposed development owned and operated by the separate and unrelated companies Donaldson Coal Pty Ltd and Bloomfield Collieries Pty Ltd. Both companies are working co-operatively under a commercial arrangement, with aspects of the Donaldson and Bloomfield operations integrated in accordance with mining industry best practice.

A4. SCOPE AND STRUCTURE OF THE WATER MANAGEMENT PLAN

As noted in the Introduction, this Water Management Plan deals with all surface and groundwater issues related to the Abel Coal Project and is structured to reflect the separate responsibilities of Donaldson Coal and Bloomfield Colliery for particular aspects of the project and the shared responsibility for monitoring of surface and groundwater within the geographical area covered by the Abel project:

Part A of this report contains general information related to the project. **Section A5** provides an overview of the Project. **Section A6** summarises the relevant Conditions of Consent and the Statement of Commitments. The way this plan integrates with other Plans, the Surface Water Monitoring Plan and Groundwater Monitoring Plan are provided in **Sections A7** to **A9**. The proposed meteorological monitoring is set out in **Section A10**

Part B of this report provides information on the Abel Underground Mine and associated facilities. **Sections B1 and B2** describe the proposed surface facilities at the Abel Mine and the interactions with Bloomfield and Donaldson Mines. Information on site water balance and water transfers between Abel and Bloomfield is provided in **Section B3** while the proposals for erosion and sediment control for surface works, including construction of the mine portal and conveyor, are set out in **Section B4**. Surface Water and Groundwater Response Plans and Management of the Final Void are outlined in **Sections B5 to B6**.

Part C of this report provides information on the Bloomfield CHPP. **Sections C1 and C2** describes the proposed surface facilities at the Bloomfield CHPP and the interactions with Bloomfield, Donaldson, Abel and Tasman Mines. Site water balance and the arrangements for water transfer and discharge are set out in **Section C3**. Erosion Sediment Control Plans for CHPP and diversion around Lake Foster are discussed in **Sections C4 and C5**. Surface Water and Groundwater Response Plans are set out in **Section C6**. Finally, the arrangements for disposal of tailings and coarse rejects, and rehabilitation of the tailings dumps, are outlined in **Section C7**.

Appendix 1 contains baseline surface water and groundwater data while **Appendix 2** contains a summary of the Water Balance Model used to assess the overall water balance of Four Mile Creek during the life of the project, including water transfers between Abel and Bloomfield and discharges to Four Mile Creek.

A5. PROJECT OVERVIEW

The Abel Coal Project comprises the development of a new underground mine south from the high wall of the existing Donaldson Open Cut Mine.

Donaldson Coal currently owns and operates Donaldson Open Cut Mine, 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 technique. 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 underground lease area, shown on **Figure A1.1**, 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° 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 open cut.

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 Tasman Mine. An expansion of approximately 30% in Bloomfield's CHPP existing capacity of 5 million tonnes per annum ROM coal will be required to cater for coal from these sources as well as Bloomfield's existing production and coal from the Abel Underground Mine.

The major components of the Abel Coal Project are listed in **Table A5.1**.

Table A5.1: Major Components of the Abel Coal Project

Aspect	Description
Mining and Reserves	Extraction from three adjacent groups of mining panels in the Upper Donaldson and Lower Donaldson Seams, using continuous miners in flexible bord and pillar systems with associated pillar extraction. Mineable reserve of 45-55 Mt and an underground mining area of around 2,750 ha.
Project Life	An expected project life of 21 years (from the date of grant of a mining lease), including 20 years of mining.
Coal Production	Abel would produce up to 4.5 Mtpa of ROM coal, which, following washing, would provide up to 3.6 Mtpa of product coal.
Coal Washing	At the existing Bloomfield CHPP, proposed to be modified to allow total processing of up to 6.5 Mtpa. Total product coal from the CHPP would then be up to 5 Mtpa of product coal, a 43% increase on the currently approved limit of 3.5 Mtpa. The project approval includes continued use of the CHPP.
Construction	Stage 1 involves excavation of a box cut for the mine entries, three underground mine access roadways and a ventilation shaft, together with temporary surface facilities and a stack-out conveyor. Stage 2 involves construction of permanent surface facilities after blasting has ceased in the Donaldson open cut. Stage 3 involves construction of a ROM coal reclaim system and the potential construction of an overland conveyor from the ROM stockpile to the Bloomfield CHPP. Construction of modifications to the Bloomfield CHPP would take place over a period of 12 months, with the start date determined by demand (ie increasing ROM coal output from Abel and the remainder of the Donaldson/Bloomfield mining complex).
Water Demand and Supply	Annual water demand for the entire Abel/Donaldson/Bloomfield mining complex will vary between 2,230 and 3,230 ML, or 6.1 – 8.8 ML per day until 2022 and then decline to about 1,200 ML/year by 2027. This water will mainly be used for coal processing and dust suppression. The CHPP's current water demand is around 2,000 ML/year. Initially, water would continue to be sourced primarily from former Bloomfield underground workings and from surface run-off feeding five existing surface storages. In later years water inflow to the Abel underground workings in projected to exceed the requirements for mining and will provide the main source of water for the CHPP. Adequate water is available to meet all projected water requirements.
Coarse Rejects and Tailings Management	Coarse rejects from Bloomfield CHPP would continue to be mixed with overburden and placed into mined-out voids. Fine tailings will also be placed within available mined-out open cut voids at Bloomfield.
Employment	Peak construction workforce of about 70 and peak operational workforce of 375 employees.
Hours of Operation	Operations would take place 24 hours a day, 7 days a week.
Construction Hours	Underground construction of the Abel mine would take place 24 hours a day, 7 days a week. Construction of the surface facilities would be undertaken Monday to Friday 7.00 am to 5.00 pm and Saturday 7.00 am to 1.00 pm, and exclude public holidays.
ROM Coal Transport	ROM coal would be transported to Bloomfield CHPP, initially by truck on internal private haul roads but later by a planned new overland conveyor.
Product Coal Transport	Product coal would be loaded onto trains (average of 3 – 6 trains per day) and transported to the Port of Newcastle via the Bloomfield rail loop connected to the Main Northern Railway, operated by Australian Rail Track Corporation.
Mine Access	Access to mine surface facilities is via the existing Donaldson mine access road to John Renshaw Drive.

A6. CONDITIONS OF CONSENT AND COMMITMENTS

A6.1 Conditions of Consent

Table A6.1 summarises the issues relating to surface and groundwater management that are set out in Schedules 4 and 5 of the Minister for Planning's approval for the Abel Project. The table also lists the section in this Water Management Plan where each condition is addressed.

Table A6.1: Conditions of Consent Addressed within this Water Management Plan

Relevant Conditions		Reference in this Plan
Schedule 4 Specific Environmental Conditions		
Water Management (these conditions should be read in conjunction with Sections 5, 6 7 & 8 of the Statement of Commitments – refer Section A6.2 below)		
10. Discharge	*Except as may be expressly provided for by an EPL, the Proponent shall not discharge any surface waters from the site. However, water may be transferred within the site, and between the site and the adjoining Donaldson, Bloomfield and Tasman mines, in accordance with any approved Water Management Plan.*	Section B3.5 Section C3.8
11. Water Management Plan	*The Proponent shall prepare and implement a Water Management Plan for the project to the satisfaction of the D-G. This plan must:* *(a) be submitted to the D-G for approval within 6 months of this approval;* *(b) be prepared by suitably qualified expert/s whose appointment/s have been approved by the D-G,* *(c) be prepared in consultation with the DECC and DWE;* *(d) be integrated, as far as is practicable, with the water management plans of the adjoining Bloomfield, Donaldson and Tasman Mines; and* *(e) include a:*	This Plan
	▪ *Site Water Balance*	Section B3 Section C3 Appendix 2.
	▪ *Erosion and Sediment Control Plan*	Section B4 Section C5 Section C6.
	▪ *Surface Water Monitoring Program*	Section A8
	▪ *Groundwater Monitoring Program*	Section A9
	▪ *Surface and Groundwater Response Plan*	Section B5 Section C6

Relevant Conditions		Reference in this Plan
Landscape Management (these conditions should be read in conjunction with Sections 10 & 12 of the Statement of Commitments – refer Section A6.2 below)		
21. Final Void Management	*The Final Void Management Plan must describe what actions and measures would be implemented to:* *(a) minimise any potential adverse impacts associated with the modified final void of the Donaldson mine on the Abel site; and* *(b) manage and monitor the potential impacts of this final void over time.*	Section B6
Meteorological Monitoring		
27.Meteorological Monitoring	*During the project, the Proponent shall maintain a suitable meteorological station on site to the satisfaction of the DECC and Director-General. This station must satisfy the requirements in the Approved Methods for Sampling of Air Pollutants in New South Wales publication.*	Section A10
Waste		
34. Disposal of Tailings and Coarse Rejects	*The Proponent shall ensure that the:* *(a) fine tailings generated by the project are disposed of within existing underground workings or open cut pits on the Bloomfield site; and* *(b) coarse rejects generated by the project are disposed of within existing open cut pits on the Bloomfield site, to the satisfaction of the D-G.*	Section C7
Schedule 5 Environmental Management, Monitoring, Reporting and Auditing (Schedule 5 should be read in conjunction with Sections 12, 14 & 15 of the Statement of Commitments – refer Section A6.2 below)		
2. Environmental Monitoring Program	*The Proponent shall prepare and implement an Environmental Monitoring Program for the project to the satisfaction of the D-G. This program must be submitted to the D-G within 6 months of this approval, consolidate the various monitoring requirements in schedule 4 of this approval into a single document, and be integrated as far as is practicable with the monitoring programs of the adjoining Bloomfield, Donaldson and Tasman mines.*	Section A8 Section A9

A6.2 Statement of Commitments

The Director-General's requirements for the Abel Coal Project require that the Part 3A Environmental Assessment includes a Statement of Commitments which details the measures proposed for environmental mitigation, management and monitoring in accordance with Section 75F(6) of the *Environmental Planning and Assessment Act 1979.* The project Statement of Commitments are attached to the Project Approval contained in Appendix 3.

In addition to specific conditions, the Conditions of Consent for the Abel Project include the Statement of Commitments that formed part of the Part 3A Environmental Assessment. The relevant Commitments are summarised in **Table A6.2** below.

Table A6.2: Water Management Commitments

Relevant Commitment	Reference
Water Management	
5. Surface Water Management – Abel Underground Mine	
5.5 Surface Water Management Plan:	
▪ Bloomfield CHPP	Section C
▪ Abel Underground Pit Top Facilities	Section B
6. Surface Water Management – Bloomfield CHPP and the Abel Underground Pit Top Facilities	Sections B and C
7. Surface Water Monitoring Program	Section A8
8. Groundwater Management Plan and Groundwater Monitoring Program	Section A9
10. Flora and Fauna	
▪ Pambalong Nature Reserve Monitoring	Sections A8.2 and A8.4
12. Environmental Management Systems	
▪ Water Management Plan	This document
▪ Erosion and Sediment Control Plan	Sections B4 and C4
▪ Groundwater Management Plan	Section A9
▪ Watercourse Subsidence Management Plan	Separate plan
13. Rehabilitation	Section C8.4

A7. INTEGRATION WITH OTHER PLANS

This Water Management Plan contains the following plans within the Sections listed in **Table A7.1** below:

Table A7.1: Related Plans

Plan	Reference
Surface Water Monitoring Plan for Blue Gum Creek, Buttai Creek, Viney Creek, Long Gully and Four Mile Creeks.	Section A8
Erosion and Sediment Control Plans – Portal and Conveyor Construction for Abel Underground Mine.	Sections B4
Erosion and Sediment Control Plans – CHPP and Diversion around Lake Foster for Bloomfield CHPP.	Sections C4, C5
Surface Water Response Plans for Abel Underground Mine and Bloomfield CHPP.	Sections B5, C6
Groundwater Monitoring Plan for the Abel Mine Project.	Section A9
Groundwater Response Plans for Abel Underground Mine and Bloomfield CHPP.	Sections B5, C6

This Water Management Plan integrates with:

- Relevant aspects of the Abel Mine Project Management Plan,
- Watercourse Subsidence Management Plan, and
- Environmental Management Plans for Donaldson Coal and Bloomfield Collieries.

A8. SURFACE WATER MONITORING PLAN

This Surface Water Monitoring Plan covers the monitoring of surface waters within and adjacent to the Abel Underground Mine Area. This includes the following drainage systems:

- Blue Gum Creek, Long Gully and the Pambalong Nature Reserve,
- Viney Creek and Weakley's Flat Creek,
- Buttai Creek, and
- Four Mile Creek.

A8.1 Condition of Consent No. 14 - Surface Water Monitoring Program

The Surface Water Management and Monitoring Plan must include:

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

(b) surface water impact assessment criteria;

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

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

A8.2 Surface Water Monitoring Program

A surface water monitoring program has been in operation for both the Bloomfield and Donaldson Mines for several years. Monitoring undertaken to date on Weakley's Flat Creek and Four Mile Creek will be used to provide baseline data for the Abel Coal Project. In April 2006 additional watercourses were included in the monitoring program to provide baseline data specifically for the Abel Coal Project.

Current monitoring undertaken by Donaldson Mine and Bloomfield Colliery includes 13 sites in the Four Mile Creek catchment and 3 sites on the Weakleys Flat Creek. At present there is duplication of monitoring in Four Mile Creek at the following locations:

- 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
- Downstream of John Renshaw Drive

An Integrated Monitoring program will be established for the Donaldson, Bloomfield, Tasman and Abel mines. The surface water monitoring program, is summarised in **Table A8.1** to **Table A8.5** and described in further detail below, includes water quality and flow, macro-invertebrates and geomorphic characteristics. **Figure A8.1** shows the locations of the routine water quality monitoring sites including the existing duplicate sites that will be consolidated as follows:

- The existing water quality monitoring point at the New England Highway will be relocated to the flow gauging site behind the Four Mile Workshops (about 500 m upstream of the highway) to provide an improved basis for assessing the interaction between flow and water quality;
- A common monitoring point will be established downstream of John Renshaw drive;

- A common monitoring point will be established near the boundary between the Donaldson and Bloomfield lease areas.

Table A8.1: Routine Water Quality Monitoring Sites and Locations.

Site	Location
Four Mile Creek and Tributaries	
• EM1/WM10	Four Mile Creek d/s John Renshaw Dr.
• EM2/WM6	Four Mile Creek d/s Donaldson
• WM5	Elwells Creek @ Haul Road
• WM3	Elwells Creek @ Four Mile Creek
• WM12	Shamrock Creek @ Four Mile Creek
• WM11	Four Mile Creek @ Workshop
Water Storages	
• WM7	Possums Puddle
• WM4	Possums Puddle outflow
• WM8	Lake Foster
• WM9	Lake Kennerson
	Big Kahuna
Viney Creek and Tributaries	
• EM3	Weakleys Flat Creek upstream
• EM4[1]	Weakleys Flat Creek downstream
	Viney Creek u/s John Renshaw Drive
Blue Gum Creek and Tributaries	
	Blue Gum Ck @ Tasman Mine
	Blue Gum Ck @ George Booth Drive
	Blue Gum Ck @ Stockrington Road u/s
	Long Gully u/s Blue Gum Creek
	Blue Gum Ck u/s Pambalong Reserve
	Pambalong Reserve @ Cedar Hill Dr
Buttai Creek	
	Buttai Ck @ Lings Road
Scotch Dairy Creek	
• EM5[1]	Scotch Dairy Creek upstream
• EM6[1]	Scotch Dairy Creek downstream

Note 1: Monitoring scheduled to cease 3-4 years after completion of mining at Donaldson Open Cut

Table A8.2: Routine Water Quality Monitoring Sites, Frequency and Parameters

Frequency	Parameters
1. **Monthly** field monitoring at all listed sites for the range of parameters listed	• Temperature • pH • EC • DO • Turbidity
2. **Monthly** grab sample at all listed sites and laboratory analysis for the range of parameters listed	• TSS • TDS • pH • EC
3. **Quarterly** grab sample at all listed sites and laboratory analysis for the range of parameters listed (in addition to field and laboratory monitoring requirements listed for monthly field and grab sampling)	• Chlorides • Sulfates • Alkalinity (Bicarb) • Alkalinity (Carb) • Calcium • Magnesium • Sodium • Potassium

Table A8.3: Water Level and Flow Monitoring

Site	Frequency	Parameters
Blue Gum Creek u/s George Booth Drive	Continuous	• Water level and flow[1]
Blue Gum Creek @ Dog Hole Road	Continuous	• Water level and flow
Pambalong Nature Reserve @ Cedar Hill Drive	Monthly	• Water level
Four Mile Creek @ Four Mile Workshop	Continuous	• Water level and flow

Note 1: Flow to be calculated based on continuous water level record and site rating curve

Table A8.4: Biological and Geomorphological Monitoring

Site	Location	Frequency	Parameters
• EM1/WM10 • EM2/WM6 • WM3	Four Mile Creek d/s John Renshaw Dr. Four Mile Creek d/s Donaldson Four Mile Creek at Elwells Creek Blue Gum Creek @ Stockrington Road Pambalong Nature Reserve	Six months	• Field monitoring of temperature, pH, EC, DO, turbidity. • Macro-invertebrate sampling • AUSRIVAS assessment of biological health • SIGNAL Index • RCE Inventory-

In addition to routine water quality monitoring, the monitoring set out in **Table A8.5** will be undertaken in the event of any licenced discharge to Four Mile Creek, such as from Lake Kennerson, or overflow from the Bloomfield Stockpile Dam.

Table A8.5 Discharge Event Monitoring Locations and Parameters

Sites	Location	Frequency	Parameters
Lake Kennerson Discharge		Each event: – grab sample and laboratory analysis for the range of parameters listed.	• non-filterable residue (NFR) • turbidity • pH • conductivity • filterable iron
• WM8	Lake Kennerson Discharge		
• WM11	Four Mile Creek @ Workshop		
Stockpile Dam Overflow			
	Bloomfield Stockpile Dam Overflow		
• WM11	Four Mile Creek @ Workshop		

A8.3 Baseline Data

Baseline water quality data has been collected by Bloomfield Colliery since 1996 and by Donaldson Mine since 2006 in some of the nominated creeks as follows:

- Four Mile Creek – Sites EM1, EM2, WM5, WM6, WM10, WM 11 and WM12.
- Weakleys Flat Creek – Sites EM3 and EM4 and Weakleys Drive.

Appendix 1 contains statistics for the water quality data from each monitoring location. **Table A8.6** summarises the key water quality parameters in Four Mile Creek while **Table A8.7** summarises the same parameters for Weakleys Flat Creek.

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Table A8.6 Water Quality Summary for Four Mile Creek

Location Site Designation >	Four Mile Creek Upstream Donaldson EM1	Four Mile Creek @ John Renshaw Dr WM10	Four Mile Creek D/S Donaldson EM2	Four Mile Creek U/S Lake Foster WM6	Elwells Creek Adj Haul Road WM5	Elwells Creek / Four Mile Creek WM3	Shamrock Creek / Four Mile Creek WM12	Four Mile Creek @ Highway	Four Mile Creek @ Highway WM11
pH (Field)									
Mean	6.57	7.22	6.87	6.81	6.66	7.12	7.21	6.97	7.22
Minimum	5.70	5.70	5.80	5.80	3.40	4.20	4.10	6.10	5.70
10th Percentile	6.01	6.7	6.14	6.4	5.1	6.7	6.79	6.4	6.7
90th Percentile	6.99	7.7	7.33	7.2	7.8	7.6	7.6	7.4	7.7
Maximum	7.15	8.70	7.80	8.50	8.40	8.10	8.10	7.80	8.70
EC (µS/cm)									
Mean	328	427	167	239	1,969	1,444	1,567	782	2,063
Minimum	80	50	85	121	90	230	310	300	120
10th Percentile	118	200	125	166	450	370	546	400	587
90th Percentile	617	650	260	326	3,970	2,784	2,829	1,478	4,686
Maximum	905	1,080	380	2,100	6,620	6,080	5,750	2,100	5,930
Total Dissolved Solids (mg/L)									
Mean	216	296	108	151	1,002	724	902	518	1,402
Minimum	55	1390	55	50	100	120	126	170	97
10th Percentile	78	171	75	73	230	182	310	265	310
90th Percentile	390	426	143	240	2,030	1,048	1,547	965	3,520
Maximum	520	560	240	410	6,110	5,070	4,830	1,440	5,130
Total Suspended Solids (mg/L)									
Mean	72	45	265	29	39	19	41	11	95
Minimum	1	2	1	1	1	1	1	12	1
10th Percentile	6	8	1.6	1.6	4	2	1.6	2	2.9
90th Percentile	221	107	867	67	80	36	99	20	75
Maximum	528	180	6,430	370	470	140	270	49	5,470

Table A8.7: Water Quality Summary for Weakleys Flat Creek

Location Site Designation >	Upstream Donaldson EM3	Downstream Donaldson EM4	Highway
pH (Field)			
Mean	6.0	6.0	7.34
Minimum	4.7	4.7	6.20
10th Percentile	5.32	5.3	6.48
90th Percentile	6.7	6.9	8.32
Maximum	7.4	7.8	8.60
EC (µS/cm)			
Mean	518	256	899
Minimum	0	0	260
10th Percentile	185	96	418
90th Percentile	955	528	1,552
Maximum	1,240	1,800	2,600
Total Dissolved Solids (mg/L)			
Mean	340	167	578
Minimum	0	0	175
10th Percentile	121	62	251
90th Percentile	600	361	952
Maximum	960	1,130	1,750
Total Suspended Solids (mg/L)			
Mean	4,081	1,693	48
Minimum	0	0	2
10th Percentile	19	13	8
90th Percentile	14,120	4,290	100
Maximum	50,300	30,240	408

The progressive development of the Abel Underground Mine will allow more baseline data to be collected prior to subsidence occurring. In particular, Donaldson Mine will be able to collect another 15 years of baseline data for Blue Gum Creek and the Pambalong Nature Reserve prior to any subsidence occurring within their catchment area. This will include the flow gauging, macro-invertebrate monitoring and geomorphic information in addition to water quality data.

A8.4 Impact Assessment Criteria

Water quality impacts for aquatic ecosystems will be assessed in accordance with the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC/ARMCANZ, 2000).

The Guidelines present a set of water quality values formulated for specific objectives, such as the protection of aquatic ecosystems or recreational usage. Each objective lists a set of parameters with corresponding default trigger values which should ensure the sustenance of the particular environmental or human value.

The ANZECC/ARMCANZ criteria are recommended default guidelines only and each stream has its own unique physico-chemistry and biology. ANZECC/ARMCANZ recommends that site specific studies be undertaken to test the validity of the guidelines and to formulate relevant specific values for each stream. The surface water monitoring program for the Abel Project will compare results against the ANZECC/ARMCANZ guidelines for the Protection of Aquatic Ecosystems as well as the water quality and biological health monitoring data collected to date in Four Mile Creek and Weakleys Flat Creek (Tuft & Assoc 2001 – 2007). The data will be used to develop specific trigger values for each creek system. Any subsequent exceedance of the trigger values will lead to further investigations to establish the cause of the exceedance and appropriate response action as set out in **Section A8.5**.

Select reaches of Long Gully, Blue Gum Creek and Pambalong Nature Reserve are classified as having "high conservation/ecological value" as described in the ANZECC Guidelines. The water quality objective for such ecosystems of high conservation/ecological value is to ensure that there is "*no detectable change (beyond natural variability) in the levels of the physical and chemical stressors*" except "*where there is considerable biological assessment data showing that such changes will not affect biological diversity in the system*".

Other watercourses within the underground mine area are considered to be "slightly to moderately disturbed ecosystems" as described in the ANZECC Guidelines. A less conservative approach will be adopted for water quality criteria based on a low risk of impact to the ecosystems. However, maintenance of biodiversity will remain a management goal.

The impacts on the Pambalong Nature Reserve will be assessed against the relevant desired outcomes of the *Draft Plan of Management for Pambalong Nature Reserve* (DEC, 2004), namely:

- No evidence of increased sediment loads into the reserve from soil erosion in the upper catchment.
- No reduction in the water quality and health of watercourses in the reserve.
- Natural flow regimes are maintained where possible and there is an increased knowledge and understanding of hydrological processes affecting the site.

Pambalong Nature Reserve will be protected in accordance with the goals and principles of the *NSW Wetlands Management Policy* (DLWC, 1996) which is a component policy of the *State Rivers & Estuaries Policy* (NSW Water Resources Council, 1993). The relevant principle of the Policy is that "*appropriate water regimes and water quality needed to maintain or restore the ecological sustainability of wetlands will be provided through the implementation of Water Management Plans*".

A8.4.1 Water Quality

Water quality parameters will be measured using a combination of on-site monitoring and collection of grab samples for laboratory analysis. Monitoring locations are shown on **Figure A8.1** and the monitoring frequency and parameters to be measured are shown in **Table A8.1** and **Table A8.2**.

Physical Parameters to be monitored include temperature, suspended solids (non filterable residue) and turbidity.

- Temperature influences many of the chemical reactions which occur in water as well as stimulating plant growth and animal activity. It also provides a measure of the degree of mixing within a water body.
- Suspended solids reflect the amount of particulates within the water column. Such particulates may include algae and soils from runoff, affecting the penetration of light.
- Turbidity directly measures the impedance of light which may be due to suspended solids or finer, more colloidal particles.

Chemical parameters are represented by dissolved oxygen, pH, metals, organic chemicals and anions/cations:

- The pH is a measure of acidity/alkalinity, which may reflect geology and/or landuse activities.
- The concentration of dissolved salts in an aquatic system is determined by electrical conductivity and total dissolved solids analysis. Like temperature, it can be used to gauge mixing as well as indicating possible pollutant sources and ground water influences. As conductivity is easily measured in the field it may assist the rapid recognition of environmental change. Total dissolved solids, sulphates, chlorides, fluorides, calcium, magnesium, sodium, potassium and alkalinity will also be analysed in the laboratory.
- Dissolved oxygen (D.O.) levels often restrict the amount of animal activity within a stream and may also reflect the flow rate. It may also be used to assess the level of algal growth. Many other factors including rotting vegetation, leachate, sewage and animal faeces may influence the dissolved oxygen results. Again, being a parameter which may be measured in the field, dissolved oxygen provides an immediate indicator of possible influences. Dissolved oxygen levels usually follow a cyclic trend over a 24 hour period. Measurements made within the first few hours of daylight usually represent the stream at a time when D.O. levels are at their lowest. Measurements taken at midday or early afternoon should reflect maximum D.O. conditions.

A8.4.2 Water Level and Flow

Water level and flow data are measured in Four Mile Creek at the Four Mile Workshops (about 500 m upstream of the New England Highway and Blue Gum Creek upstream of George Booth Drive.

A8.4.3 Biological Monitoring

Assessment of stream fauna will be used to assess areas of environmental stress through the diversity of the macro-invertebrate population and the presence of pollutant-sensitive or pollutant tolerant animals. Healthy systems are usually characterised by a high diversity but relatively low abundance. Conversely, stressed systems favour the growth of only a few pollution-tolerant organisms, which results in a lower diversity but often higher abundance. Also, as animal diversity and abundance are relatively slow to change when compared to chemical parameters, biological data has the advantage of reflecting the long-term average condition of a system rather than at a single point in time.

Macro-invertebrates are aquatic animals including insect larvae, snails and worms which live amongst aquatic vegetation, wood debris and bed material. They can provide an indication of water quality as well as a measure of the diversity and sensitivity of the aquatic ecosystem. Data can be collected on the number of families present as well as the abundance of each family. Two biotic indices are available for macro-invertebrates within Australia. The first, the SIGNAL index has been especially developed for freshwaters of South Eastern Australia. There is a specific index for the Hunter region. The second, AusRIVAS is an Australia wide index using reference sites for specific regions.

The edge/pool habitat of the streams is sampled at each of the sites using a fine net for a stream length of 10 m. The complete sample is assessed for the abundance of each family as a percentage. Specimens of each discrete taxa are then transferred to a 100 mL phial and preserved with ethanol. Specimens are to be identified to family using a dissecting microscope, except for Chironomids which should be identified to subfamily.

In addition to macro-invertebrate sampling, any sightings or signs of vertebrates within the stream environment (eg fish, amphibia, aquatic birds or reptiles) will also be recorded. The relative abundance of algae and macrophytes are included as observations, to assess the degree of eutrophication as well as the degree of weed infestation of the riparian zone.

On each occasion that biological monitoring is undertaken, a detailed field observation sheet is completed covering riparian (stream bank) vegetation, stream geomorphology, visual characteristics and odour to allow a Riparian-Channel-Environmental Inventory (RCE) to be calculated. This assessment was developed by Peterson (1992) and evaluates the condition of; adjacent land, banks, channel and bed (includes in-stream vegetation and algae) and riparian vegetation.

Since 2001, macro-invertebrate sampling has been undertaken at two locations in Four Mile Creek and two locations in Weakleys Flat Creek twice per year. Once mining is completed for the Donaldson Open Cut mine, monitoring of Weakleys Flat Creek will no longer be relevant and will be discontinued. For the integrated monitoring program, biological monitoring will be undertaken twice per year at the following sites:

- Four Mile Creek at Elwells Creek (WM3)
- Viney Creek u/s John Renshaw Drive
- Viney Creek u/s New England Highway
- Blue Gum Creek @ location
- Pambalong Nature Reserve

A8.4.4 Geomorphic Characteristics

The impact on the geomorphic characteristics of the watercourses on the land surface above the Abel Underground Mine will be monitored within the Watercourse Subsidence Management Plan (WSMP), prepared Geoterra as a component of the overall Subsidence Management Plan (SMP). The WSMP will be developed prior to any mining that will impact on any Schedule 1 streams.

A8.5 Response Actions

In the event of any exceedance of the adopted water quality trigger values or a significant trend in ecological health or fluvial geomorphic characteristics, the response actions listed below would be initiated. A TARP action sheet will be prepared to reflect these actions.

- The nature of the suspected impact and all relevant monitoring data will be immediately referred to an independent qualified aquatic ecologist (or fluvial geomorphologist as relevant) for assessment.
- An assessment will be made to determine the reason for the exceedance, the potential magnitude of the impact and the level of future risk.
- If assessed as being caused by the mining operation, and it is further assessed to be likely to cause an adverse impact on an existing beneficial or environmental use of surface water, then an appropriate preventative and/or remedial strategy would be prepared for discussion with DWE, DECC and/or DPI-Minerals as appropriate, which may comprise:
  - Additional monitoring;
  - Modification of mine water management procedures;
  - Modification to mine water management facilities; or
  - (If appropriate) no change to operations.
- A response/mitigation plan will be implemented to the satisfaction of DWE, DECC and/or DPI-Minerals.

A8.6 Reporting Procedures

The following information will be included in the Annual Environmental Management Report (AEMR) in accordance with Condition 4 Schedule 5 of the Project Approval:

- a summary of the monitoring results for the project during the past year;
- an analysis of these monitoring results against the relevant:
  - impact assessment criteria/limits;
  - monitoring results from previous years; and
  - predictions in the Environmental Assessment (relevant predictions for groundwater inflows and water balance are included in Appendix 2).
- Identification of any trends in the monitoring results over the life of the project.

Incident reporting will be undertaken in accordance Condition 3 Schedule 5 of the Project Approval.

A9. GROUNDWATER MONITORING PLAN

A9.1 Condition of Consent No. 15 - Groundwater Monitoring Program

The Groundwater Monitoring Program must include:

(a) further development of the regional and local groundwater model;

(b) detailed baseline data to benchmark the natural variation in groundwater levels, yield and quality (including at any privately-owned bores in the vicinity of the site);

(c) groundwater impact assessment criteria;

(d) monitoring of the Pambalong Nature Reserve and rainforest areas identified within the Project Approval (refer Appendix 3);

(e) a program to monitor the impact of the project on groundwater levels, yield and quality;

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

A9.2 Further Development of the Groundwater Model

The groundwater model used for the simulation of impacts from the proposed Abel mine was limited to the Donaldson seams and the coal measures stratigraphically overlying them. Thus the model does not extend north of the sub-crop line of the Lower Donaldson Seam, and does not therefore include all of the Bloomfield mining operation. This limitation was considered adequate for the purpose of predicting impacts from the Abel project.

The model does include the existing Donaldson open cut, however that operation has been simulated in a simplified fashion, rather than detailed simulation of the westward advance of the open cut and progressive backfilling with waste.

There is currently a groundwater depression centred on the deepest part of current mining in the open cuts near the southern boundary of the Bloomfield lease, and a lesser depression centred on the water recovery bore into the former underground Big Ben workings which are the current depository for tailings from the coal washery. Hence the Bloomfield operation constitutes a regional groundwater sink.

In accordance with part (a) of Condition No. 15, it is proposed to expand the current groundwater model to include deeper layers and an expanded area, that will incorporate the Bloomfield operations and areas of possible groundwater impact around Bloomfield. It is proposed to calibrate this expanded model with ongoing monitoring data from Bloomfield, and more detailed simulation of the Donaldson mining and backfilling.

A9.3 Baseline Data

The available groundwater baseline data includes monitoring records from Abel, as well as from Bloomfield, Donaldson and Tasman.

Abel baseline groundwater monitoring commenced during the investigation program in 2005, and as each piezometer was completed, it was added to the monitoring network. The network includes 14 piezometers at 8 sites. Five of the sites have multi-level piezometers installed.

Nine piezometers are standpipes which are available for both water level and water quality monitoring. The remainder are vibrating wire piezometers, which are monitored for groundwater pressures (groundwater levels).

The available groundwater level/pressure and groundwater quality data are presented in **Appendix 1.**

Groundwater monitoring data at Donaldson have been collected routinely since 2001 (monthly groundwater levels and laboratory analysis of bore water samples). The available data are presented graphically in **Appendix 1**. Limited monitoring data are available from Bloomfield – they include both groundwater quality and groundwater levels from 24 piezometers installed at 8 sites in 2007, and infrequent measurements from a small number of exploration drill-holes from 2005-6. Tasman monitoring records include almost two years of groundwater levels and quality from 9 standpipe piezometers from 2000 to 2002 and current monitoring from a new series of 10 piezometers installed during 2006 and 2007. All available monitoring data are presented in **Appendix 1**.

The main water quality characteristics of groundwater from within the Abel lease area are as follows:

Salinity
Salinity is variable, with measured values ranging from 518 to 13000 mg/L total dissolved solids (TDS).

pH
pH is close to neutral.

Dissolved Metals
Sampling of dissolved metals revealed generally low concentrations relative to ANZECC (2000) freshwater ecosystem protection guidelines.

Nutrients
Sampling for nutrients revealed concentrations ranging from 0.3 to 13 mg/L ammonia (as N).

Figure A9.1 shows the location of the Abel, Bloomfield, Donaldson and Tasman groundwater sampling sites.

A9.4 Impact Assessment Criteria

Impact assessment criteria are recommended for:

- Mine inflow rate
- Mine inflow water quality
- Groundwater levels around Pambalong Nature Reserve and Hexham Swamp
- Subsidence induced impacts on surficial groundwater levels and/or creek baseflows.

A9.4.1 Mine Inflow Rate

A mine inflow rate substantially higher than predicted by the modeling may indicate greater impacts on near-surface groundwater and / or the wetland environments. The inflow rate has been predicted to increase progressively from 20 kL/d in Year 1 to a maximum rate of 3,180 kL/d in 2026, as in **Table A9.1.**

Table A9.1: Predicted Inflow Rates to Abel Underground Mine

Mine Year	Predicted Mine Inflow Rate	
	(kL/d)	ML/year
1	20	7.3
2	20	7.3
3	175	64
4	172	63
5	524	191
6	511	187
7	983	359
8	955	349
9	1,420	518
10	1,379	503
11	1,748	638
12	1,701	621
13	2,097	765
14	2,039	744
15	2,349	857
16	2,294	837
17	2,822	1,030
18	2,766	1,009
19	3,183	1,161
20	3,123	1,140

An observed inflow rate 100 percent in excess of the predicted inflow rate at any stage during the mine life sustained over a consecutive 3 month period would require a response action, as detailed in **Section A9.4.5**.

A9.4.2 Mine Inflow Water Quality

Mine inflow water quality is expected to be variable, but similar to the range of historical inflows to the Donaldson Open Cut, with TDS in the range 1,500-2,000 mg/L and pH around 7. Over time, a gradual increase in salinity may occur, to an eventual salinity around 3,000-4,000 mg/L TDS.

A mine inflow water quality significantly different from the above likely range would not of itself be cause for concern, as the groundwater within the coal measures is highly variable, with measured TDS values ranging from 518 to 13,000 mg/L. A rapid change to a significantly lower or higher salinity at any time might indicate that a source of surface water or near-surface groundwater may have been induced to inflow to the mine. Likewise a sudden change to the average pH of the mine inflow water may indicate the interception of a new source of water inflows.

The average salinity and pH of groundwater inflow to the mine will be monitored throughout the mine life. An observed increase or decrease in salinity by more than 25 percent, sustained over a consecutive 6-month period, would require a response action as detailed in **Section A9.4.5**.

A9.4.3 Groundwater Levels Around Pambalong Nature Reserve and Hexham Swamp

The Abel mining project is not expected to have a detectable impact on either Pambalong Nature Reserve or Hexham Swamp. Specific monitoring piezometers will be maintained to detect any unexpected impact on groundwater levels due to subsidence induced impacts on the shallow groundwater or surface water levels in either the Reserve or the Swamp. These piezometers are being monitored and will continue to be monitored to establish baseline trends in response to natural climatic influences.

A deviation from these trends after mining has commenced could indicate an unexpected adverse impact by the mining operation on the wetlands of the Pambalong Nature Reserve and/or Hexham Swamp. An additional drawdown of 0.5m relative to normal seasonal and climatically influenced fluctuations in the near-surface groundwater levels would require a response action, as detailed in **Section A9.4.5.**

A9.4.4 Subsidence Induced Impacts on Surficial Groundwater Levels or Creek Baseflows

Aside from the Pambalong Nature Reserve and Hexham Swamp, in other areas there is believed to be a general hydraulic interconnection between the near-surface groundwater (if present) in the alluvium/colluvium/weathered bedrock zone and the surface water flow in the creeks. The deeper groundwater within the Permian coal seams and interburden sediments is believed to by hydraulically isolated from the near-surface groundwater and surface water, except in areas where the particular coal seams or other permeable strata subcrop or outcrop. That is, there is limited connectivity vertically through the Permian strata, with groundwater flow occurring predominantly along the bedding.

However, subsidence-induced fracturing may cause some degree of vertical interconnection through the fractured strata. In places of relatively shallow cover depth, subsurface fracturing may provide connection through to the ground surface, or may allow intersection of sub-surface fracturing extending up from the goaf with surface fracturing extending downwards from the surface in areas of surface subsidence.

Complete connection to the surface may result in drainage of near-surface groundwater and/or creek streamflow into the underground workings. Partial connection may result in creek streamflow draining into the near-surface groundwater system, and/or to another aquifer at intermediate depth between the surface and the mine. Either outcome may result in an adverse impact on beneficial use of surface or groundwater, or a groundwater dependent ecosystem impact.

Any significant reduction or loss of creek flow, or sudden fall in the near-surface groundwater levels above an active mine area, may be an indication of an adverse impact. Should the groundwater level in any shallow piezometer fall by at least 2m relative to normal seasonal or climate-induced trends, or if baseflow in any creek should be visibly diminished relative to normal seasonal patterns, then the response plan outlined in **Section A9.4.5** would be initiated.

A9.4.5 Response Action

In the event of any exceedance detailed in Sections **A9.4.1** to **A9.4.4** above, response actions listed below would be initiated. A TARP action sheet will be prepared to reflect these actions.

- Refer the matter to an independent hydrogeologist for review.
- Assessment by him/her to determine the reason for the exceedance.
- If assessed as being caused by the mining operation, and it is further assessed to be likely to cause an adverse impact on an existing beneficial or environmental use of surface water or groundwater, then an appropriate preventative and/or remedial strategy would be recommended, which may comprise:
  - Additional monitoring;
  - Modification of mine water management procedures;
  - Modification to mine water management facilities; or
  - (If appropriate) no change to operations.
- The above response program would be carried out in consultation with DWE and DPI-Minerals.

A9.5 Pambalong Nature Reserve, Hexham Swamp, and Forest Vegetation Areas

Additional piezometers will be installed around Pambalong Nature Reserve and Hexham Swamp, to facilitate monitoring of potential impacts on the wetlands due to mining. They will include:

- Multi-level piezometers to the west and north of Pambalong Nature Reserve, to provide additional data on groundwater pressures in the intervening strata between the Donaldson seams and the alluvium (supplementing the data from existing piezometers C081A and B and C082).
- Multi-level piezometers along the eastern side of the Abel project area, located at nominally 3 sites between the F3 Freeway and the lease boundary, to resolve apparent anomalous water levels below sea level at C063A and B, and to provide additional data on groundwater pressures in the intervening strata between the Donaldson seams and the Hexham Swamp alluvium.

Additional piezometers are recommended for installation above the initial underground mining areas, to assess the impacts of surface and sub-surface fracturing on both groundwater and surface water. It is recommended that a monitoring network of multi-level piezometers and extensometers be installed above the first 4 or 5 extraction panels, which will be in the area of shallowest overburden cover. The monitoring network will aim to verify the predicted subsurface fracture heights as reported by Strata Engineering (2006), and the associated impacts on groundwater levels/pressures and hydraulic properties of the strata.

The subsidence monitoring network should comprise the following:

- Multi-level piezometers situated centrally within the extraction panels, with vibrating wire piezometers set at nominally 30m intervals from the surface down to 30m above the Upper Donaldson roof level.

- Shallow standpipe piezometers adjacent to each multi-level vibrating wire piezometer, set to the base of the colluvium/weathered bedrock zone, to monitor any impact on the surficial unconfined aquifer. Standpipe piezometers will allow repeat hydraulic testing and water quality sampling, as well as water level monitoring.

- These monitoring bores would be installed prior to commencement of each extraction panel, and would be monitored closely before, during and after extraction. Based on the monitoring results during extraction of the first 4 or 5 panels, an appropriate ongoing monitoring program would be developed for the subsequent deeper panels as mining progresses downdip.

Piezometers have been installed along the western and southern boundaries of the Abel project area, in an area which previously lacked monitoring points. These are shown on **Figure A9.1**.

A9.6 Monitoring Program

The groundwater monitoring programs that have been operating on the Abel project site since September 2005 and at the Donaldson mine since June 2000 will be continued and expanded to include the Tasman and Bloomfield areas, as an integrated monitoring system covering all four sites. It will also be integrated with the surface water monitoring program.

The groundwater monitoring program will include:

- Monthly measurement of water levels in a representative network of piezometers. Initially, all piezometers currently available would be monitored, however it is recommended that the representativeness of the piezometers be reviewed after the first two years of mining on the Abel project, and an appropriate suite of piezometers be selected on the basis of this review for ongoing monitoring. All piezometers located around Pambalong Nature Reserve would continue to be monitored through the life of the project.

- Quarterly sampling of all standpipe piezometers, for laboratory analysis of electrical conductivity (EC), total dissolved solids (TDS) and pH.

- Annual collection of water samples from all standpipe piezometers for laboratory analysis of a broader suite of parameters
  - Physical properties (EC, TDS and pH)
  - Major cations and anions (Ca, Mg, Na, K, Cl, SO_4, HCO_3 and CO_3)
  - Nutrients
  - Dissolved metals.

- Weekly measurement of the volume of mine water pumped from the underground workings. Separate inflow rates should be monitored if two or more separate mining areas are active at any time.
- Weekly measurement on site of the EC, TDS and pH of the mine water pumped from the underground workings.

The additional regional monitoring piezometers recommended in A9.5 above will be added to the existing monitoring network.

At the end of the second year of underground mining, a comprehensive review of the performance of the groundwater system will be undertaken. This will include re-running the groundwater model in transient calibration mode, to verify that the actual inflow rates and groundwater level impacts are in accordance with the model predictions described in this report. If necessary, further adjustment would be made to the model at that time, and new forward predictions of mine inflows and water level impacts would be undertaken.

A9.7 Reporting Procedures

The following information will be included in the Annual Environmental Management Report (AEMR) in accordance with Condition 4 Schedule 5 of the Project Approval:

- a summary of the monitoring results for the project during the past year;
- an analysis of these monitoring results against the relevant:
  - impact assessment criteria/limits;
  - monitoring results from previous years; and
  - predictions in the EA;
- Identification of any trends in the monitoring results over the life of the project.

Incident reporting will be undertaken in accordance Condition 3 Schedule 5 of the Project Approval.

A10. METEOROLOGICAL MONITORING

A10.1 Condition of Consent No. 27 – Meteorological Monitoring

During the project, the Proponent shall maintain a suitable meteorological station on site to the satisfaction of the DECC and the D-G. This station must satisfy the requirements in the Approved Methods for Sampling of Air Pollutants in New South Wales publication.

A10.2 Continuous Recording Stations

The existing continuous recording stations will be maintained at the following locations:

- Tasman Mine (headwaters of Blue Gum Creek);
- Donaldson Mine Office (headwaters of Weakleys Flat Creek);

The stations operate continuously to record ten minute wind speed, wind direction, temperatures, humidity and rainfall data.

A10.3 Daily Read Stations

There is an existing daily read rain gauge at the Bloomfield Mine Office (near the centroid of Four Mile Creek). An additional daily read rain gauge will be established near the junction of Long Gully and Blue Gum Creek to measure rainfall in the lower reaches of Blue Gum Creek and near to the headwaters of Viney Creek.

A summary of the meteorological data will be presented in the Annual Environmental Management Report.

A11. REFERENCES

ANZECC (2000), *Australian and New Zealand Guidelines for Fresh and Marine Water Quality.*

DEC (2004), *Draft Plan of Management for Pambalong Nature Reserve*.

DLWC (1996), *NSW Wetlands Management Policy*.

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.

NSW Water Resources Council (1993), *State Rivers & Estuaries Policy.*

Strata Engineering (2006). *Mine Subsidence Impact assessment for the Proposed Mine Layout and Extraction Panels, Abel Underground Mine.*

A12. GLOSSARY AND ABBREVIATIONS

A12.1 Glossary

Abel site	That part of the site set out in Part A of Appendix 1 of the Project Approval
Affected Councils	Cessnock City Council, Maitland City Council and Newcastle City Council
Bloomfield site	That part of the site set out in Part B of Appendix 1 of the Project Approval
Director-General	Director-General of Department of Planning, or delegate
Donaldson	Donaldson Coal Pty Ltd
Privately-owned land	Land that is not owned by a public agency, or a mining company (or its subsidiary)
Product Coal	Coal the product of a Coal Handling and Preparation Plant
Proponent	Donaldson Coal Pty Limited or any other person or persons who rely on this approval to carry out the development that is subject to this approval
Site	Land to which the project application applies, which is a combination of the Abel site and Bloomfield site
Subsidence	Subsidence of the land surface caused by underground coal mining

A12.2 Abbreviations

AEMR	Annual Environmental Management Report
AUSRIVAS	Australian River Assessment System
CHPP	Coal Handling and Preparation Plant
DECC	Department of Environment and Climate Change
DPI	Department of Primary Industries
DNR	Department of Natural Resources
EA	Environmental Assessment prepared for Donaldson Coal Pty Limited entitled Abel Underground Mine Part 3A Environmental Assessment, Volumes 1-5 (dated 22 September 2006) including the Response to Submissions (dated 19 January 2007) and the additional information on the Coal Handling and Preparation Plant (dated 5 February 2007)
EC	Electrical Conductivity
EP&A Act	Environmental Planning and Assessment Act 1979
EP&A Regulation	Environmental Planning and Assessment Regulation 2000

EPA	Environmental Protection Authority
EPL	Environment Protection Licence issued under the Protection of the Environment Operations Act 1997
EME	Emergency Response Element
ERP	Emergency Response Plan
ESCP	Erosion and Sediment Control Plan
LGA	Local Government Area
MSDS	Material Safety Data Sheets
NFR	Non-filterable residue
RLF	Rail Loading Facility
RTA	Roads and Traffic Authority
ROM Coal	Run of Mine Coal
SMP	Subsidence Management Plan
TDS	Total Dissolved Solids
TSS	Total Suspended Solids
WSMP	Watercourse Subsidence Management Plan

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B1. WORKS AND FACILITIES

B1.1 Surface Facilities

The Abel Underground Mine surface facilities comprise:

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

The surface facilities area 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). In addition, temporary site office facilities will be established at an access point adjacent to the newly constructed internal haul road.
- 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.

B1.2 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 B1.1**, which summarises the important surface water features within the catchment.

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 2 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. After leaving the Bloomfield Mine lease area, Four Mile Creek continues northwards and then eastwards towards Ashtonfields and under the New England Highway. Further downstream the creek enters an extensive wetland area on the Hunter River floodplain to the east of East Maitland and Tenambit before eventually draining into the Hunter River.

B1.3 Drainage

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.

A sump will be established in this vicinity and provided with simple sedimentation and oil separation system to remove coarse 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.

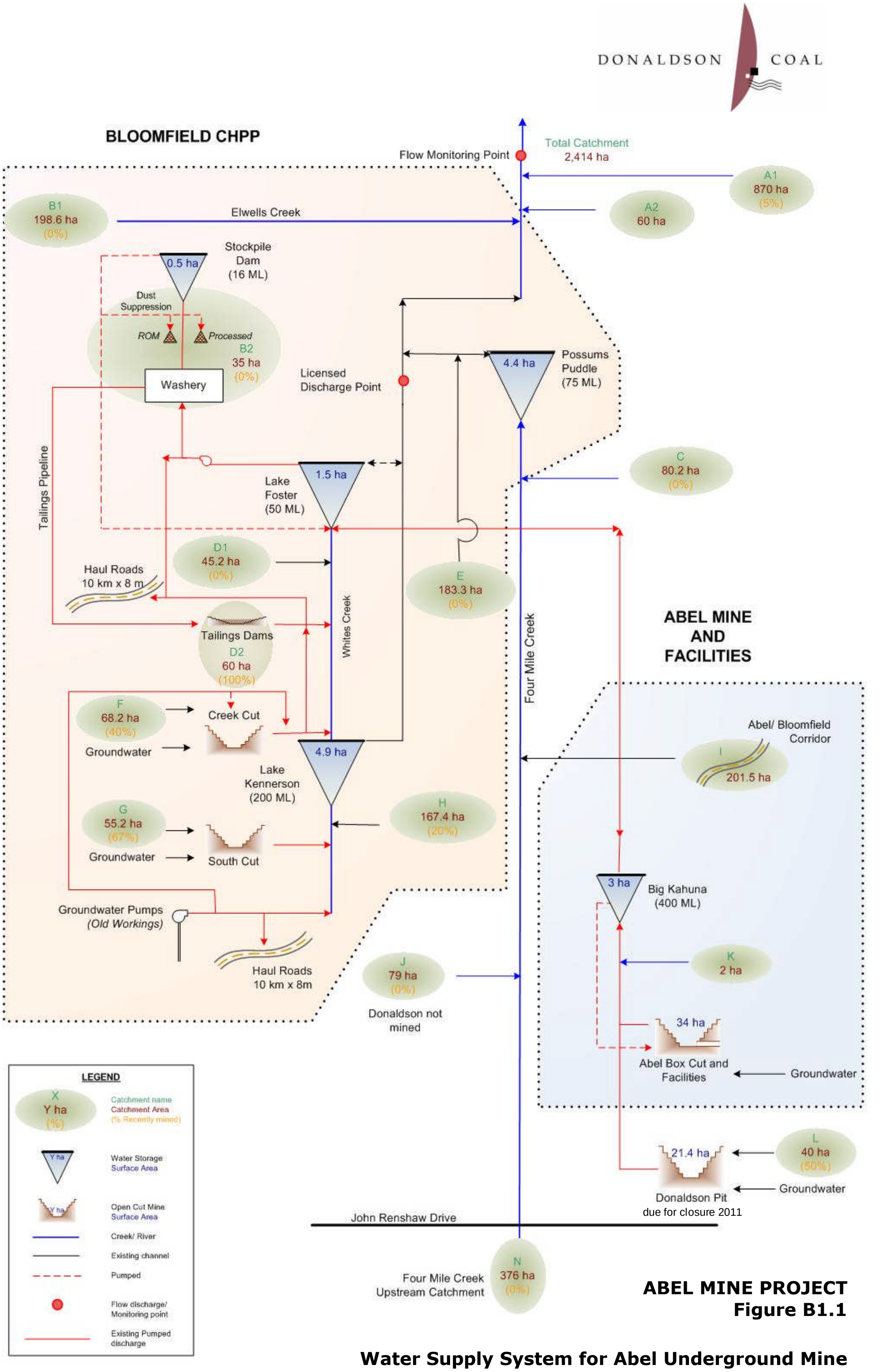
An existing pipeline between Big Kahuna Dam and the Bloomfield CHPP will be upgraded to permit transfer of water between the Big Kahuna Dam and Bloomfield. This pipeline will primarily be used to convey water from the Big Kahuna Dam to Bloomfield at sufficient rate to ensure that no overflow occurs from 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.

B1.4 Roadworks

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.

The existing haul roads that will also service the Abel mine (existing sealed 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 standard erosion and sediment control practices will be implemented during construction. 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 MINE PROJECT
Figure B1.1

Water Supply System for Abel Underground Mine

B2. INTERACTIONS BETWEEN BLOOMFIELD, DONALDSON AND ABEL MINES

B2.1 Bloomfield Mine

The Bloomfield Mine delivers approximately 800,000 tonnes per annum of ROM to the Bloomfield CHPP.

The areas of Bloomfield mine lease area that form part of the Abel project approval include:

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

The expansion of the Bloomfield CHPP will allow it to process up to 6.5 million tonnes of ROM coal per year. This coal will be sourced from a number of mines, with the tonnages from each mine varying over the years depending on the stage of mining:

- Bloomfield Open Cut Mine up to 0.8 Mtpa delivered by truck.
- Donaldson Open Cut Mine up to 2.25 Mtpa delivered by truck
- Abel Underground Mine up to 4.5 Mtpa delivered by truck or conveyor
- Tasman Underground Mine up to 0.975 Mtpa delivered by truck

Initially, water required for operation of the CHPP will be drawn from existing surface and groundwater sources within the Bloomfield mine lease area. As mining progresses, groundwater inflow to the Abel mine workings is expected to increase and exceed the operational water requirements. Excess water from the Abel operation will then be transferred to Lake Foster (the supply point for water for the CHPP) and substituted for water currently obtained from groundwater sources within the Bloomfield mine lease area. Operating rules for this transfer are set out in Section B3.6 below.

B2.2 Donaldson Open Cut Mine

The Donaldson Open Cut Mine currently delivers up to 2.25 million tonnes per annum ROM coal to the Bloomfield CHPP with 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 pit top 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.

B2.3 Abel Underground Mine

The Abel Underground Mine will deliver up to 4.5 million tonnes per annum ROM coal to the Bloomfield CHPP with consent to operate until 2027. The mine portal and surface facilities will be located within an internally draining remnant void (34 ha) from the Donaldson Open Cut Mine. The main interactions between the Abel Underground Mine and the Bloomfield CHPP will be:

- Transport of ROM coal from stockpiles located within the Abel surface facilities to Bloomfield CHPP initially by truck using the existing Donaldson haul road and subsequently by conveyor.
- Transfer of water from the "Big Kahuna" dam to Lake Foster.

B3. SITE WATER BALANCE

B3.1 Condition of Consent No. 12

The Site Water Balance must:

(a) include details of:

- *sources of water;*
- *reliability of water supply;*
- *water use on site;*
- *water management on site;*
- *off-site water transfers;*
- *reporting procedures; and*

(b) describe measures to minimise water use by the project.

B3.2 Background

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 B1.1**. Note that the areas that relate specifically to the Abel Underground Mine are shown shaded on **Figure B1.1**. Further details of the model are contained in **Appendix 2**.

The water balance model has been configured to test a variety of operating regimes in order to identify operation of the water storages and pumps in a manner designed to achieve zero discharge to the environment from Big Kahuna.

B3.3 Model Setup and Operation

Details of the model setup and validation are contained in **Appendix 2**. The main features of the model are that it:

- Operates on a daily basis utilising historic daily records of 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.
- Incorporates a variety of catchments that have different runoff characteristics.
- Includes groundwater inflow to open cut pits and underground workings.
- For each water storage it accounts for runoff into the storage, pumped transfer into or out of the storage and rainfall on to, and evaporation from, the surface of the storage.
- Allows for extraction of water for dust suppression purposes on haul roads, stockpiles and work areas.
- Accounts for water used in the CHPP.

B3.4 Sources of Water

Table B3.1 summarises the catchments and groundwater sources that relate directly to the Abel Underground Mine.

Table B3.1 Catchments and Groundwater Sources – Abel Underground Mine

Source	Designation[1]	Catchment Area (ha)	Average Yield (ML/year)
Catchment to Big Kahuna Dam	K	2	3
Abel surface facilities	L	34	85
Abel groundwater inflow 2010			21
Abel groundwater inflow 2015			314
Abel groundwater inflow 2020			661
Abel groundwater inflow 2027			1,118

Note 1: Designation refers to the catchment lettering shown on **Figure B1.1**

B3.5 Abel Site Water Management

The Big Kahuna Dam will be the focal point for the water management system. All surface runoff from the surface facilities will drain to sump and be pumped to the Big Kahuna. Water from de-watering operations within the underground will also be pumped to the Big Kahuna. In the later stages of mining some excess water may be stored within the underground workings.

Water held in the Big Kahuna will be used for the following purposes (listed in priority order):

- Water supply for underground operating purposes;
- Dust suppression around the surface facilities and stockpiles;
- Transfer to Lake Foster for use in the Bloomfield CHPP.

A set of operating rules for the water management system have been developed based on the results of the water balance model for the whole of the Four Mile Creek system. Variations and enhancements to the existing water management arrangements comprise:

- Upgrading the existing pipeline between the Big Kahuna Dam and Lake Foster to permit the transfer of up to 10 ML/day;
- Establishing an initial target operating level within the Big Kahuna Dam of 75% capacity (400 ML) above which water would be transferred to Lake Foster (subject to the water level in Lake Foster being below the target operating level). Based on operating experience this level will need to be reviewed in later years and may need to be reduced to 70% to account for increased flow from the Abel Underground Mine.

Table B 3.2 to **Table B 3.4** summarise the estimated sources and uses of water within the Abel and Donaldson areas for each year of the Abel project under different climate conditions:

- Median rainfall year (892 mm)
- 1 in 10 dry year (673 mm)
- 1 in 10 wet year (1,198 mm)

Note that in the tables all sources of water (surface runoff and groundwater inflow to the mine workings) are positive numbers and all losses (mine uses, net evaporation and seepage, and transfer to Bloomfield) are negative numbers.

The tables show that for the range of climates analysed:

- The mine could operate without the need for import of water from Bloomfield. (The shortfall of 19 ML in a 1 in 10 dry year that occurred in 2011 as shown in Table B 3.3 is an artefact of the way the model operates and could, in fact be met by drawing down the level of the Big Kahuna Dam);
- An excess of water for transfer to Bloomfield is expected throughout the life of the mine with the exception noted above;
- There would be zero discharge from the Big Kahuna Dam under the proposed operating regime.

Table B 3.2 Estimated Water Balance for the Abel/Donaldson Mine Areas in a Median Rainfall Year for Each Year of the Abel Project

		Inflow				Losses			
Year	Abel U/G Demand (ML)	Pit Inflow (ML)	Underground Inflow (ML)	Surface Runoff (ML)	Import from Bloomfield (ML)	Net Evaporation and Seepage (ML)	Total Water Use (ML)	Transfer to Bloomfield (ML)	Overflow (ML)
2008	-9	299	4	127	0	-28	-52	-350	0
2009	-19	299	7	127	0	-28	-62	-343	0
2010	-31	299	21	127	0	-28	-74	-345	0
2011	-50	0	49	88	0	-28	-93	-16	0
2012	-75	0	95	88	0	-28	-118	-37	0
2013	-100	0	158	88	0	-28	-143	-75	0
2014	-100	0	231	88	0	-28	-143	-148	0
2015	-100	0	314	88	0	-28	-143	-231	0
2016	-100	0	394	88	0	-28	-143	-311	0
2017	-100	0	472	88	0	-28	-143	-389	0
2018	-100	0	541	88	0	-28	-143	-458	0
2019	-100	0	600	88	0	-28	-143	-517	0
2020	-100	0	661	88	0	-28	-143	-578	0
2021	-100	0	724	88	0	-28	-143	-641	0
2022	-75	0	778	88	0	-28	-118	-720	0
2023	-63	0	824	88	0	-28	-106	-778	0
2024	-50	0	891	88	0	-28	-93	-858	0
2025	-38	0	977	88	0	-28	-81	-956	0
2026	-25	0	1,053	88	0	-28	-68	-1,045	0
2027	-13	0	1,118	88	0	-28	-56	-1,122	0

Table B 3.3 Estimated Water Balance for the Abel/Donaldson Mine Areas in a 1 in 10 Dry Year for Each Year of the Abel Project

		Inflow				Losses			
Year	Abel U/G Demand (ML)	Pit Inflow (ML)	Underground Inflow (ML)	Surface Runoff (ML)	Import from Bloomfield (ML)	Net Evaporation and Seepage (ML)	Total Water Use (ML)	Transfer to Bloomfield (ML)	Overflow (ML)
2008	-9	299	4	105	0	-40	-59	-310	0
2009	-19	299	7	105	0	-40	-69	-303	0
2010	-31	299	21	105	0	-40	-81	-304	0
2011	-50	0	49	72	0	-40	-100	19	0
2012	-75	0	95	72	0	-40	-125	-2	0
2013	-100	0	158	72	0	-40	-150	-40	0
2014	-100	0	231	72	0	-40	-150	-113	0
2015	-100	0	314	72	0	-40	-150	-197	0
2016	-100	0	394	72	0	-40	-150	-276	0
2017	-100	0	472	72	0	-40	-150	-354	0
2018	-100	0	541	72	0	-40	-150	-423	0
2019	-100	0	600	72	0	-40	-150	-482	0
2020	-100	0	661	72	0	-40	-150	-543	0
2021	-100	0	724	72	0	-40	-150	-606	0
2022	-75	0	778	72	0	-40	-125	-685	0
2023	-63	0	824	72	0	-40	-113	-744	0
2024	-50	0	891	72	0	-40	-100	-823	0
2025	-38	0	977	72	0	-40	-88	-922	0
2026	-25	0	1,053	72	0	-40	-75	-1,010	0
2027	-13	0	1,118	72	0	-40	-63	-1,088	0

Table B 3.4 Estimated Water Balance for the Abel/Donaldson Mine Areas in a 1 in 10 Wet Year for Each Year of the Abel Project

		Inflow				Losses			
Year	Abel U/G Demand (ML)	Pit Inflow (ML)	Underground Inflow (ML)	Surface Runoff (ML)	Import from Bloomfield (ML)	Net Evaporation and Seepage (ML)	Total Water Use (ML)	Transfer to Bloomfield (ML)	Overflow (ML)
2008	-9	299	4	173	0	-17	-46	-413	0
2009	-19	299	7	173	0	-17	-56	-406	0
2010	-31	299	21	173	0	-17	-68	-408	0
2011	-50	0	49	126	0	-17	-87	-71	0
2012	-75	0	95	126	0	-17	-112	-92	0
2013	-100	0	158	126	0	-17	-137	-130	0
2014	-100	0	231	126	0	-17	-137	-203	0
2015	-100	0	314	126	0	-17	-137	-286	0
2016	-100	0	394	126	0	-17	-137	-366	0
2017	-100	0	472	126	0	-17	-137	-444	0
2018	-100	0	541	126	0	-17	-137	-513	0
2019	-100	0	600	126	0	-17	-137	-572	0
2020	-100	0	661	126	0	-17	-137	-633	0
2021	-100	0	724	126	0	-17	-137	-696	0
2022	-75	0	778	126	0	-17	-112	-775	0
2023	-63	0	824	126	0	-17	-100	-834	0
2024	-50	0	891	126	0	-17	-87	-913	0
2025	-38	0	977	126	0	-17	-75	-1,012	0
2026	-25	0	1,053	126	0	-17	-62	-1,100	0
2027	-13	0	1,118	126	0	-17	-50	-1,178	0

The mine water balance model indicates that in the last year of mining there would be an excess of water generated from the Abel Underground Mine that could not be utilised for mine operating purposes or the CHPP. 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. This storage will be used to contain any excess water produced from the mine.

B3.6 Off-Site Water Transfers

The arrangements for water transfer between Abel and Bloomfield are:

a) When the water level in Big Kahuna is above the target level (75% capacity initially), and Lake Foster is below its target operating level (50% capacity) water will be transferred from Big Kahuna to Lake Foster at up to 10 ML/day.

b) The arrangements for water to be transferred from Big Kahuna to Lake Foster will take priority over groundwater pumping within Bloomfield except as necessary for groundwater level control for open cut operations.

The model results show that up to 2010 while the Donaldson Open Cut Mine is operating there could be of the order of 300 - 400 ML/year available for transfer to Bloomfield. Once the Donaldson Open Cut operation ceases, the available groundwater supply would be limited for a short period but at the end of the Abel project about 1,100 ML per year would be available for transfer.

B3.7 Reliability of Water Supply

As shown in **Table B 3.2** it is anticipated that groundwater inflow to the Abel Underground Mine workings will provide an excess of water for most of the life of the mine. In the event that the actual groundwater flow to the Abel underground workings is less than predicted from the groundwater modelling, and a shortfall of water occurs in the early years of the mine, Big Kahuna is capable of providing 2-3 years supply. In addition, the pipeline between Big Kahuna and Lake Foster could be used to provide water from Bloomfield.

B3.8 Reporting Procedures

Each component of flow of water into and out of Big Kahuna will be monitored separately. Details of the overall site water balance will be presented in the Annual Environmental Management Report.

B3.9 Minimisation of Water Use

Groundwater inflow to the Abel Underground Mine is predicted to exceed the water requirements for mine operational purposes throughout the life of the mine. Any excess water will be transferred to Lake Foster for use in the Bloomfield CHPP. Water transferred from Abel to Bloomfield will substitute for water that would otherwise be extracted from underground sources on Bloomfield. The design of the Bloomfield CHPP incorporates a high degree of water recycling with only the settled fines removed for disposal. Approximately 70% of the water used in the washing process is recycled.

B3.10 Domestic Water Supply and Wastewater Treatment

For the potable water supply connection will be made to the Hunter Water Corporation's water supply line that runs through the property to the Stoney Pinch Reservoir.

During the initial start-up period, a pump out system will be used for all waste water. After the initial phase, a package treatment system will treat the grey water for re-use on the site whilst the black water will be pumped out by a licensed waste contractor for disposal.

B4. EROSION AND SEDIMENT CONTROL PLAN

B4.1 Condition of Consent No. 13

The Erosion and Sediment Control Plan must:

- *(a) be consistent with the requirements of the Department of Housing's Managing Urban Stormwater: Soils and Construction manual;*
- *(b) identify activities that could cause soil erosion and generate sediment;*
- *(c) describe measures to minimise soil erosion and the potential for transport of sediment to downstream waters;*
- *(d) describe the location, function, and capacity of erosion and sediment control structures;*
- *(e) describe what measures would be implemented to monitor and maintain the structures over time.*

B4.2 Erosion and Sediment Control Plan: Portal Construction

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.

In essence, apart from the need for standard erosion and sediment control measures to protect Four Mile Creek during initial stripping, all drainage will be inwards to the box cut and will be pumped out to Big Kahuna for subsequent re-use.

B4.3 Erosion and Sediment Control Plan: Conveyor Construction

At the time of preparation of this Plan, the timing of construction and the details of the route for the conveyor have not been finalised. Accordingly it is premature to prepare an Erosion and Sediment Control Plan (ESCP) for the conveyor.

An appropriate ESCP will be prepared once the design of the conveyor has been finalised. The ESCP will outline of the measures that will be implemented to ensure that no undue pollution of Four Mile Creek occurs during construction of the conveyor between the Abel box cut and the Bloomfield CHPP. Particular attention will be paid to the area where the conveyor crosses Four Mile Creek. The ESCP has been prepared in accordance with guidelines contained in "*Managing Urban Stormwater: Soils and Construction*" (4th Edition) (Landcom, 2004).

B5. RESPONSE PLANS

B5.1 Surface Water Response Plan

The procedure to be followed in the event of unforeseen surface water 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 aquatic ecologist 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 DWE, DECC and/or DPI-Minerals as appropriate.
4. A response/mitigation plan will be implemented to the satisfaction of DWE, DECC and/or DPI-Minerals.

B5.2 GroundWater Response Plan

The procedure to be followed in the event of significant unforeseen variances from the predicted inflow rates and/or groundwater level impacts:

1. Additional sampling and/or water level measurements will be taken to confirm the variance from expected behaviour.
2. Immediate referral to a competent hydrogeologist for assessment of the significance of the variance from expected behaviour. The review hydrogeologist would be requested to recommend an appropriate remedial action plan or amendment to the mining or water management approach. If appropriate, this recommended action plan would be discussed with DWE, DECC and/or DPI-Minerals for endorsement.

B6. FINAL VOID MANAGEMENT PLAN

B6.1 Condition of Consent No 21 – Final Void Management

The Final Void Management Plan must describe what actions and measures would be implemented to:

(a) minimise any potential adverse impacts associated with the modified final void of the Donaldson mine on the Abel site; and

(b) manage and monitor the potential impacts of this final void over time.

B6.2 General

Decommissioning of the Abel Underground Mine at the end of the extraction period will require the sealing of underground access portals and the removal of surface infrastructure, including offices, bath house, ROM coal stockpile infrastructure, workshop, conveyors and operational water management structures. The ground surface will then be reshaped to form a stable surface and soil spread over the site and seeded with tree seed including a cover crop to minimise soil erosion. Some roads may remain if required for future land uses, as determined by planning processes developed closer to closure time.

The void at the portal will be shaped and managed in a manner consistent with the rehabilitation principles for the Donaldson Open Cut Mine. **Figure B6.1** shows the proposed final void and landform at the conclusion of the Abel Underground Mine operation.

In accordance with relevant DPI guidelines, the Mine Operations Plan, required as a condition of the lease for the Abel Underground Mine, will include a Mine Closure Plan addressing in detail the above rehabilitation proposals. A detailed rehabilitation plan will be developed as part of the Mine Closure Plan closer to the time of closure.

PART C BLOOMFIELD CHPP

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FIGURES

Note: figures are located within each Section.

PHOTOGRAPHS

TABLES

PART C BLOOMFIELD CHPP

C1. WORKS AND FACILITIES

The Bloomfield Coal Handling Preparation Plant (CHPP) currently receives approximately 800,000 tonnes per annum of run-of-mine (ROM) coal from the Bloomfield Open-Cut Mine and up to 2.5 million tonnes per annum (Mtpa) from the Donaldson Open-cut Mine. The approval for the Abel Mine Project includes approval to expand the CHPP facilities to increase the processing capacity of the of Bloomfield CHPP from 5 Mtpa of ROM coal to 6.5 Mtpa. 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 slurry by pipeline.

The approval for the Abel Project includes a number of facilities that relate to the upgrading and ongoing operation of the Bloomfield CHPP:

- Modifications to the processes within the existing CHPP building to increase its capacity to 6.5 Mtpa of ROM coal;
- Enlargement of the ROM and processed coal stockpiles areas and associated coal handling equipment;
- Continued operation of water management facilities that supply water for the CHPP, with some modification to the operation of the system to account for water made available from the Abel Underground Mine.
- Continued use of remnant voids within the Bloomfield lease area for placement of coarse rejects and tailings from the CHPP.

C1.1 Bloomfield CHPP

The proposed layout of the CHPP is shown in Figure C1.1. The upgrade to the CHPP itself will involve internal refinements within the plant that do not require any enlargement of the external structure.

C1.2 Stockpile Areas

The upgrade of the ROM coal handling operation will be undertaken in two stages:

Stage One:

- Increasing the size of the ROM stockpile pad to accommodate an increase in the coal quantity whilst maintaining the ability to segregate different seams according to their quality;
- A new hopper and coal crushing system, incorporating a Bradford Breaker, crusher and screens;
- A conveyor to transport raw coal from the crushing system to the current C2 conveyor;
- ROM Stockpile Pad directional lighting; and
- Relocation of access road.

Stage Two:

- Aerial conveyors with fixed trippers and ground located drives;
- Stack out or luffing conveyors with movable trippers and tail drives;
- Coal hopper with below ground plate feeder;
- Upgraded primary process plant with jigs, screens and crushers; and
- ROM stockpile pad directional lighting.

The upgrade of the clean coal stockpiles and associated handling system includes the following:

- Construction of a new extension to the on-ground overland conveyor;
- Extension of the steaming coal conveyor and gantry and construction of a new steaming coal reclaim tunnel;
- Extension of the coking coal conveyor and gantry and extension of the existing coking coal reclaim tunnel;
- Relocation of the steaming coal bin;
- Extension of the car park;
- Relocation of the access road; and
- Construction of a new conveyor and gantry to the east of the existing gantries.

C1.3 Water Supply to the CHPP

The current water supply to the CHPP involves a series of storages and interconnecting pipelines that are shown schematically in Figure C1.2:

- Lake Foster (50 ML capacity) that receives water from various sources and acts as the supply dam for the CHPP;
- Lake Kennerson (200 ML capacity) which receives runoff from its contributing catchment (290 ha – largely rehabilitated mine overburden dumps) as well as water collected in the Creek Cut and S Cut mine pits. The catchments areas that eventually drain to Lake Kennerson include about 123 ha that currently drain to mine pits from which water is pumped to Lake Kennerson. Water from Lake Kennerson is released to supply Lake Foster;
- Possums Puddle (75 ML capacity) which is located on Four Mile Creek and provides backup supply for Lake Foster in the event that insufficient water is available for CHPP operations from other sources;
- Groundwater pumps that extract water from old underground workings below the Bloomfield open cut workings;
- Surface water as well as supernatant water from the tailings emplacement in the U Cut which is pumped to Lake Foster.

Modifications to the water management system that have been approved under the Abel Project include:

- Upgrading of the pipeline that connects the “Big Kahuna” dam to Lake Foster. (The “Big Kahuna” serves the existing Donaldson mine and will also be the focal point for water management for the Abel Underground Mine);

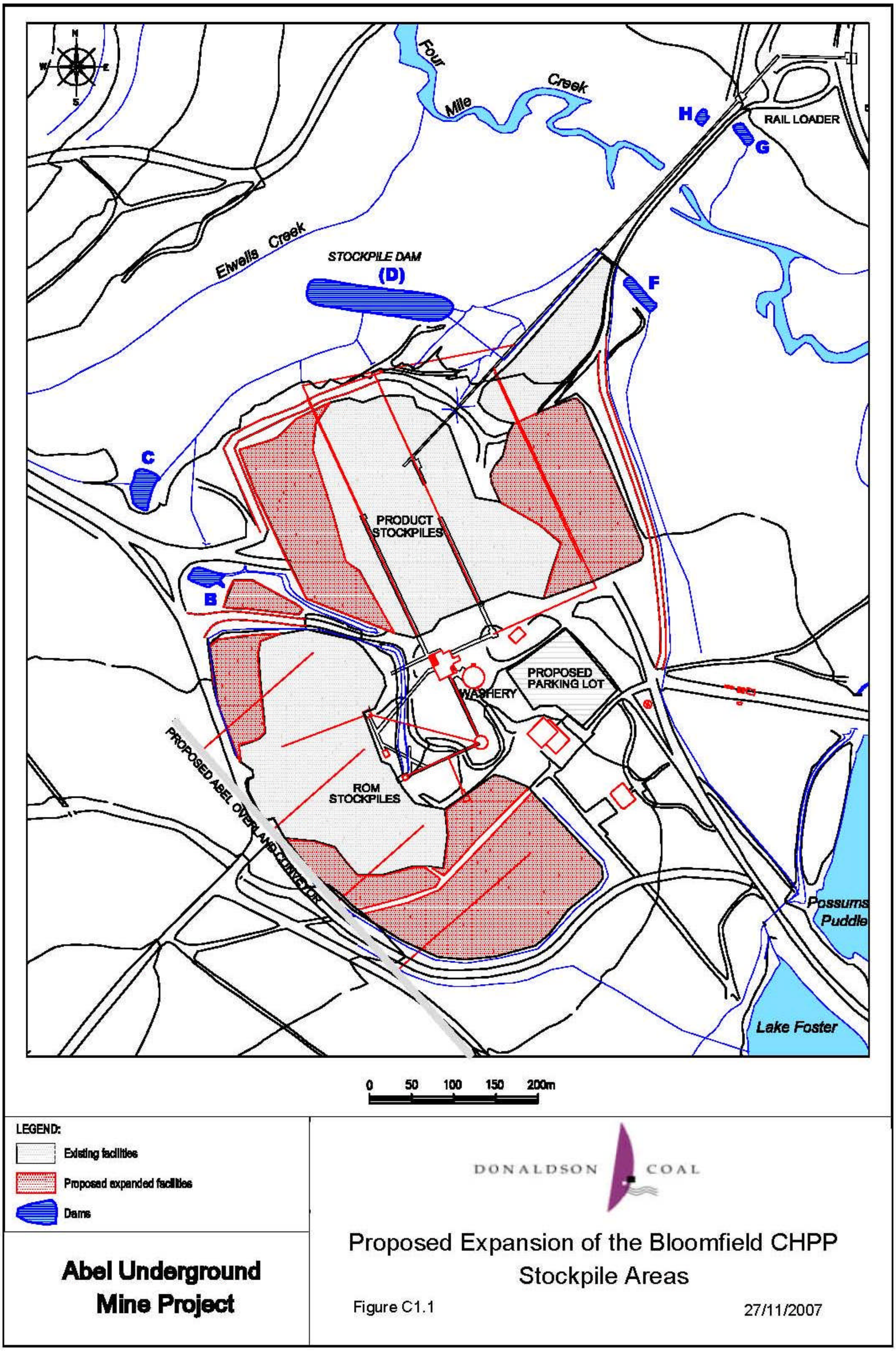
- Installation of a pipeline to connect the Stockpile Dam to Lake Foster.

The water requirements for the CHPP are a function of the tonnage processed and the source of the coal. (Open cut ROM contains a higher proportion of fine tailings than ROM from underground, and therefore requires more water for tailings disposal). Historically, water for the CHPP (2,000 – 2,500 ML/year) has been provided from the surface runoff within the Bloomfield operating area and from groundwater extracted from old underground workings (up to 2,200 ML/year). As development of the Abel mine progresses and groundwater inflows increase (see **Table A9.1**), water from Abel will progressively be substituted for water that, in the past, has been extracted from the old underground workings. In an average rainfall year, by 2025, it is estimated that all water for CHPP and other mine water uses will be provided by surface runoff or water from the Abel underground operation.

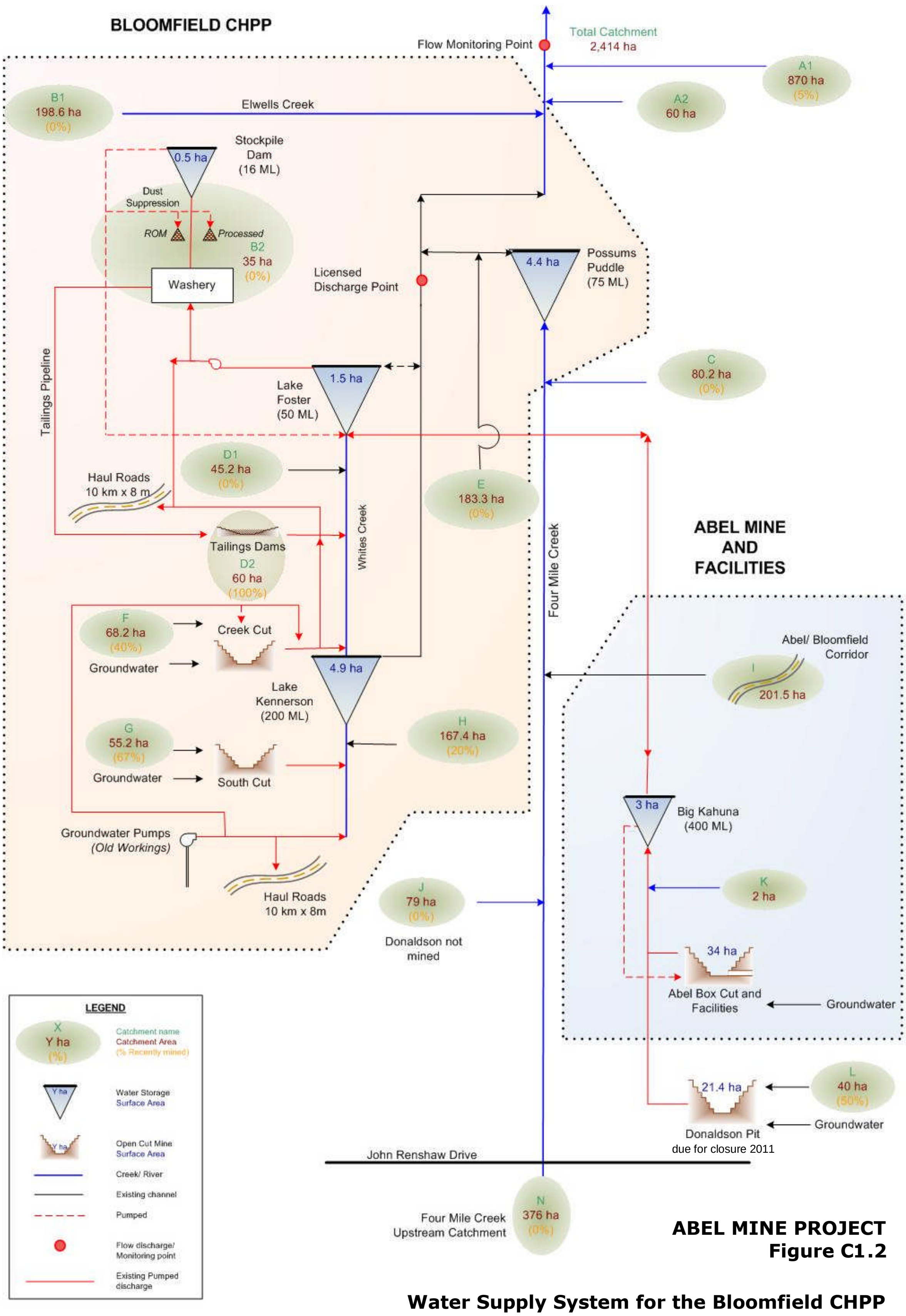
C1.4 Coarse Rejects and Tailings

The arrangements for coarse rejects and fine tailings from the CHPP are:

- Coarse rejects from the CHPP are currently trucked to a remnant void known as the U Cut. Once the U Cut has been filled, coarse rejects will be trucked to the S Cut void.
- Fine tailings are pumped for disposal. Currently all fine tailings are deposited into the U Cut. Supernatant water is pumped to Lake Foster for re-use in the CHPP.



Abel Mine Project
Figure C1.1



ABEL MINE PROJECT
Figure C1.2

Water Supply System for the Bloomfield CHPP

C2. INTERACTIONS WITH BLOOMFIELD, DONALDSON, ABEL AND TASMAN MINES

The Bloomfield CHPP and rail loading facility will handle coal from the Donaldson and Bloomfield Open Cut Mines, and the Abel and Tasman Underground Mines. 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 “clean” water from the thickener within the CHPP is redirected back into the washery. Tailings slurry is pumped for disposal as described in **Section C1.4**.

Losses of water from the vicinity of the CHPP and stockpiles include:

- Water used to convey the fine tailings (about 2,000 ML/year currently rising to approximately 2,700 ML/year at full production);
- 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 60 ML/year at present rising to about 100 ML/yea at full production;
- Coarse rejects from the washery have approximately 12% more water than ROM and account for about 70 ML/year.

The interactions between the CHPP and the Donaldson, Bloomfield, Abel and Tasman Mines are outlined below.

C2.1 Bloomfield Open Cut Mine

Bloomfield Open Cut Mine delivers approximately 800,000 tonnes per annum of ROM to the Bloomfield CHPP.

Water for the operation of the CHPP is drawn from dams and old underground workings within the Bloomfield Mine lease area.

C2.2 Donaldson Open Cut Mine

Donaldson Open Cut Mine currently delivers up to 2.5 million tonnes per annum ROM coal to the Bloomfield CHPP. The mine has consent to operate until 2012.

Donaldson Mine currently utilises the existing private haul roads for coal haulage to the Bloomfield CHPP. Elements of the existing Donaldson dirty water management system, particularly the main “Big Kahuna” storage dam and a pipeline, will be used in the transfer of water between Donaldson and Bloomfield Mines.

C2.3 Abel Underground Mine

Abel Underground Mine will extract coal from the Upper Donaldson and Lower Donaldson coal seams. 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 CHPP, initially by truck and later by conveyor, where it will be processed and loaded onto rail.

The Abel Underground Mine will use the existing “Big Kahuna” dam as the central element in the water management system. Groundwater inflow to the underground workings will be pumped to the “Big Kahuna” along with surface runoff from the vicinity of the surface facilities. Water will be extracted from the Big Kahuna for dust suppression and to meet the needs of the underground operations (approximately 160 ML/year at full production). Subject to a set of transfer rules agreed between Abel and Bloomfield, excess water from the “Big Kahuna” dam will be transferred to Lake Foster for use in the Bloomfield CHPP.

C2.4 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 mine lease area.

The water management system for the Tasman Mine will either re-use or store runoff from the surface facilities and groundwater generated from the underground workings. The mine design provides for substantial volumes of water to be stored underground to enable the mine to operate without the need for discharge of surface or groundwater. In the event that groundwater inflow exceeds predictions and insufficient water storage capacity is available in the old workings, excess water will be transferred to the “Big Kahuna” by truck.

C3. SITE WATER BALANCE

C3.1 Condition of Consent No. 12 – Site Water Balance

The Site Water Balance must:

(a) include details of:

- *sources of water;*
- *reliability of water supply;*
- *water use on site;*
- *water management on site;*
- *off-site water transfers;*
- *reporting procedures; and*

(b) describe measures to minimise water use by the project.

C3.2 Background

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 C1.2**. More details of the model are contained in **Appendix 2**. The water balance model has been used to identify operational rules for 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 overflow from the Stockpile Dam.
4. Minimise discharge from Lake Foster and Lake Kennerson to Four Mile Creek.
5. Where controlled discharge is necessary, preference is to be given to discharge from Lake Kennerson.

C3.3 Model Setup and Operation

Details of the model setup and validation are contained in **Appendix 2**. The main features of the model are that it:

- Operates on a daily basis utilising historic daily records of rainfall and evaporation.
- Operates for key stages in the life of the project representing different stages of mine production and the associated groundwater inflow to the workings.
- Keeps account of all daily inputs and outputs and provides annual summaries of the volume and frequency of pumped discharges and overflows.
- Incorporates a variety of catchments that have different runoff characteristics.
- Includes groundwater inflow to open cut pits and underground workings.

- Includes runoff into the storage, pumped transfer into or out of the storage and rainfall on to, and evaporation from, the surface of the storage.
- Allows for extraction of water for dust suppression purposes on haul roads, stockpiles and work areas.

C3.4 Sources of Water

Table C3.1 summarises the catchment areas within the Bloomfield Mine area that form part of the Four Mile Creek water balance model.

Table C3.1: Water Balance Model Catchment Areas

Catchments	Designation[1]	Total (ha)
Elwells Creek	B1	199
CHPP Stockpile area	B2	35
Possums Puddle catchment	C	87
Lake Foster catchment	D1	45
Tailings Dams and catchments	D2	60
Clean Water Diversion Past Possums Puddle	E	183
Creek Cut Void and catchment	F	68
S Cut Void and catchment	G	55
Lake Kennerson catchment	H	167
Total		**884**

Note 1: Designation refers to the catchment lettering shown on **Figure C1.2**

C3.5 Water Uses

The main water use associated with the CHPP is the water required to transport fine tailings. Other minor volumes of water are accounted for by dust suppression, water contained in coarse rejects and moisture retained within the coal that is transported off site.

Table C 3.2 summarises the estimated annual water requirements for the CHPP and associated stockpile areas in an average rainfall year at different stages in the mine life.

Table C 3.2: Average Annual Water Requirements for CHPP Operations

Year	ROM to CHPP (Mtpa)	Dust Sup'n (ML/year)	Coarse Rejects (ML/year)	Tailings (ML/year)	Coal Export (ML/year)	Total (ML/year)
2010	4,225	70	59	2,150	77	2,356
2015	5,900	70	67	2,451	115	2,703
2020	5,000	70	58	2,102	97	2,327
2027	1,500	70	22	744	27	863

Note that the decrease in estimated water requirement between 2010 and 2015, despite an increase in the ROM supplied to the CHPP, occurs because of an increased proportion of ROM from underground sources and the expected reduction in proportion of fine tailings associated with ROM from underground operations compared to open cut (6% compared to 14%).

In addition to the water requirements listed in **Table C 3.2**, about 190 ML/year is required for dust suppression on haul roads within the Bloomfield Mine lease area.

C3.6 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 C1.1.** 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.
- Both dams will be reconfigured 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.

Previously the Stockpile Dam currently acted as a reservoir for water that was only used for dust suppression in the vicinity of the CHPP. 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:

- In accordance with the 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 has been allocated to accommodate runoff from a 90th percentile 2 day storm.
- 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) by transfer to Lake Foster.
- Once drawn down to below the settlement zone (ie 10 ML remaining in storage), 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.

C3.7 Site Water Management

The water balance model for the whole of the Abel/Donaldson/Bloomfield water management system (see **Appendix 2**) has been used to develop a set of operating rules for the water management system that achieve the objectives set out in **Section C3.2**. Variations and enhancements to the existing system comprise:

- 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;
- Minor earthworks to ensure that all runoff from the enlarged ROM and coal stockpile areas adjacent the Bloomfield CHPP is directed to the Stockpile Dam or Dam F (from which water will be transferred to 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 to transfer all water to Lake Foster at a rate of up to 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;
- Operate Lake Foster at a "target" operating level of 50% capacity in order to provide "air space" for runoff from the contributing catchment or transfer from the Stockpile Dam in the event of rainfall;
- Provide water to maintain Lake Foster at the target operating level by drawing on water sources in the priority order set out in **Table C3.3**:

Table C3.3 Priority for Transfer of Water to Lake Foster

Priority	Storage/Source	Transfer Rate (ML/day)	Discharge To	Constraint
1	Stockpile Dam	5	Pumped to L Foster	-
2	S Cut	2	Pumped to L Foster	-
3	Tailings Dams (U Cut)	2	Pumped to L Foster	L Foster <50%
4	Lake Kennerson	Up to 16	Gravity flow to L Foster	L Foster < 50%
5	Big Kahuna	Up to 10	Pumped to Lake Foster	Big Kahuna > 75%, L Foster < 50% and L Kennerson < 75%
6	Creek Cut	2	Pumped to L Foster	L Foster <50%
7	Old underground workings	9	Pumped to L Kennerson	L Kennerson <50%
8	Old underground workings	7	Pumped to L Kennerson	L Kennerson <40%

C3.8 Off-Site Water Transfers

Off site water transfers associated with the future operation of the Bloomfield CHPP include:

- Transfer of water from the Big Kahuna dam (which will receive groundwater and surface runoff from the Abel Mine) subject to priority being given to water sources within the Bloomfield water management system including groundwater pumping necessary for control of groundwater levels to minimise inflow to the active mine pit. Provisional operational storage limits within the Bloomfield water management system for transfer from Big Kahuna to Lake Foster are set out in **Table C3.3**. These operating limits have been derived by use of the water balance model to test the effectiveness of a range of operating conditions required to meet all mine water demands (including the CHPP) as well as minimise discharge to the environment. The operating rules that are summarised in **Table C3.3** will be reviewed and revised in the light of operating experience.
- Discharge from Lake Kennerson to Four Mile Creek in accordance with Bloomfield's existing discharge licence. The key features in the licence are:
  - Discharge limited to 40 ML/day and only permitted on the days following rainfall as follows:
    - Discharge for one day following rainfall of at least 10 mm in 24 hours;
    - Discharge for two days following rainfall of at least 15 mm in 24 hours;
    - Discharge for three days following rainfall of at least 20 mm in 24 hours;
  - Discharge water quality requirements:
    - TSS upper limit 30 mg/L;
    - pH in the range 6.5 – 8.5;
    - EC upper limit 6,000 µs/cm;
    - Filterable iron upper limit 1 mg/L.
  - Water quality monitoring by means of grab samples collected at the discharge point and downstream. (Site references WM8 and WM11 – see **Figure A8.1**).

Discharge from Bloomfield has varied significantly depending on climate conditions and the depth of the pit with respect to the local groundwater level. Since 1999, annual discharge has varied from zero in 2006 to 2,200 ML in 2002 with an average of 770 ML/year. The water balance modelling indicates that controlled discharge volume and frequency from Lake Kennerson would be reduced significantly compared to historic conditions in the early years of the Abel Mine project.

C3.9 Bloomfield Water Balance

Detailed water balance modelling was undertaken for the Environmental Assessment of the Abel Mine Project (including the whole of the Four Mile Creek system and all the associated mine water storages and transfers as illustrated in the schematic diagram in **Figure C1.2**). **Table C 3.4** to **Table C 3.6** summarise the estimated sources and uses of water within the Bloomfield mine lease area for each year of the Abel project under different climate conditions:

- Median rainfall year (892 mm)
- 1 in 10 dry year (673 mm)
- 1 in 10 wet year (1,198 mm)

Note that in the tables all sources of water (surface runoff and groundwater inflow to the mine workings) are positive numbers and all losses (mine uses, net evaporation and seepage, and transfer to Bloomfield) are negative numbers.

Table C 3.4: Estimated Water Balance for the Bloomfield Mine Area in a Median Rainfall Year for Each Year of the Abel Project

Lake Kennerson					Lake Foster								
Inflow		Uses & Losses			Inflow					Uses & Losses			
Pit Inflow (ML)	Surface Runoff (ML)	Net Evaporation & Seepage (ML)	Transfer to Lake Foster (ML)	Controlled Discharge (ML)	Transfer from Big Kahuna (ML)	Transfer from Stockpile Area and Tailings (ML)	Groundwater Pumping from Old Workings (ML)	Surface Runoff (ML)	Import from Lake Kennerson (ML)	Net Evaporation & Seepage (ML)	Dust Suppression Uses (ML)	CHPP and Lost in Product (ML)	Overflow (ML)
37	638	-46	-525	-103	350	408	1,572	68	525	-14	-255	-2,655	0
37	638	-46	-530	-98	343	408	1,815	68	530	-14	-255	-2,896	0
37	638	-46	-537	-91	345	408	1,266	68	537	-14	-255	-2,356	0
37	638	-46	-552	-77	16	408	1,123	68	552	-14	-255	-1,898	0
37	638	-46	-554	-75	37	408	1,518	68	554	-14	-255	-2,316	0
0	634	-46	-512	-76	75	408	1,939	68	512	-14	-255	-2,734	0
0	634	-46	-505	-83	148	408	1,873	68	505	-14	-255	-2,734	0
0	634	-46	-496	-92	231	408	1,768	68	496	-14	-255	-2,703	0
0	634	-46	-491	-97	311	408	1,634	68	491	-14	-255	-2,644	0
0	634	-46	-483	-105	389	408	1,497	68	483	-14	-255	-2,577	0
0	634	-46	-481	-107	458	408	1,368	68	481	-14	-255	-2,515	0
0	634	-46	-479	-109	517	408	1,123	68	479	-14	-255	-2,327	0
0	634	-46	-477	-111	578	408	1,064	68	477	-14	-255	-2,327	0
0	634	-46	-471	-117	641	408	1,007	68	471	-14	-255	-2,327	0
0	634	-46	-451	-137	720	408	529	68	451	-14	-255	-1,908	0
0	634	-46	-429	-159	778	408	284	68	429	-14	-255	-1,699	0
0	634	-46	-350	-238	858	408	74	68	350	-14	-255	-1,490	0
0	634	-46	-43	-545	956	408	74	68	43	-14	-255	-1,281	0
0	634	-46	0	-588	1,045	408	0	68	0	-14	-255	-1,072	-181
0	634	-46	0	-588	1,122	408	0	68	0	-14	-255	-863	-467

Table C 3.5: Estimated Water Balance for the Bloomfield Mine Area in a 1 in 10 Dry Year for Each Year of the Abel Project

Lake Kennerson					Lake Foster								
Inflow		Uses & Losses			Inflow					Uses & Losses			
Pit Inflow (ML)	Surface Runoff (ML)	Net Evaporation & Seepage (ML)	Transfer to Lake Foster (ML)	Controlled Discharge (ML)	Transfer from Big Kahuna (ML)	Transfer from Stockpile Area and Tailings (ML)	Groundwater Pumping from Old Workings (ML)	Surface Runoff (ML)	Import from Lake Kennerson (ML)	Net Evaporation & Seepage (ML)	Dust Suppression Uses (ML)	CHPP and Lost in Product (ML)	Overflow (ML)
37	523	-65	-410	-85	310	345	1,812	63	410	-20	-264	-2,655	0
37	523	-65	-411	-84	303	345	2,059	63	411	-20	-264	-2,896	0
37	523	-65	-411	-84	304	345	1,518	63	411	-20	-264	-2,356	0
37	539	-65	-454	-58	-19	345	1,339	63	454	-20	-264	-1,898	0
37	539	-65	-462	-50	2	345	1,728	63	462	-20	-264	-2,316	0
0	539	-65	-420	-55	40	345	2,150	63	420	-20	-264	-2,734	0
0	539	-65	-408	-67	113	345	2,089	63	408	-20	-264	-2,734	0
0	539	-65	-400	-75	197	345	1,983	63	400	-20	-264	-2,703	0
0	539	-65	-394	-81	276	345	1,850	63	394	-20	-264	-2,644	0
0	539	-65	-388	-87	354	345	1,711	63	388	-20	-264	-2,577	0
0	539	-65	-381	-94	423	345	1,587	63	381	-20	-264	-2,515	0
0	539	-65	-374	-101	482	345	1,347	63	374	-20	-264	-2,327	0
0	539	-65	-357	-118	543	345	1,303	63	357	-20	-264	-2,327	0
0	539	-65	-352	-123	606	345	1,245	63	352	-20	-264	-2,327	0
0	539	-65	-336	-139	685	345	763	63	336	-20	-264	-1,908	0
0	539	-65	-323	-152	744	345	509	63	323	-20	-264	-1,699	0
0	539	-65	-298	-177	823	345	245	63	298	-20	-264	-1,490	0
0	539	-65	-175	-300	922	345	61	63	175	-20	-264	-1,281	0
0	539	-65	0	-475	1,010	345	0	63	0	-20	-264	-1,072	-62
0	539	-65	0	-475	1,088	345	0	63	0	-20	-264	-863	-348

Table C 3.6: Estimated Water Balance for the Bloomfield Mine Area in a 1 in 10 Wet Year for Each Year of the Abel Project

Lake Kennerson					Lake Foster								
Inflow		Uses & Losses			Inflow					Uses & Losses			
Pit Inflow (ML)	Surface Runoff (ML)	Net Evaporation & Seepage (ML)	Transfer to Lake Foster (ML)	Controlled Discharge (ML)	Transfer from Big Kahuna (ML)	Transfer from Stockpile Area and Tailings (ML)	Groundwater Pumping from Old Workings (ML)	Surface Runoff (ML)	Import from Lake Kennerson (ML)	Net Evaporation & Seepage (ML)	Dust Suppression Uses (ML)	CHPP and Lost in Product (ML)	Overflow (ML)
37	897	-27	-806	-101	413	429	1,176	88	806	-8	-249	-2,655	0
37	897	-27	-808	-99	406	429	1,422	88	808	-8	-249	-2,896	0
37	897	-27	-808	-98	408	429	880	88	808	-8	-249	-2,356	0
37	897	-27	-825	-82	71	429	743	88	825	-8	-249	-1,898	0
37	897	-27	-834	-73	92	429	1,131	88	834	-8	-249	-2,316	0
0	874	-27	-762	-84	130	429	1,582	88	762	-8	-249	-2,734	0
0	874	-27	-757	-89	203	429	1,514	88	757	-8	-249	-2,734	0
0	874	-27	-745	-101	286	429	1,412	88	745	-8	-249	-2,703	0
0	874	-27	-745	-101	366	429	1,273	88	745	-8	-249	-2,644	0
0	874	-27	-744	-102	444	429	1,129	88	744	-8	-249	-2,577	0
0	874	-27	-744	-102	513	429	998	88	744	-8	-249	-2,515	0
0	874	-27	-743	-103	572	429	752	88	743	-8	-249	-2,327	0
0	874	-27	-742	-104	633	429	692	88	742	-8	-249	-2,327	0
0	874	-27	-723	-123	696	429	648	88	723	-8	-249	-2,327	0
0	874	-27	-699	-147	775	429	174	88	699	-8	-249	-1,908	0
0	874	-27	-500	-346	834	429	106	88	500	-8	-249	-1,699	0
0	874	-27	-211	-635	913	429	106	88	211	-8	-249	-1,490	0
0	874	-27	-106	-635	1,012	429	0	88	106	-8	-249	-1,281	-201
0	874	-27	-106	-635	1,100	429	0	88	106	-8	-249	-1,072	-499
0	874	-27	-106	-635	1,178	429	0	88	106	-8	-249	-863	-785

The water balance results in **Table C 3.4, Table C 3.5** and **Table C 3.6** demonstrate that the water management system can be managed to achieve the following outcomes:

- Adequate water available to meet all requirements for dust suppression and operation of the CHPP under all mine operating and climate conditions.
- Groundwater extraction from the Bloomfield underground workings would not exceed historic levels and would progressively decline as water transferred from the Abel Underground Mine is substituted for groundwater from the Bloomfield underground workings.

- The modelling indicates that discharge volume and frequency from Lake Kennerson would be reduced significantly compared to historic conditions in the early years of the project. The model results indicate that by 2027 (the modelled year with maximum predicted groundwater contribution from Abel – about 1,200 ML/year) discharge from Lake Kennerson would range from an average of about 480 ML/year in a dry year to 870 ML/year in a wet year.
- 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. The risk of pollution would be further reduced by the proposed re-configuring of the dam as a "first flush" capture dam.

C3.10 Reliability of Water Supply

The water supply system for the Bloomfield CHPP is able to draw on multiple different sources of surface water and groundwater depending on operational requirements. Ultimately, any shortage of surface runoff from contributing catchments will be made up by groundwater from the Abel Underground Mine (that needs to be extracted to permit mine operations) or from groundwater extracted from the old underground workings that underlie the Bloomfield Mine area (which provide the majority of the existing supply for the CHPP).

The robustness of the water management system has been assessed by using the water balance model to test the sensitivity of the system to a range of assumptions:

- The water balance model has been used to assess the performance of the water management system for a scenario in which coal production from Able Underground was 45% higher over the life of the mine (with consequential increase in water requirements for the CHPP). The model results indicate that the water management system would be capable of being managed in a way that would ensure adequate supply for the CHPP as well as achieve the objectives set out in Section C3.2.
- The water balance model water balance has also been used to assess the performance of the water management system for a scenario in which 80% of water from fine tailings returned from use in the CHPP. The results show that the water management system is capable of being managed without exceeding historic levels of surface water discharge to Four Mile Creek from Lake Kennerson.
- The robustness of the water management system has also been 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 has been undertaken by combining reduced coal production towards the end of the life of the mine with "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 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.

C3.11 Reporting Procedures

Each component of flow of water within the Bloomfield water management system will be monitored. Details of water transfers between Abel and Bloomfield, transfers between storages within the Bloomfield water management system and the overall site water balance will be presented in the Annual Environmental Management Report.

C3.12 Minimisation of Water Use

The major component of water use within the CHPP is the water required for transport of fine tailings for disposal. Because of the water treatment and pumping costs involved, there is a strong incentive to minimise the volume of water required for tailings disposal. The proposed upgrading of the CHPP is intended to improve the overall efficiency of the plant including minimising water usage.

In addition, there is expected to be a progressive reduction in water requirements for tailings disposal as the ROM source to the CHPP gradually changes from open cut to underground sources. Open cut ROM typically contains 14% fine tailings whereas the greater selectivity associated with underground mining is expected to reduce the fine tailings to 6%.

C4. EROSION AND SEDIMENT CONTROL PLAN: CHPP STOCKPILE AREAS

C4.1 Condition of Consent No. 13

The Erosion and Sediment Control Plan must:

(a) be consistent with the requirements of the Department of Housing's Managing Urban Stormwater: Soils and Construction manual;

(b) identify activities that could cause soil erosion and generate sediment;

(c) describe measures to minimise soil erosion and the potential for transport of sediment to downstream waters;

(d) describe the location, function, and capacity of erosion and sediment control structures;

(e) describe what measures would be implemented to monitor and maintain the structures over time.

C4.2 Introduction

This Erosion and Sediment Control Plan (ESCP) describes the measures that will be implemented to ensure that no undue pollution of receiving waters occurs during earthworks construction for the expansion of the Bloomfield CHPP stockpile areas. The ESCP has been prepared in accordance with guidelines contained in "*Managing Urban Stormwater: Soils and Construction*" (4th Edition) (Landcom, 2004).

A series of clean and dirty water diversions, mine water dams, silt traps, pumps and a water reticulation system characterize the existing Bloomfield CHPP surface water management system. The expansion of the CHPP from a capacity of 5 Mtpa of ROM to 6.5 Mtpa requires a proportional increase in the stockpile areas for ROM and processed coal. The existing system will provide sediment controls during construction of the enlarged stockpile areas and will be enhanced to accommodate the proposed expansion thus providing effective erosion and sediment control for CHPP area during and after the construction process.

C4.3 Activities that Could Cause Soil Erosion

The expansion of the stockpile areas adjacent to the CHPP primarily involves minor earthworks to redirect surface runoff in order to ensure:

- "Clean" runoff from outside the stockpile area is diverted around the stockpile area;
- "Dirty" runoff within the stockpile area is directed to a series silt traps and the Stockpile Dam.

The earthworks required will include construction of bunding around the southern and eastern side of the ROM stockpile area and upgrading of an existing drain.

Minor earthworks will also be required within the stockpile area for construction of coal recovery facilities and conveyors.

C4.4 Measures to Minimise Erosion

The erosion caused by the earthworks will be minimal because of the limited extent of earthworks required.

C4.5 Sediment Control Structures

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 (Dam D). The Stockpile Dam has a capacity of 17 ML.

All clean "run-on" water, where practicable, will be diverted around the CHPP stockpile area so as to minimize the dirty water catchment area. Dirty water runoff will be intercepted and re-directed to a series of mine water dams, some of which have existing pumping facilities to reticulate water from dam to dam and/or recycle dirty water to the washery. The rail load-out facility area is not included in the dirty water circuit. Two silt traps are responsible for sediment control from the western side of the rail facility.

Mine water dams receiving dirty runoff from the expanded CHPP area, together with the rail load-out facility's silt traps, are illustrated in **Figure C1.1**. A schedule of mine water dams and silt traps with corresponding capacities is presented in **Table C4.1**.

Table C4.1 Schedule of Dams

Dam ID	Type	Pumping Facility	Capacity (ML)
B	Silt Trap	No	0.15
C	Mine Water	No	0.5
D	Mine Water	Yes	17.0
F	Mine Water	Yes	1.0
G	Silt Trap	No	0.1
H	Silt Trap	No	0.05

To cater for the increased throughput of the CHPP the stockpile area will be enlarged yielding a catchment of approximately 35 ha, as shown on **Figure C1.1**. 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 (Dam D) via Dams C and F.
- 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 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 (Dam D) 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.
- Both dams will be reconfigured 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.

Containment of dirty water in the Stockpile Dam (Dam D) is critical to the success of the dirty water system. Whilst Dams B and C enhance the settling capacity and increases the cumulative dam volume within the total system, the consequences of overflow from these dams is not significant. Discharge from Dam B and Dam C eventually reports to Dam D, the structure that is pivotal to the success of the surface water management system because of its large capacity (17 ML) and location (adjacent to Four Mile Creek).

Table C4.2 provides a comparison of the Stockpile Dam's (Dam D) existing capacity with the *Managing Urban Stormwater: Soils and Construction*, Landcom, 2004 or the "Blue Book" as it is known in government circles and the 1-in-100 year (1% ARI), time of concentration (tc) duration design criteria.

Table C4.2 Stockpile Dam Design Capacities

Existing Capacity (ML)	Required Capacity (ML) "Blue Book"*	Required Capacity (ML) 1% ARI/ tc #
17.0	10.0	17.5

- the "Blue Book" calculations relate to Type F sediment dams
- # ARI : average recurrence interval

The cumulative capacity of Dams B, C, D and F exceeds the volume of runoff generated by a 1-in-100 year rainfall event.

C4.6 Monitoring and Maintenance of Sediment Control Structures

The Stockpile Dam (Dam D) 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 the "Blue Book") a settlement zone storage capacity at 7 ML is required to accommodate runoff from a 90th percentile 2 day storm.
- 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 3.5ML/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.
- 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 "Blue Book".

C5. EROSION AND SEDIMENT CONTROL PLAN: DIVERSION AROUND LAKE FOSTER

C5.1 Erosion and Sediment Control Plan

This Erosion and Sediment Control Plan (ESCP) describes the measures that will be implemented to ensure that no undue pollution of receiving waters occurs during earthworks construction to increase the capacity of the bypass channel around Lake Foster The ESCP has been prepared in accordance with guidelines contained in "*Managing Urban Stormwater: Soils and Construction*" (4th Edition) (Landcom, 2004).

C5.2 Activities that Could Cause Soil Erosion

To effectively convey controlled discharges from Lake Kennerson around the western side of Lake Foster, the capacity of the existing bypass channel will be increased. During high flows this channel can currently spill into Lake Foster.

The bypass channel will be enlarged by increasing the channel's eastern side batter's freeboard. Inert fill material (soil and/or spoil) from the mine will be utilised to fill the existing low point between the bypass channel and Lake Foster (refer Photo C5.1). The enlargement of the bypass channel has the potential to create sedimentation problems.

Photo C5.1 Low point between the bypass channel and Lake Foster

C5.3 Measures to Minimise Erosion

All disturbed areas will be revegetated at the cessation of earthworks.

C5.4 Sediment Control Structures

Sediment filter fencing will be erected in this area during the importation and shaping of the fill material to prevent downstream sedimentation from the necessary earthworks.

C6. RESPONSE PLANS

C6.1 Surface Water Response Plans

The procedure to be followed in the event of unforeseen surface 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 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 DWE, DECC and/or DPI-Minerals as appropriate.
4. A response/mitigation plan will be implemented to the satisfaction of DWE, DECC and/or DPI-Minerals.

C6.2 Groundwater Response Plan

The procedure to be followed in the event of significant unforeseen variances from the predicted inflow rates and/or groundwater level impacts:

1. Additional sampling and/or water level measurements will be taken to confirm the variance from expected behaviour.
2. Immediate referral to a competent hydrogeologist for assessment of the significance of the variance from expected behaviour. The review hydrogeologist would be requested to recommend an appropriate remedial action plan or amendment to the mining or water management approach. If appropriate, this recommended action plan would be discussed with DNR and other agencies for endorsement.

C7. DISPOSAL OF TAILINGS AND COARSE REJECTS

C7.1 Condition of Consent No. 34 - Disposal of Tailings and Coarse Reject

The Proponent shall ensure that the:

(f) fine tailings generated by the project are disposed of within existing underground workings or open cut pits on the Bloomfield site; and

(g) coarse rejects generated by the project are disposed of within existing open cut pits on the Bloomfield site, to the satisfaction of the D-G.

C7.2 Production of Coarse Rejects and Fine Tailings

During the coal washing process, waste coal material is produced in solid and more liquid (slurry) form. The solid material is termed coarse reject. The slurry material, a mixture of fine waste and water, is termed tailings.

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

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

Table C7.1 summarises the projected tonnages of ROM, coarse rejects and fine tailings expected to be produced during the life of the project together with the estimated cumulative volume that will be filled in the various voids.

Table C7.1: Projected Coal Production and Tailings Disposal Volumes

Year	Total ROM (t x 1000)	Coarse Rejects (t x 1,000)	Fine Tailings (t x 1,000)	Disposal Cum'ive (m^3 x 1,000)
2010	4,225	667	458	5,250
2015	5,900	780	520	10,460
2020	5,000	672	448	15,660
2027	1,500	252	168	20,150

C7.3 Disposal of Coarse Rejects and Fine Tailings

Bloomfield CHPP coarse reject material is currently mixed with overburden material and placed back into open cut pits. It is proposed to continue this process, which assists in filling voids in preparation for surface rehabilitation, including revegetation.

Between 2003 and early 2007, fine tailings were pumped into the former underground workings at Bloomfield Colliery. Currently all tailings is pumped to a partially filled remnant void; the U Cut. Supernatant water from the settled tailings flows to an adjacent small storage from which it is pumped to Lake Foster.

Table C7.2 summarises the available volumes for disposal of coarse rejects and fine tailings within remnant voids and in the subsequent overtopping of voids within the Bloomfield Mine area.

Table C7.2: Estimated Available Volumes for Rejects and Tailings Disposal

Location	**Volume (m^3 x 10^6)**		
	Void	**Above Ground**	**Total**
U North open cut void	1.9	3.5	5.1
U South open cut void	0.8	3.0	3.8
Creek Cut void	5.3	2.0	7.3
S Cut void (final)	8.8	2.7	11.5
Total	**16.8**	**11.2**	**27.7**

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

The data in **Table C7.2** shows that the available void space of about 28 million cubic metres, is more than sufficient to accommodate the expected volume generated by the operation of the CHPP (20 million cubic metres – see **Table C7.1**).

C7.4 Rehabilitation of Tailings Dumps

As described above, it is proposed to fill former open cut voids within Bloomfield Mine area with coarse rejects and fine tailings from the coal washing process. This will assist in filling and rehabilitating these areas. Rehabilitation will be undertaken in accordance with DPI guidelines which, as a condition of the Bloomfield mining lease, require the Bloomfield Mine Operations Plan to provide details on proposed outcomes to be achieved through rehabilitation and final landform. Dewatering of these tailings areas will continue to be undertaken in accordance with current methods, which include the pumping of excess water back to the washery for settling and reuse, and the covering of dewatered areas with soil, landform shaping and seeding for tree cover.

As the final stage of rehabilitation, all reshaped areas will be trimmed to facilitate surface water drainage, deep ripped and rock raked. Harvested rock will be utilised to line waterways or mounded within designated woodland areas to provide habitat features. Soil conservation works will be incorporated into the final design to ensure that water is directed into the adjacent watercourses via suitable drains, graded banks and sediment control structures.

Due to a topsoil deficit in the vicinity of U Cut, reshaped areas will not be topsoiled. Instead, biosolids will be used to topdress the reshaped landform. Treated areas will be contour harrowed and direct seeded with a pasture and native tree species mix.

During final rehabilitation, the rejects emplacement areas will be seeded with pasture only to reduce the risk of exposure and subsurface combustion.

DONALDSON COAL

Abel Coal Project

Water Management Plan

Appendices

DONALDSON COAL

Appendix 1

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
Maximum value	2100	600	2600	905	380	1240	1800	2930	3200	1751

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	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
Minimum value	53	21	7	0	0	0	0	0	0	9
10% Percentile	54	28	17	0	0	0	0	0	0	11

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	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
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

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	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
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

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
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)										
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

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	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
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

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	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
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

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	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
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

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
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										
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

Table 1-1: Groundwater Quality Data - Statistical Summary

			Bore	C062A	C062B	C072A	C072B	C078A	C078B	C081B	C082	C087
			No of samples	1	1	0	1	1	1	1	1	1
				Abel	Abel	Abel	Abel	Abel	Abel	Abel	Abel	Abel
Parameter	Units	LOR	ANZECC (2000) Guideline Value for	27-May-06	30-May-06		20-Mar-06	02-Jan-00	30-May-06	20-Mar-06	20-Mar-06	29-May-06
pH Value		0.01		7.26	6.64		7.19	6.94	7.23	7.36	12.20	11.90
pH (insitu)												
Sodium Adsorption Ratio				2.48	34.02		12.59	10.91	34.65	35.86	22.59	28.94
Conductivity @ 25°C	µS/cm	1		904	10200		3800	3140	23400	10300	2770	3220
Conductivity (insitu)	µS/cm											
Total Dissolved Solids (TDS)	mg/L	1		518	8890		2460	2070	13000	7440	2230	1980
Total Suspended Solids (TSS)	mg/L											
Hardness (calculations)												
Calcium	mg/L	1		21.0	68.0		103.0	109.0	163.0	70.0	27.0	42.0
Magnesium	mg/L	1		34.0	266.0		73.0	72.0	499.0	137.0	1.0	1.0
Sodium	mg/L	1		79.0	2780.0		683.0	598.0	3950.0	2240.0	439.0	681.0
Potassium	mg/L	1		40.0	33.0		16.0	12.0	45.0	45.0	8.0	24.0
Hydroxide Alk as $CaCO_3$	mg/L	1		<1	1.0		1.0	1.0	1.0	1.0	146.0	87.0
Carbonate Alk as $CaCO_3$	mg/L	1		<1	1.0		1.0	1.0	1.0	1.0	119.0	88.0
Bicarbonate Alk as $CaCO_3$	mg/L	1		249.0	686.0		539.0	515.0	1220.0	1210.0	265.0	1.0
Alkalinity (total)	mg/L											
Sulphate	mg/L	1		62.0	888.0		160.0	84.0	1070.0	46.0	323.0	235.0
Chloride	mg/L	1		92.2	4620.0		1100.0	1010.0	6970.0	3550.0	388.0	930.0
Flourides	mg/L											
CaCO3 Saturation Index												
Aluminium - Filtered	mg/L	0.1/0.01	0.055				0.010			0.010	1.460	
Arsenic - Filtered	mg/L	0.01/0.001	0.013				0.00100			0.01100	0.00600	
Barium - Filtered	mg/L	0.01										
Cadmium - Filtered	mg/L	0.005/0.0001	0.0002				0.00010			0.00010	0.00010	
Chromium - Filtered	mg/L	0.01/0.001	ID				0.00200			0.00100	0.00200	
Cobalt - Filtered	mg/L	0.01										
Copper - Filtered	mg/L	0.01/0.001	0.0014				0.00100			0.00100	0.00400	
Lead - Filtered	mg/L	0.01/0.001	0.0034				0.00100			0.00100	0.00100	
Manganese - Filtered	mg/L	0.01	1.9				1.29000			0.53900	0.00100	
Nickel - Filtered	mg/L	0.01/0.001	0.011				0.00800			0.00300	0.00600	
Selenium - Filtered	mg/L	0.01	0.005				0.01000			0.01000	0.01000	
Silver - Filtered	mg/L	0.001	0.00005				0.00100			0.00100	0.00100	
Zinc - Filtered	mg/L	0.01/0.001	0.008				0.006			0.005	0.005	
Boron - Filtered	mg/L	0.1/0.01	0.37				0.12000			0.99000	0.07000	
Iron - Filtered	mg/L	0.1	ID				1.56			2.13	0.05	
Mercury - Filtered	mg/L	0.0001	0.00006				0.0001			0.0001	0.0001	
Ammonia as N	mg/L	0.01	0.9				0.283			4.02	13.4	
Nitrite as N	mg/L	0.01					0.01			0.01	0.042	
Nitrate as N	mg/L	0.01	0.7				0.085			0.01	0.116	
Total Kjeldahl Nitrogen as N	mg/L	0.1					3.3			7.2	15	
Total Phosphorus as P	mg/L	0.01					0.04			0.23	0.14	
Reactive Phosphorus as P	mg/L	0.01					0.034			0.035	0.029	
Total Cations (reported)	meq/L	0.01		8.24	162		41.2	40.5	243		21.6	34.6
Total Anions (reported)	meq/L	0.01		8.3	147		45.1	37.7	222		23	32.4
Anion-Cation Difference (reported)	meq/L	0.01		0.38%	4.93%		4.47%	3.59%	4.58%		3.06%	3.40%
Allowable Anion-Cation Difference (reptd)	meq/L	0.01		2.00%	5.00%		5.00%	5.00%	5.00%		5.00%	5.00%
Anion-Cation Difference (reported)	%											
Allowable Anion-Cation Difference (reptd)	%											
Total Cations (calculated)	meq/L	0.01		8.30	147.05		41.26	37.68	222.16	114.00	20.73	32.33
Total Anions (calculated)	meq/L	0.01		8.87	162.53		45.13	40.53	243.28	125.00	22.97	31.13
% Difference (calculated)	%	0.01		-3.28%	-5.00%		-4.48%	-3.64%	-4.54%	4.88%	-5.12%	1.90%
Allowed % Difference (calculated)	%	0.01		2.00%	2.00%		2.00%	2.00%	2.00%	2.00%	5.00%	2.00%

Table 1-1: Groundwater Quality Data - Statistical Summary

			Bore	DPZ-1			DPZ-2			DPZ-3			DPZ-4@25m		
			No of samples	61			5			78			22		
				Donaldson			Donaldson			Donaldson			Donaldson		
Parameter	**Units**	**LOR**	**ANZECC (2000) Guideline Value for**	**MIN**	**MEAN**	**MAX**	**MIN**	**MEAN**	**MAX**	**MIN**	**MEAN**	**MAX**	**MIN**	**MEAN**	**MAX**
pH Value		**0.01**		5.04	5.88	6.30	5.92	6.20	6.46	5.70	6.64	7.07	2.85	3.74	4.80
pH (insitu)				5.14	5.74	6.24	5.47	5.95	6.41	5.80	6.51	7.70	2.40	3.61	4.60
Sodium Adsorption Ratio															
Conductivity @ 25°C	µS/cm	**1**		1290	1504	1780	3950	5596	6370	285	8653	17500	2230	3481	5210
Conductivity (insitu)	µS/cm			1260	1507	1880	3900	5536	6500	170	8623	14530	2090	3557	5360
Total Dissolved Solids (TDS)	mg/L	**1**		755	878	1110	2130	3096	3530	180	5806	11000	250	2080	3550
Total Suspended Solids (TSS)	mg/L			69	467	1427	192	799	2640	15	520	3670	99	309	982
Hardness (calculations)															
Calcium	mg/L	**1**		10.0	12.3	14.0	6.1	8.1	10.0	0.0	149.8	240.0	4.5	5.8	7.0
Magnesium	mg/L	**1**		19.0	23.0	27.0	32.0	52.5	73.0	0.4	272.4	500.0	55.0	57.0	59.0
Sodium	mg/L	**1**		230.0	252.5	270.0	693.0	831.5	970.0	890.0	1744.4	2550.0	380.0	390.0	400.0
Potassium	mg/L	**1**		6.1	7.1	8.6	14.0	17.5	21.0	21.0	43.2	69.0	16.0	16.0	16.0
Hydroxide Alk as $CaCO_3$	mg/L	**1**													
Carbonate Alk as $CaCO_3$	mg/L	**1**													
Bicarbonate Alk as $CaCO_3$	mg/L	**1**													
Alkalinity (total)	mg/L			56.0	101.5	150.0	120.0	200.0	280.0	270.0	815.3	1050.0			
Sulphate	mg/L	**1**		60.0	139.8	285.0	130.0	150.4	190.0	25.0	417.4	4960.0	3.0	95.2	250.0
Chloride	mg/L	**1**		319.0	347.5	390.0	1071.0	1450.0	1829.0	1269.0	3287.7	4430.0	744.0	854.0	964.0
Flourides	mg/L			0.6	0.7	1.0	1.5	1.8	2.1	0.6	1.1	2.1	0.1	0.2	0.4
CaCO3 Saturation Index															
Aluminium - Filtered	mg/L	**0.1/0.01**	**0.055**	0.690	19.173	50.000	1.400	21.200	41.000	0.180	4.489	44.000	3.900	7.050	10.200
Arsenic - Filtered	mg/L	**0.01/0.001**	**0.013**	0.00500	0.00775	0.01200	0.00100	0.01150	0.02200	0.00100	0.00615	0.01800	0.01100	0.01300	0.01500
Barium - Filtered	mg/L	**0.01**		0.15000	0.22750	0.31000	0.08200	0.19600	0.31000	0.03800	0.09529	0.25000	0.35000	0.77500	1.20000
Cadmium - Filtered	mg/L	**0.005/0.0001**	**0.0002**	<0.00005	0.00020	0.00035	-0.00100	-0.00018	0.00065	0.00001	13.52961	230.00000	0.00100	0.00120	0.00140
Chromium - Filtered	mg/L	**0.01/0.001**	**ID**	0.01000	0.02525	0.06700	0.00200	0.02900	0.05600	0.00100	0.01359	0.07600	0.00800	0.01100	0.01400
Cobalt - Filtered	mg/L	**0.01**		0.00100	0.00718	0.01600	0.00480	0.01690	0.02900	0.00100	0.00508	0.01900	0.04700	0.24850	0.45000
Copper - Filtered	mg/L	**0.01/0.001**	**0.0014**	0.00760	0.01675	0.03400	0.00450	0.03225	0.06000	0.00200	0.00821	0.03300	0.01400	0.01750	0.02100
Lead - Filtered	mg/L	**0.01/0.001**	**0.0034**	0.01000	0.06050	0.11000	0.24000	0.58500	0.93000	0.00110	0.01112	0.07700	0.04300	0.08150	0.12000
Manganese - Filtered	mg/L	**0.01**	**1.9**	0.15000	0.22750	0.31000	0.68000	1.09000	1.50000	0.26000	0.41235	0.70000	0.40000	1.60000	2.80000
Nickel - Filtered	mg/L	**0.01/0.001**	**0.011**												
Selenium - Filtered	mg/L	**0.01**	**0.005**	0.00100	0.00100	0.00100									
Silver - Filtered	mg/L	**0.001**	**0.00005**												
Zinc - Filtered	mg/L	**0.01/0.001**	**0.008**	0.05000	0.12175	0.20000	0.100	0.240	0.380	0.005	0.107	0.990	0.250	2.025	3.800
Boron - Filtered	mg/L	**0.1/0.01**	**0.37**												
Iron - Filtered	mg/L	**0.1**	**ID**	4.70	13.70	25.00	8.60	36.30	64.00	0.89	7.44	36.00	4.90	25.95	47.00
Mercury - Filtered	mg/L	**0.0001**	**0.00006**												
Ammonia as N	mg/L	**0.01**	**0.9**												
Nitrite as N	mg/L	**0.01**													
Nitrate as N	mg/L	**0.01**	**0.7**												
Total Kjeldahl Nitrogen as N	mg/L	**0.1**													
Total Phosphorus as P	mg/L	**0.01**													
Reactive Phosphorus as P	mg/L	**0.01**													
Total Cations (reported)	meq/L	**0.01**													
Total Anions (reported)	meq/L	**0.01**													
Anion-Cation Difference (reported)	meq/L	**0.01**													
Allowable Anion-Cation Difference (reptd)	meq/L	**0.01**													
Anion-Cation Difference (reported)	%														
Allowable Anion-Cation Difference (reptd)	%														
Total Cations (calculated)	meq/L	**0.01**													
Total Anions (calculated)	meq/L	**0.01**													
% Difference (calculated)	%	**0.01**													
Allowed % Difference (calculated)	%	**0.01**													

Table 1-1: Groundwater Quality Data - Statistical Summary

			Bore		DPZ-4@50m			DPZ-5			DPZ-6			DPZ-7@25	
			No of samples		35			74			9			79	
					Donaldson			Donaldson			Donaldson			Donaldson	
Parameter	Units	LOR	ANZECC (2000) Guideline Value for	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX
pH Value		0.01		3.20	5.79	6.23	5.30	6.27	7.80	5.60	5.72	6.10	5.10	5.92	6.70
pH (insitu)				3.00	5.58	6.30	5.30	6.27	8.70	5.40	5.67	6.00	5.36	5.95	6.90
Sodium Adsorption Ratio															
Conductivity @ 25°C	µS/cm	1		26	2161	4120	16	3736	9450	3450	3541	3670	220	2085	2400
Conductivity (insitu)	µS/cm			950	2231	4060	380	3874	10000	3220	3493	3810	1280	2110	2440
Total Dissolved Solids (TDS)	mg/L	1		505	1273	2690	240	2389	5690	1990	2096	2200	110	1162	1410
Total Suspended Solids (TSS)	mg/L			33	1070	5128	4	805	11850	129	1074	4910	23	231	983
Hardness (calculations)															
Calcium	mg/L	1		3.1	5.8	8.3	0.0	76.5	160.0	12.0	14.7	17.0	0.0	16.1	25.0
Magnesium	mg/L	1		15.0	29.5	66.0	15.0	132.2	250.0	48.0	50.7	52.0	23.0	29.6	45.0
Sodium	mg/L	1		290.0	332.5	420.0	210.0	975.0	1700.0	570.0	623.0	680.0	230.0	324.1	380.0
Potassium	mg/L	1		7.2	10.2	17.0	6.5	17.6	29.0	16.0	18.7	22.0	7.0	10.6	40.0
Hydroxide Alk as $CaCO_3$	mg/L	1													
Carbonate Alk as $CaCO_3$	mg/L	1													
Bicarbonate Alk as $CaCO_3$	mg/L	1													
Alkalinity (total)	mg/L			-1.0	92.3	140.0	62.0	455.7	750.0	67.0	94.3	134.0	90.0	119.8	152.0
Sulphate	mg/L	1		5.0	55.7	200.0	2.0	137.1	395.0	30.0	43.6	73.0	27.0	57.5	130.0
Chloride	mg/L	1		454.0	576.3	922.0	347.0	1671.4	2446.0	990.0	1050.0	1100.0	63.0	526.6	621.0
Flourides	mg/L			0.1	0.9	1.5	0.5	0.8	1.5	0.7	1.1	1.9	0.1	0.5	1.2
CaCO3 Saturation Index															
Aluminium - Filtered	mg/L	0.1/0.01	0.055	1.300	4.375	9.300	0.560	27.353	240.000	0.270	0.363	0.550	0.110	3.560	21.000
Arsenic - Filtered	mg/L	0.01/0.001	0.013	0.00200	0.00650	0.01400	0.00060	0.00913	0.03400	0.00600	0.03167	0.06500	0.00080	0.00173	0.00500
Barium - Filtered	mg/L	0.01		0.07300	0.62825	2.20000	0.00720	0.14395	0.80000	0.17000	0.39000	0.74000	0.11000	0.16313	0.36000
Cadmium - Filtered	mg/L	0.005/0.0001	0.0002	0.00011	0.00028	0.00036	0.00005	5.31300	85.00000	0.00005	0.00018	0.00035	0.00005	0.81265	13.00000
Chromium - Filtered	mg/L	0.01/0.001	ID	0.00300	0.00675	0.01200	0.00200	0.04344	0.35000	0.00400	0.01133	0.02200	0.00100	0.00688	0.03100
Cobalt - Filtered	mg/L	0.01		0.00030	0.01333	0.04900	0.00022	0.02514	0.18000	0.06600	0.15867	0.30000	0.00030	0.00308	0.00870
Copper - Filtered	mg/L	0.01/0.001	0.0014	0.00400	0.01133	0.01800	0.00300	0.10331	0.63000	0.00300	0.01467	0.03000	0.00100	0.00865	0.02300
Lead - Filtered	mg/L	0.01/0.001	0.0034	0.00640	0.06285	0.16000	0.00190	0.03954	0.24000	0.03200	0.10400	0.16000	0.00250	0.90860	14.00000
Manganese - Filtered	mg/L	0.01	1.9	0.27000	1.07750	3.20000	0.04100	0.63444	2.20000	3.60000	7.43333	13.00000	0.68000	1.89625	18.00000
Nickel - Filtered	mg/L	0.01/0.001	0.011												
Selenium - Filtered	mg/L	0.01	0.005												
Silver - Filtered	mg/L	0.001	0.00005												
Zinc - Filtered	mg/L	0.01/0.001	0.008	0.013	0.113	0.390	0.007	0.151	1.100	0.110	0.200	0.380	0.005	0.027	0.085
Boron - Filtered	mg/L	0.1/0.01	0.37												
Iron - Filtered	mg/L	0.1	ID	10.00	16.50	20.00	2.00	33.94	210.00	110.00	913.33	2200.00	0.18	19.89	31.00
Mercury - Filtered	mg/L	0.0001	0.00006												
Ammonia as N	mg/L	0.01	0.9												
Nitrite as N	mg/L	0.01													
Nitrate as N	mg/L	0.01	0.7												
Total Kjeldahl Nitrogen as N	mg/L	0.1													
Total Phosphorus as P	mg/L	0.01													
Reactive Phosphorus as P	mg/L	0.01													
Total Cations (reported)	meq/L	0.01													
Total Anions (reported)	meq/L	0.01													
Anion-Cation Difference (reported)	meq/L	0.01													
Allowable Anion-Cation Difference (reptd)	meq/L	0.01													
Anion-Cation Difference (reported)	%														
Allowable Anion-Cation Difference (reptd)	%														
Total Cations (calculated)	meq/L	0.01													
Total Anions (calculated)	meq/L	0.01													
% Difference (calculated)	%	0.01													
Allowed % Difference (calculated)	%	0.01													

Table 1-1: Groundwater Quality Data - Statistical Summary

			Bore	DPZ-8			DPZ-9			DPZ-10			DPZ-12		
			No of samples	73			79			77			62		
				Donaldson			Donaldson			Donaldson			Donaldson		
Parameter	**Units**	**LOR**	**ANZECC (2000) Guideline Value for**	**MIN**	**MEAN**	**MAX**	**MIN**	**MEAN**	**MAX**	**MIN**	**MEAN**	**MAX**	**MIN**	**MEAN**	**MAX**
pH Value		0.01		5.00	5.92	6.50	5.70	7.02	7.88	5.70	6.59	7.20	5.70	6.62	7.60
pH (insitu)				5.09	5.97	6.90	5.67	6.85	7.32	5.70	6.48	7.30	6.00	6.55	7.10
Sodium Adsorption Ratio															
Conductivity @ 25°C	µS/cm	1		1530	1872	2230	1360	4728	9590	3080	3577	4090	1820	9453	27900
Conductivity (insitu)	µS/cm			1575	2039	11960	110	5264	47040	2960	3468	4190	2200	9174	25060
Total Dissolved Solids (TDS)	mg/L	1		895	1090	1360	800	2708	5370	1770	2009	2600	1270	6081	14990
Total Suspended Solids (TSS)	mg/L			26	324	3750	25	124	617	9	104	1197	4	468	4212
Hardness (calculations)															
Calcium	mg/L	1		0.0	16.5	24.0	0.0	41.8	70.0	20.0	31.5	48.0	0.0	74.3	152.0
Magnesium	mg/L	1		22.0	31.3	43.0	24.0	60.1	91.0	50.0	62.9	92.0	13.0	278.1	635.0
Sodium	mg/L	1		180.0	267.9	350.0	290.0	731.9	1400.0	460.0	583.8	820.0	260.0	2170.0	3870.0
Potassium	mg/L	1		5.9	10.7	39.0	7.1	18.7	30.0	7.0	12.0	36.0	3.5	23.7	46.0
Hydroxide Alk as $CaCO_3$	mg/L	1													
Carbonate Alk as $CaCO_3$	mg/L	1													
Bicarbonate Alk as $CaCO_3$	mg/L	1													
Alkalinity (total)	mg/L			20.0	86.0	136.0	140.0	534.0	760.0	75.0	364.4	450.0	125.0	606.3	1015.0
Sulphate	mg/L	1		15.0	74.7	167.0	2.0	54.5	464.0	34.0	103.3	925.0	75.0	796.6	3750.0
Chloride	mg/L	1		450.0	491.1	568.0	390.0	1115.3	2480.0	822.0	908.4	1030.0	440.0	3270.9	5960.0
Flourides	mg/L			0.1	0.6	1.7	0.2	0.8	1.7	0.4	0.7	1.9	0.2	1.1	3.1
CaCO3 Saturation Index															
Aluminium - Filtered	mg/L	0.1/0.01	0.055	0.030	3.163	29.000	0.350	1.665	5.600	0.040	2.695	30.000	0.090	20.238	190.000
Arsenic - Filtered	mg/L	0.01/0.001	0.013	0.00100	0.00421	0.02300	0.00050	0.00363	0.00800	0.00060	0.00576	0.01400	0.00100	0.00923	0.07800
Barium - Filtered	mg/L	0.01		0.17000	0.23067	0.41000	0.11000	0.31667	0.98000	0.03600	0.06144	0.20000	0.00710	0.16959	1.10000
Cadmium - Filtered	mg/L	0.005/0.0001	0.0002	-0.00100	0.93334	14.00000	0.00005	2.53370	38.00000	0.00005	6.00035	36.00000	0.00005	4.58373	55.00000
Chromium - Filtered	mg/L	0.01/0.001	ID	0.00100	0.00467	0.02900	0.00001	0.00593	0.01200	0.00060	0.00629	0.04300	0.00100	0.04958	0.33000
Cobalt - Filtered	mg/L	0.01		0.00020	0.00445	0.01900	0.00080	0.00384	0.01400	0.00020	0.00295	0.01100	0.00040	0.02661	0.16000
Copper - Filtered	mg/L	0.01/0.001	0.0014	0.00100	0.00821	0.03900	0.00400	0.01352	0.03700	0.00100	0.06538	0.63000	0.00100	0.03925	0.25000
Lead - Filtered	mg/L	0.01/0.001	0.0034	0.00020	0.00956	0.09700	0.00770	0.08358	0.26000	0.00050	1.08633	14.00000	0.00060	0.08625	0.84000
Manganese - Filtered	mg/L	0.01	1.9	0.30000	0.49067	0.75000	0.11000	0.38200	0.95000	0.16000	0.22250	0.32000	0.03000	0.62358	4.20000
Nickel - Filtered	mg/L	0.01/0.001	0.011												
Selenium - Filtered	mg/L	0.01	0.005										0.00100	0.00143	0.00300
Silver - Filtered	mg/L	0.001	0.00005												
Zinc - Filtered	mg/L	0.01/0.001	0.008	0.005	0.033	0.140	0.016	0.128	0.240	0.00900	0.46600	4.00000	0.00500	0.14042	0.99000
Boron - Filtered	mg/L	0.1/0.01	0.37												
Iron - Filtered	mg/L	0.1	ID	7.30	17.89	32.00	1.10	4.53	11.00	2.00	4.79	25.00	0.76	39.18	310.00
Mercury - Filtered	mg/L	0.0001	0.00006												
Ammonia as N	mg/L	0.01	0.9												
Nitrite as N	mg/L	0.01													
Nitrate as N	mg/L	0.01	0.7												
Total Kjeldahl Nitrogen as N	mg/L	0.1													
Total Phosphorus as P	mg/L	0.01													
Reactive Phosphorus as P	mg/L	0.01													
Total Cations (reported)	meq/L	0.01													
Total Anions (reported)	meq/L	0.01													
Anion-Cation Difference (reported)	meq/L	0.01													
Allowable Anion-Cation Difference (reptd)	meq/L	0.01													
Anion-Cation Difference (reported)	%														
Allowable Anion-Cation Difference (reptd)	%														
Total Cations (calculated)	meq/L	0.01													
Total Anions (calculated)	meq/L	0.01													
% Difference (calculated)	%	0.01													
Allowed % Difference (calculated)	%	0.01													

Table 1-1: Groundwater Quality Data - Statistical Summary

			Bore	DPZ-13			DPZ-14			DPZ-15			DPZ-16		
			No of samples		79 Donaldson			2 Donaldson			10 Donaldson			8 Donaldson	
Parameter	Units	LOR	ANZECC (2000) Guideline Value for	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX
pH Value		0.01		3.91	6.85	7.43	6.50	6.52	6.54	6.43	6.68	6.90	6.36	6.50	6.58
pH (insitu)				6.10	6.74	7.40	6.23	6.26	6.28	6.29	6.51	6.58	5.99	6.20	6.43
Sodium Adsorption Ratio															
Conductivity @ 25°C	µS/cm	1		10350	13285	17300	2520	2625	2730	1520	3805	4740	300	2183	2890
Conductivity (insitu)	µS/cm			10050	12584	14990	2610	2635	2660	1430	3798	4910	290	2181	2780
Total Dissolved Solids (TDS)	mg/L	1		7260	8517	9500	1420	1725	2030	850	2298	2950	165	1271	1650
Total Suspended Solids (TSS)	mg/L			2	21	83	49	116	182	53	3601	22100	37	60	90
Hardness (calculations)															
Calcium	mg/L	1		0.0	111.4	150.0				84.0	92.0	100.0	17.0	19.0	21.0
Magnesium	mg/L	1		190.0	313.9	420.0				61.0	69.0	77.0	23.0	26.0	29.0
Sodium	mg/L	1		1500.0	2395.6	3300.0				610.0	805.0	1000.0	430.0	465.0	500.0
Potassium	mg/L	1		22.0	33.0	48.0				17.0	22.0	27.0	12.0	12.5	13.0
Hydroxide Alk as $CaCO_3$	mg/L	1													
Carbonate Alk as $CaCO_3$	mg/L	1													
Bicarbonate Alk as $CaCO_3$	mg/L	1													
Alkalinity (total)	mg/L			525.0	890.3	960.0				510.0	530.0	550.0	310.0	370.0	430.0
Sulphate	mg/L	1		19.0	563.0	1175.0	72.0	73.5	75.0	84.0	228.1	305.0	8.0	69.0	107.0
Chloride	mg/L	1		3900.0	4241.3	4700.0				1248.0	1264.0	1280.0	625.0	667.5	710.0
Flourides	mg/L			0.6	1.0	2.4				0.5	0.7	1.0	0.3	0.6	1.0
CaCO3 Saturation Index															
Aluminium - Filtered	mg/L	0.1/0.01	0.055	0.020	0.248	1.700				0.720	285.360	570.000	0.920	2.460	4.000
Arsenic - Filtered	mg/L	0.01/0.001	0.013	0.00020	0.00476	0.01800				0.00070	0.00935	0.01800	0.00300	0.00300	0.00300
Barium - Filtered	mg/L	0.01		0.01500	0.04131	0.11000				0.03200	0.20600	0.38000	0.04900	0.05150	0.05400
Cadmium - Filtered	mg/L	0.005/0.0001	0.0002	-0.00005	8.12521	130.00000				0.00005	0.00068	0.00130	0.00005	0.00015	0.00024
Chromium - Filtered	mg/L	0.01/0.001	ID	0.00100	0.00488	0.01600				0.00200	0.12100	0.24000	0.00200	0.00300	0.00400
Cobalt - Filtered	mg/L	0.01		0.00030	0.00355	0.02400				0.00220	0.19110	0.38000	0.00240	0.00555	0.00870
Copper - Filtered	mg/L	0.01/0.001	0.0014	0.00200	0.00656	0.04200				0.00130	0.07565	0.15000	0.00440	0.00970	0.01500
Lead - Filtered	mg/L	0.01/0.001	0.0034	0.00020	0.00828	0.07800				0.00300	0.05050	0.09800	0.01300	0.12650	0.24000
Manganese - Filtered	mg/L	0.01	1.9	0.02000	0.19250	0.38000				0.20000	0.37500	0.55000	0.23000	0.33500	0.44000
Nickel - Filtered	mg/L	0.01/0.001	0.011												
Selenium - Filtered	mg/L	0.01	0.005	0.00100	0.00129	0.00300									
Silver - Filtered	mg/L	0.001	0.00005												
Zinc - Filtered	mg/L	0.01/0.001	0.008	0.00100	0.02738	0.17000				0.001	0.341	0.680	0.033	0.049	0.064
Boron - Filtered	mg/L	0.1/0.01	0.37												
Iron - Filtered	mg/L	0.1	ID	0.99	1.57	3.50				5.20	52.60	100.00	2.50	3.75	5.00
Mercury - Filtered	mg/L	0.0001	0.00006												
Ammonia as N	mg/L	0.01	0.9												
Nitrite as N	mg/L	0.01													
Nitrate as N	mg/L	0.01	0.7												
Total Kjeldahl Nitrogen as N	mg/L	0.1													
Total Phosphorus as P	mg/L	0.01													
Reactive Phosphorus as P	mg/L	0.01													
Total Cations (reported)	meq/L	0.01													
Total Anions (reported)	meq/L	0.01													
Anion-Cation Difference (reported)	meq/L	0.01													
Allowable Anion-Cation Difference (reptd)	meq/L	0.01													
Anion-Cation Difference (reported)	%														
Allowable Anion-Cation Difference (reptd)	%														
Total Cations (calculated)	meq/L	0.01													
Total Anions (calculated)	meq/L	0.01													
% Difference (calculated)	%	0.01													
Allowed % Difference (calculated)	%	0.01													

Table 1-1: Groundwater Quality Data - Statistical Summary

			Bore No of samples	DPZ-17(24m) 10 Donaldson			DPZ-17(38.05m) 10 Donaldson			DPZ-17(62M) 64 Donaldson			DPZ-18(72m) 12 Donaldson		
Parameter	**Units**	**LOR**	**ANZECC (2000) Guideline Value for**	**MIN**	**MEAN**	**MAX**	**MIN**	**MEAN**	**MAX**	**MIN**	**MEAN**	**MAX**	**MIN**	**MEAN**	**MAX**
pH Value		**0.01**		5.88	6.03	6.19	5.64	5.97	6.18	5.20	6.67	9.10	5.69	5.98	6.30
pH (insitu)				3.20	5.71	6.23	5.79	6.03	6.24	5.60	66.73	3800.00	5.74	6.44	8.00
Sodium Adsorption Ratio															
Conductivity @ 25°C	µS/cm	**1**		1230	1492	1850	1240	1435	1640	528	2876	5300	190	1235	1840
Conductivity (insitu)	µS/cm			955	1485	1950	1160	1471	1720	1010	2925	6240	125	1269	2010
Total Dissolved Solids (TDS)	mg/L	**1**		685	877	1100	720	854	990	107	1659	3150	110	708	1060
Total Suspended Solids (TSS)	mg/L			119	364	760	94	291	782	7	176	818	46	556	1252
Hardness (calculations)															
Calcium	mg/L	**1**		3.2	12.6	22.0	2.6	8.3	14.0	0.0	55.1	100.0	4.3	14.7	32.0
Magnesium	mg/L	**1**		11.0	17.5	24.0	10.0	15.5	21.0	7.0	49.0	89.0	5.1	14.7	23.0
Sodium	mg/L	**1**		260.0	280.0	300.0	250.0	260.0	270.0	140.0	553.1	1000.0	42.0	207.3	310.0
Potassium	mg/L	**1**		6.6	6.7	6.7	6.4	6.6	6.8	5.6	14.9	24.0	4.0	7.8	11.0
Hydroxide Alk as $CaCO_3$	mg/L	**1**													
Carbonate Alk as $CaCO_3$	mg/L	**1**													
Bicarbonate Alk as $CaCO_3$	mg/L	**1**													
Alkalinity (total)	mg/L			100.0	120.0	140.0	50.0	79.5	109.0	90.0	434.6	680.0	14.0	68.0	125.0
Sulphate	mg/L	**1**		23.0	63.9	147.0	21.0	55.3	125.0	1.0	61.0	280.0	2.0	44.2	140.0
Chloride	mg/L	**1**		362.0	401.0	440.0	369.0	426.0	483.0	227.0	786.0	1240.0	82.0	353.7	525.0
Flourides	mg/L			0.4	0.7	1.0	0.3	0.7	1.1	0.2	0.7	1.7	0.0	0.5	0.9
CaCO3 Saturation Index															
Aluminium - Filtered	mg/L	**0.1/0.01**	**0.055**	6.700	8.100	9.500	3.300	3.900	4.500	0.470	2.391	12.000	2.900	7.300	15.000
Arsenic - Filtered	mg/L	**0.01/0.001**	**0.013**	0.00300	0.00400	0.00500	0.00300	0.00300	0.00300	0.00100	0.00265	0.00500	0.00280	0.00560	0.00800
Barium - Filtered	mg/L	**0.01**		0.07500	0.09750	0.12000	0.04300	0.07650	0.11000	0.05100	0.12346	0.21000	0.08700	0.15567	0.28000
Cadmium - Filtered	mg/L	**0.005/0.0001**	**0.0002**	0.00021	0.00023	0.00025	0.00007	0.00012	0.00017	0.00005	6.00017	78.00000	0.00009	0.00035	0.00061
Chromium - Filtered	mg/L	**0.01/0.001**	**ID**	0.00900	0.01050	0.01200	0.00400	0.00450	0.00500	0.00300	0.00686	0.01400	0.00600	0.01100	0.01700
Cobalt - Filtered	mg/L	**0.01**		0.00870	0.01085	0.01300	0.00070	0.00180	0.00290	0.00120	0.00347	0.00740	0.00160	0.00657	0.01200
Copper - Filtered	mg/L	**0.01/0.001**	**0.0014**	0.01400	0.01800	0.02200	0.00720	0.00860	0.01000	0.00130	0.01641	0.04300	0.00650	0.02250	0.03700
Lead - Filtered	mg/L	**0.01/0.001**	**0.0034**	0.31000	0.42500	0.54000	0.12000	0.20000	0.28000	0.02400	0.14992	0.63000	0.04300	0.48100	1.00000
Manganese - Filtered	mg/L	**0.01**	**1.9**	0.22000	0.29000	0.36000	0.18000	0.36000	0.54000	0.14000	0.68769	1.50000	0.32000	0.64667	1.20000
Nickel - Filtered	mg/L	**0.01/0.001**	**0.011**												
Selenium - Filtered	mg/L	**0.01**	**0.005**												
Silver - Filtered	mg/L	**0.001**	**0.00005**												
Zinc - Filtered	mg/L	**0.01/0.001**	**0.008**	0.110	0.120	0.130	0.034	0.072	0.110	0.041	0.179	0.440	0.052	0.191	0.420
Boron - Filtered	mg/L	**0.1/0.01**	**0.37**												
Iron - Filtered	mg/L	**0.1**	**ID**	0.17	6.59	13.00	9.90	11.95	14.00	2.20	7.88	16.00	14.00	15.67	19.00
Mercury - Filtered	mg/L	**0.0001**	**0.00006**												
Ammonia as N	mg/L	**0.01**	**0.9**												
Nitrite as N	mg/L	**0.01**													
Nitrate as N	mg/L	**0.01**	**0.7**												
Total Kjeldahl Nitrogen as N	mg/L	**0.1**													
Total Phosphorus as P	mg/L	**0.01**													
Reactive Phosphorus as P	mg/L	**0.01**													
Total Cations (reported)	meq/L	**0.01**													
Total Anions (reported)	meq/L	**0.01**													
Anion-Cation Difference (reported)	meq/L	**0.01**													
Allowable Anion-Cation Difference (reptd)	meq/L	**0.01**													
Anion-Cation Difference (reported)	%														
Allowable Anion-Cation Difference (reptd)	%														
Total Cations (calculated)	meq/L	**0.01**													
Total Anions (calculated)	meq/L	**0.01**													
% Difference (calculated)	%	**0.01**													
Allowed % Difference (calculated)	%	**0.01**													

Table 1-1: Groundwater Quality Data - Statistical Summary

			Bore		**DPZ-18(90m)**			**DPZ-19(56m)**			**DPZ-19(73m)**			**DPZ20**	
			No of samples		**9** Donaldson			**7** Donaldson			**7** Donaldson			**7** Donaldson	
Parameter	**Units**	**LOR**	**ANZECC (2000) Guideline Value for**	**MIN**	**MEAN**	**MAX**	**MIN**	**MEAN**	**MAX**	**MIN**	**MEAN**	**MAX**	**MIN**	**MEAN**	**MAX**
pH Value		**0.01**		5.80	6.27	6.62	5.86	6.17	6.48	6.17	6.40	6.54	4.50	5.57	6.20
pH (insitu)				6.07	6.36	7.00	5.80	6.13	6.51	6.19	6.35	6.50	5.50	5.84	6.30
Sodium Adsorption Ratio															
Conductivity @ 25°C	µS/cm	**1**		170	1671	2010	1650	2131	2730	2080	2319	2530	4060	4597	5000
Conductivity (insitu)	µS/cm			185	1676	2050	1566	2105	2560	1900	2223	2460	4350	4641	4800
Total Dissolved Solids (TDS)	mg/L	**1**		115	1005	1210	980	1284	1560	1310	1386	1470	2930	3193	3530
Total Suspended Solids (TSS)	mg/L			94	376	916	118	389	788	33	190	412	112	747	2910
Hardness (calculations)															
Calcium	mg/L	**1**		40.0	41.5	43.0	19.0	39.0	59.0	50.0	52.0	54.0	34.0	59.5	85.0
Magnesium	mg/L	**1**		24.0	24.5	25.0	24.0	30.0	36.0	33.0	33.0	33.0	110.0	118.0	126.0
Sodium	mg/L	**1**		280.0	285.0	290.0	320.0	350.0	380.0	330.0	335.0	340.0	568.0	634.0	700.0
Potassium	mg/L	**1**		8.4	8.7	8.9	11.0	11.0	11.0	9.8	9.9	9.9	18.0	18.5	19.0
Hydroxide Alk as $CaCO_3$	mg/L	**1**													
Carbonate Alk as $CaCO_3$	mg/L	**1**													
Bicarbonate Alk as $CaCO_3$	mg/L	**1**													
Alkalinity (total)	mg/L			155.0	195.0	235.0	130.0	160.0	190.0	180.0	217.5	255.0	81.0	110.5	140.0
Sulphate	mg/L	**1**		1.0	52.9	122.0	37.0	73.0	122.0	17.0	64.1	105.0	60.0	77.0	105.0
Chloride	mg/L	**1**		483.0	507.5	532.0	518.0	592.5	667.0	639.0	656.5	674.0	1420.0	1445.0	1470.0
Flourides	mg/L			0.5	0.5	0.6	0.6	0.7	0.8	0.4	0.5	0.6	0.6	0.9	1.2
CaCO3 Saturation Index															
Aluminium - Filtered	mg/L	**0.1/0.01**	**0.055**	2.300	2.500	2.700	8.100	12.550	17.000	4.000	5.600	7.200	1.800	1.900	2.000
Arsenic - Filtered	mg/L	**0.01/0.001**	**0.013**	0.00400	0.00400	0.00400	0.00400	0.00550	0.00700	0.00500	0.00500	0.00500	0.00300	0.00450	0.00600
Barium - Filtered	mg/L	**0.01**		0.12000	0.12500	0.13000	0.19000	0.24500	0.30000	0.12000	0.14500	0.17000	0.43000	0.45000	0.47000
Cadmium - Filtered	mg/L	**0.005/0.0001**	**0.0002**	0.00011	0.00016	0.00021	0.00031	0.00057	0.00083	0.00013	0.00025	0.00036	0.00005	0.00010	0.00015
Chromium - Filtered	mg/L	**0.01/0.001**	**ID**	0.00700	0.00750	0.00800	0.01100	0.01300	0.01500	0.00900	0.01000	0.01100	0.00300	0.00400	0.00500
Cobalt - Filtered	mg/L	**0.01**		0.00160	0.00160	0.00160	0.00560	0.01030	0.01500	0.00510	0.00610	0.00710	0.01700	10.00850	20.00000
Copper - Filtered	mg/L	**0.01/0.001**	**0.0014**	0.00760	0.00810	0.00860	0.02100	0.03400	0.04700	0.00740	0.01520	0.02300	0.00400	0.00500	0.00600
Lead - Filtered	mg/L	**0.01/0.001**	**0.0034**	0.36000	0.36500	0.37000	0.33000	0.62500	0.92000	0.36000	0.47500	0.59000	0.01500	0.09750	0.18000
Manganese - Filtered	mg/L	**0.01**	**1.9**	0.59000	0.66500	0.74000	0.41000	1.00500	1.60000	0.55000	0.64000	0.73000	2.50000	2.65000	2.80000
Nickel - Filtered	mg/L	**0.01/0.001**	**0.011**												
Selenium - Filtered	mg/L	**0.01**	**0.005**												
Silver - Filtered	mg/L	**0.001**	**0.00005**												
Zinc - Filtered	mg/L	**0.01/0.001**	**0.008**	0.064	0.092	0.120	0.170	0.295	0.420	0.054	0.137	0.220	0.035	0.037	0.038
Boron - Filtered	mg/L	**0.1/0.01**	**0.37**												
Iron - Filtered	mg/L	**0.1**	**ID**	10.00	10.95	11.90	10.20	12.60	15.00	5.20	5.50	5.80	0.06	12.03	24.00
Mercury - Filtered	mg/L	**0.0001**	**0.00006**												
Ammonia as N	mg/L	**0.01**	**0.9**												
Nitrite as N	mg/L	**0.01**													
Nitrate as N	mg/L	**0.01**	**0.7**												
Total Kjeldahl Nitrogen as N	mg/L	**0.1**													
Total Phosphorus as P	mg/L	**0.01**													
Reactive Phosphorus as P	mg/L	**0.01**													
Total Cations (reported)	meq/L	**0.01**													
Total Anions (reported)	meq/L	**0.01**													
Anion-Cation Difference (reported)	meq/L	**0.01**													
Allowable Anion-Cation Difference (reptd)	meq/L	**0.01**													
Anion-Cation Difference (reported)	%														
Allowable Anion-Cation Difference (reptd)	%														
Total Cations (calculated)	meq/L	**0.01**													
Total Anions (calculated)	meq/L	**0.01**													
% Difference (calculated)	%	**0.01**													
Allowed % Difference (calculated)	%	**0.01**													

Table 1-1: Groundwater Quality Data - Statistical Summary

			Bore	FMCPZ-1			FMCPZ-1@24m			FMCPZ-2			FMCPZ-2@15M		
			No of samples	73			3			73			4		
				Donaldson			Donaldson			Donaldson			Donaldson		
Parameter	**Units**	**LOR**	**ANZECC (2000) Guideline Value for**	**MIN**	**MEAN**	**MAX**	**MIN**	**MEAN**	**MAX**	**MIN**	**MEAN**	**MAX**	**MIN**	**MEAN**	**MAX**
pH Value		0.01		5.70	7.02	7.88	6.02	6.04	6.06	5.71	6.51	7.40	6.99	7.05	7.13
pH (insitu)				5.67	6.85	7.32	5.67	5.90	6.01	5.70	7.29	68.00	6.85	7.18	7.36
Sodium Adsorption Ratio															
Conductivity @ 25°C	µS/cm	1		1360	4728	9590	1760	1860	2030	1680	2303	4250	3460	3640	4010
Conductivity (insitu)	µS/cm			110	5264	47040	1910	1983	2110	1745	2265	4230	3530	3730	4230
Total Dissolved Solids (TDS)	mg/L	1		800	2708	5370	1040	1063	1080	960	1306	2370	2030	2148	2250
Total Suspended Solids (TSS)	mg/L			25	124	617	120	1699	4799	33	136	710	76	150	182
Hardness (calculations)															
Calcium	mg/L	1		0.0	41.8	70.0	30.0	30.3	31.0	0.0	27.5	45.0	35.0	39.8	45.0
Magnesium	mg/L	1		24.0	60.1	91.0	24.0	25.3	26.0	22.0	31.8	55.0	52.0	53.5	55.0
Sodium	mg/L	1		290.0	731.9	1400.0	290.0	308.0	321.0	240.0	382.9	620.0	575.0	588.5	620.0
Potassium	mg/L	1		7.1	18.7	30.0	7.1	7.8	8.5	7.0	10.5	20.0	17.0	19.3	22.0
Hydroxide Alk as $CaCO_3$	mg/L	1													
Carbonate Alk as $CaCO_3$	mg/L	1													
Bicarbonate Alk as $CaCO_3$	mg/L	1													
Alkalinity (total)	mg/L			140.0	534.0	760.0	140.0	156.7	170.0	105.0	343.7	835.0	460.0	547.5	620.0
Sulphate	mg/L	1		2.0	54.5	464.0	48.0	51.3	55.0	2.0	35.7	95.0	80.0	85.0	95.0
Chloride	mg/L	1		390.0	1115.3	2480.0	510.0	543.3	567.0	50.0	529.9	1134.0	794.0	919.8	1134.0
Flourides	mg/L			0.2	0.8	1.7	0.2	0.2	0.2	0.3	0.6	1.3	0.8	0.9	1.0
CaCO3 Saturation Index															
Aluminium - Filtered	mg/L	0.1/0.01	0.055	0.350	1.665	5.600	2.000	20.533	57.000	0.030	1.305	4.200	2.200	4.125	7.800
Arsenic - Filtered	mg/L	0.01/0.001	0.013	0.00050	0.00363	0.00800	0.00100	0.00600	0.01200	0.00100	0.00236	0.00800	0.00200	0.00550	0.01000
Barium - Filtered	mg/L	0.01		0.11000	0.31667	0.98000	0.13000	0.31000	0.62000	0.10000	0.20933	0.61000	0.33000	0.42000	0.61000
Cadmium - Filtered	mg/L	0.005/0.0001	0.0002	0.00005	2.53370	38.00000	0.00017	0.00086	0.00140	0.00005	1.80028	27.00000	0.00044	0.00086	0.00100
Chromium - Filtered	mg/L	0.01/0.001	ID	0.00001	0.00593	0.01200	0.00200	0.01633	0.04200	0.00200	0.00613	0.01200	0.00200	0.00425	0.00700
Cobalt - Filtered	mg/L	0.01		0.00080	0.00384	0.01400	0.01100	0.03767	0.08800	0.00050	0.00386	0.01300	0.00230	0.00660	0.01700
Copper - Filtered	mg/L	0.01/0.001	0.0014	0.00400	0.01352	0.03700	0.00600	0.05127	0.14000	0.00280	0.01779	0.06400	0.01200	0.01650	0.02600
Lead - Filtered	mg/L	0.01/0.001	0.0034	0.00770	0.08358	0.26000	0.23000	0.34000	0.53000	0.00420	0.10628	0.33000	0.28000	0.33000	0.39000
Manganese - Filtered	mg/L	0.01	1.9	0.11000	0.38200	0.95000	0.82000	1.73000	3.50000	0.16000	0.47867	1.10000	0.34000	0.44500	0.52000
Nickel - Filtered	mg/L	0.01/0.001	0.011												
Selenium - Filtered	mg/L	0.01	0.005												
Silver - Filtered	mg/L	0.001	0.00005												
Zinc - Filtered	mg/L	0.01/0.001	0.008	0.016	0.128	0.240	0.086	0.409	0.950	0.007	0.127	0.270	0.180	0.295	0.510
Boron - Filtered	mg/L	0.1/0.01	0.37												
Iron - Filtered	mg/L	0.1	ID	1.10	4.53	11.00	5.20	34.37	88.00	0.06	10.61	27.00	2.70	4.83	8.60
Mercury - Filtered	mg/L	0.0001	0.00006												
Ammonia as N	mg/L	0.01	0.9												
Nitrite as N	mg/L	0.01													
Nitrate as N	mg/L	0.01	0.7												
Total Kjeldahl Nitrogen as N	mg/L	0.1													
Total Phosphorus as P	mg/L	0.01													
Reactive Phosphorus as P	mg/L	0.01													
Total Cations (reported)	meq/L	0.01													
Total Anions (reported)	meq/L	0.01													
Anion-Cation Difference (reported)	meq/L	0.01													
Allowable Anion-Cation Difference (reptd)	meq/L	0.01													
Anion-Cation Difference (reported)	%														
Allowable Anion-Cation Difference (reptd)	%														
Total Cations (calculated)	meq/L	0.01													
Total Anions (calculated)	meq/L	0.01													
% Difference (calculated)	%	0.01													
Allowed % Difference (calculated)	%	0.01													

Table 1-1: Groundwater Quality Data - Statistical Summary

			Bore	GTOO2	JRD1			JRD2			REGDPZ-1		
			No of samples	1	47			49			75		
				Donaldson	Donaldson			Donaldson			Donaldson		
Parameter	Units	LOR	ANZECC (2000) Guideline Value for	18-Apr-01	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX
pH Value		0.01		6.66	6.20	6.98	7.30	6.20	7.10	7.50	4.30	5.57	7.02
pH (insitu)				5.85	6.00	6.82	7.20	6.30	6.97	7.60	4.10	5.70	7.10
Sodium Adsorption Ratio													
Conductivity @ 25°C	µS/cm	1		2710	1400	3186	4250	535	2929	3580	240	1189	10390
Conductivity (insitu)	µS/cm			2440	1725	3071	4160	490	2821	3530	260	1070	1650
Total Dissolved Solids (TDS)	mg/L	1		1440	800	1800	2520	360	1657	2050	135	633	1070
Total Suspended Solids (TSS)	mg/L			1350	2	97	994	4	86	602	2	54	1498
Hardness (calculations)													
Calcium	mg/L	1		21.0	0.0	76.0	110.0	0.0	65.2	79.0	0.0	1.6	4.9
Magnesium	mg/L	1		27.0	46.0	68.1	86.0	38.0	56.9	65.0	4.0	7.3	15.0
Sodium	mg/L	1		440.0	370.0	530.9	620.0	300.0	491.0	620.0	43.0	185.4	310.0
Potassium	mg/L	1		17.0	8.0	14.0	22.0	7.0	9.3	13.0	4.1	6.6	11.0
Hydroxide Alk as $CaCO_3$	mg/L	1											
Carbonate Alk as $CaCO_3$	mg/L	1											
Bicarbonate Alk as $CaCO_3$	mg/L	1											
Alkalinity (total)	mg/L			330.0	380.0	524.4	635.0	385.0	595.0	650.0	5.0	36.7	85.0
Sulphate	mg/L	1		110.0	5.0	87.7	160.0	5.0	73.1	104.0	2.0	45.5	190.0
Chloride	mg/L	1		656.0	638.0	813.0	993.0	383.0	664.1	780.0	49.0	311.3	468.0
Flourides	mg/L			0.3	0.3	0.9	3.5	0.0	0.5	1.4	0.1	0.6	1.4
CaCO3 Saturation Index													
Aluminium - Filtered	mg/L	0.1/0.01	0.055	13.000	0.020	2.139	13.000	0.020	0.551	3.600	0.080	1.619	6.500
Arsenic - Filtered	mg/L	0.01/0.001	0.013	0.00200	0.00100	0.00148	0.00330	0.00100	0.00140	0.00300	0.00200	0.00667	0.01500
Barium - Filtered	mg/L	0.01		0.06100	0.07900	0.14811	0.32000	0.05500	0.08490	0.10000	0.01700	0.07820	0.26000
Cadmium - Filtered	mg/L	0.005/0.0001	0.0002	0.00210	0.00005	9.55578	86.00000	0.00005	6.90014	69.00000	0.00005	0.16028	2.40000
Chromium - Filtered	mg/L	0.01/0.001	ID	0.01100	0.00100	0.00556	0.02900	0.00100	0.00240	0.00800	0.00000	0.00300	0.00900
Cobalt - Filtered	mg/L	0.01		0.01300	0.00050	0.21533	1.90000	0.00030	0.04162	0.40000	0.00020	0.00378	0.00900
Copper - Filtered	mg/L	0.01/0.001	0.0014	0.00650	0.00100	0.00589	0.03000	0.00100	0.00480	0.02000	0.00100	0.01003	0.03600
Lead - Filtered	mg/L	0.01/0.001	0.0034	0.07500	0.00040	0.04782	0.19000	0.00020	0.00431	0.01100	0.00040	0.01778	0.06900
Manganese - Filtered	mg/L	0.01	1.9	0.08500	0.00100	0.21933	0.81000	0.03500	0.06510	0.12000	0.04300	0.07467	0.11000
Nickel - Filtered	mg/L	0.01/0.001	0.011										
Selenium - Filtered	mg/L	0.01	0.005										
Silver - Filtered	mg/L	0.001	0.00005										
Zinc - Filtered	mg/L	0.01/0.001	0.008	0.160	0.005	0.036	0.130	0.005	0.021	0.068	0.000	0.108	0.390
Boron - Filtered	mg/L	0.1/0.01	0.37										
Iron - Filtered	mg/L	0.1	ID	3.00	0.01	5.24	35.00	0.00	1.59	6.50	1.00	3.23	6.10
Mercury - Filtered	mg/L	0.0001	0.00006										
Ammonia as N	mg/L	0.01	0.9										
Nitrite as N	mg/L	0.01											
Nitrate as N	mg/L	0.01	0.7										
Total Kjeldahl Nitrogen as N	mg/L	0.1											
Total Phosphorus as P	mg/L	0.01											
Reactive Phosphorus as P	mg/L	0.01											
Total Cations (reported)	meq/L	0.01											
Total Anions (reported)	meq/L	0.01											
Anion-Cation Difference (reported)	meq/L	0.01											
Allowable Anion-Cation Difference (reptd)	meq/L	0.01											
Anion-Cation Difference (reported)	%												
Allowable Anion-Cation Difference (reptd)	%												
Total Cations (calculated)	meq/L	0.01											
Total Anions (calculated)	meq/L	0.01											
% Difference (calculated)	%	0.01											
Allowed % Difference (calculated)	%	0.01											

Table 1-1: Groundwater Quality Data - Statistical Summary

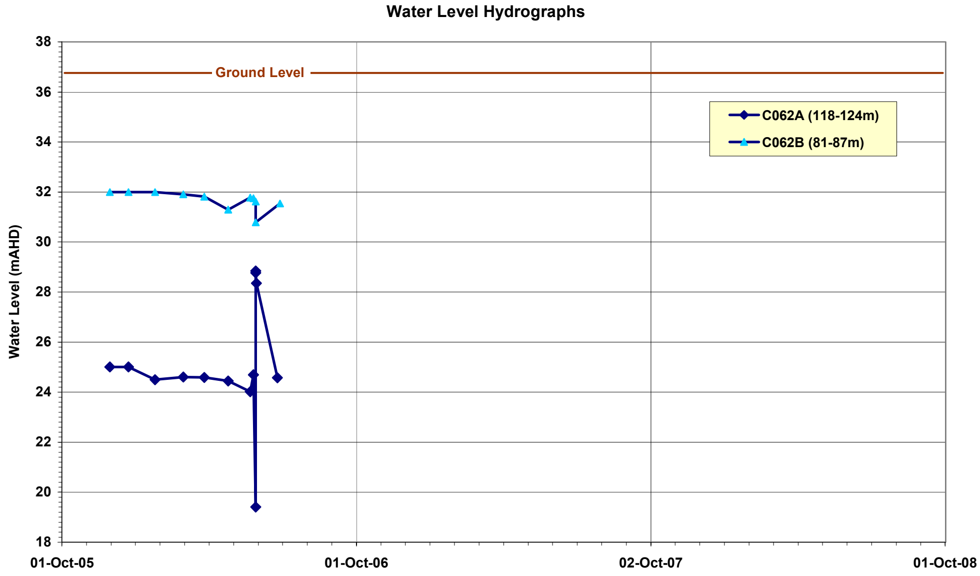
			Bore	ODO003			TAS009B	TAS010			TAS011		
			No of samples	6			1	2			13		
				Tasman			Tasman	Tasman			Tasman		
Parameter	Units	LOR	ANZECC (2000) Guideline Value for	MIN	MEAN	MAX	13-Sep-01	MIN	MEAN	MAX	MIN	MEAN	MAX
pH Value		0.01		6.52	6.64	6.74	7.41	6.54	6.95	7.36	6.34	6.57	6.99
pH (insitu)													
Sodium Adsorption Ratio				7.80	10.15	14.20	6.90	6.10	16.40	16.40	0.40	3.85	7.20
Conductivity @ 25°C	µS/cm	1		1050	1255	1480	2770	5130	5205	5280	215	667	1260
Conductivity (insitu)	µS/cm												
Total Dissolved Solids (TDS)	mg/L	1		705	841	990	1860	3180	3310	3440	145	446	845
Total Suspended Solids (TSS)	mg/L												
Hardness (calculations)				90	119	182	573	628	632	636	64	101	178
Calcium	mg/L	1		23.0	27.2	31.0	132.0	98.0	98.0	98.0	22.0	29.1	44.0
Magnesium	mg/L	1		8.0	9.6	13.8	59.0	93.0	94.0	95.0	2.2	6.9	16.5
Sodium	mg/L	1		183.0	221.8	270.0	380.0	890.0	915.0	940.0	18.0	96.5	220.0
Potassium	mg/L	1		3.6	4.5	7.3	6.5	12.0	12.7	13.4	0.7	2.5	4.9
Hydroxide Alk as $CaCO_3$	mg/L	1											
Carbonate Alk as $CaCO_3$	mg/L	1											
Bicarbonate Alk as $CaCO_3$	mg/L	1		200.0	259.2	330.0	370.0	295.0	295.0	295.0	60.0	134.7	250.0
Alkalinity (total)	mg/L												
Sulphate	mg/L	1		23.0	40.7	54.0	65.0	270.0	275.0	280.0	10.0	44.5	140.0
Chloride	mg/L	1		148.0	219.8	284.0	666.0	1489.0	1489.5	1490.0	28.0	119.4	270.0
Flourides	mg/L												
CaCO3 Saturation Index				-1.8	-1.0	-0.7	-0.7	-0.5	-0.3	-0.1	-1.8	-1.2	-0.2
Aluminium - Filtered	mg/L	0.1/0.01	0.055										
Arsenic - Filtered	mg/L	0.01/0.001	0.013										
Barium - Filtered	mg/L	0.01											
Cadmium - Filtered	mg/L	0.005/0.0001	0.0002										
Chromium - Filtered	mg/L	0.01/0.001	ID										
Cobalt - Filtered	mg/L	0.01											
Copper - Filtered	mg/L	0.01/0.001	0.0014										
Lead - Filtered	mg/L	0.01/0.001	0.0034										
Manganese - Filtered	mg/L	0.01	1.9										
Nickel - Filtered	mg/L	0.01/0.001	0.011										
Selenium - Filtered	mg/L	0.01	0.005										
Silver - Filtered	mg/L	0.001	0.00005										
Zinc - Filtered	mg/L	0.01/0.001	0.008										
Boron - Filtered	mg/L	0.1/0.01	0.37										
Iron - Filtered	mg/L	0.1	ID	2.10	21.33	85.00	2.60	4.40	10.65	16.90	<0.05	0.76	1.50
Mercury - Filtered	mg/L	0.0001	0.00006										
Ammonia as N	mg/L	0.01	0.9										
Nitrite as N	mg/L	0.01											
Nitrate as N	mg/L	0.01	0.7										
Total Kjeldahl Nitrogen as N	mg/L	0.1											
Total Phosphorus as P	mg/L	0.01											
Reactive Phosphorus as P	mg/L	0.01											
Total Cations (reported)	meq/L	0.01											
Total Anions (reported)	meq/L	0.01											
Anion-Cation Difference (reported)	meq/L	0.01											
Allowable Anion-Cation Difference (reptd)	meq/L	0.01											
Anion-Cation Difference (reported)	%												
Allowable Anion-Cation Difference (reptd)	%												
Total Cations (calculated)	meq/L	0.01											
Total Anions (calculated)	meq/L	0.01											
% Difference (calculated)	%	0.01											
Allowed % Difference (calculated)	%	0.01											

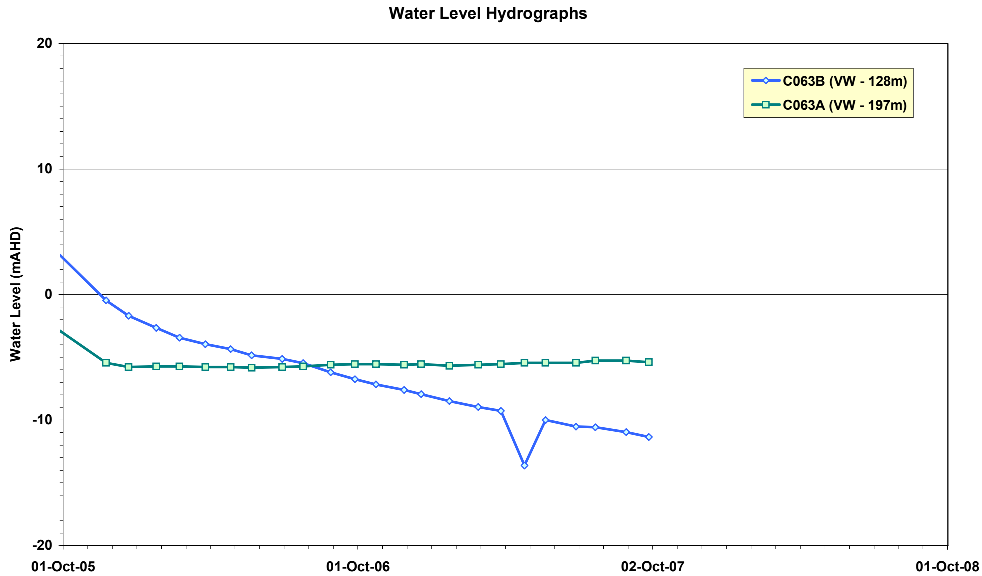
Table 1-1: Groundwater Quality Data - Statistical Summary

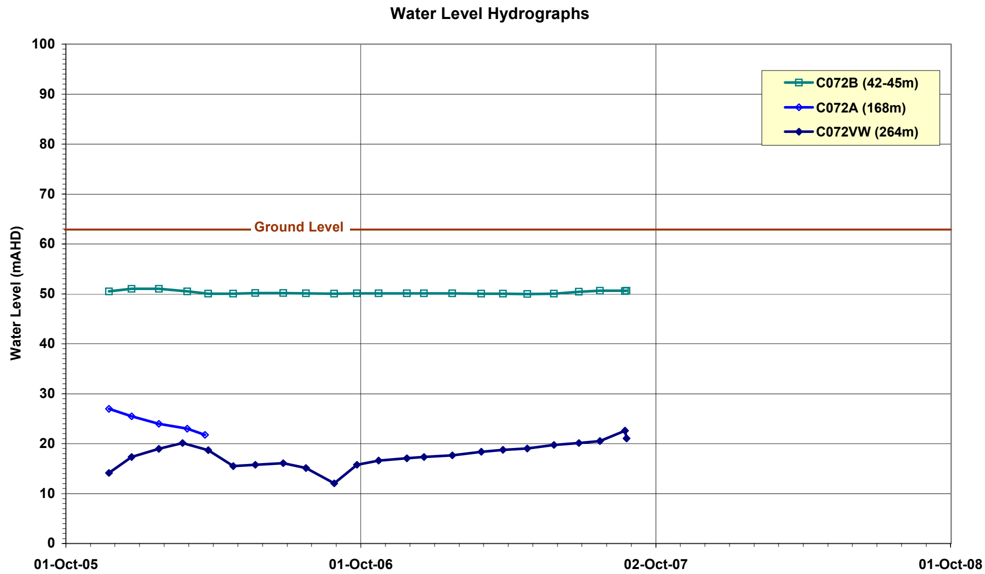
			Bore	TAS012			TAS013			TAS014A		
			No of samples	8			13			4		
				Tasman			Tasman			Tasman		
Parameter	Units	LOR	ANZECC (2000) Guideline Value for	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX
pH Value		0.01		6.24	6.47	6.77	5.96	6.21	6.68	4.36	4.58	4.78
pH (insitu)												
Sodium Adsorption Ratio				6.80	26.00	26.00	8.00	9.99	18.00	4.10	5.80	5.80
Conductivity @ 25°C	µS/cm	1		2820	3343	3650	1970	2309	2470	840	888	910
Conductivity (insitu)	µS/cm											
Total Dissolved Solids (TDS)	mg/L	1		1890	2239	2450	1320	1538	1650	565	595	610
Total Suspended Solids (TSS)	mg/L											
Hardness (calculations)				563	649	689	248	268	361	92	95	97
Calcium	mg/L	1		120.0	139.9	154.0	51.0	58.9	72.0	10.0	11.0	12.3
Magnesium	mg/L	1		64.0	72.9	81.0	23.0	26.8	30.0	15.6	16.4	17.1
Sodium	mg/L	1		400.0	435.0	460.0	314.0	344.9	380.0	117.0	123.5	129.0
Potassium	mg/L	1		10.8	11.9	12.6	9.8	10.7	12.0	7.0	7.5	7.8
Hydroxide Alk as $CaCO_3$	mg/L	1										
Carbonate Alk as $CaCO_3$	mg/L	1										
Bicarbonate Alk as $CaCO_3$	mg/L	1		260.0	270.0	300.0	200.0	213.5	235.0	<1	1.8	4.0
Alkalinity (total)	mg/L											
Sulphate	mg/L	1		57.0	114.3	142.0	45.0	62.8	70.0	15.0	16.3	18.0
Chloride	mg/L	1		904.0	944.5	994.0	6.0	529.3	610.0	262.0	265.8	276.0
Flourides	mg/L											
$CaCO_3$ Saturation Index				-0.6	-0.4	-0.1	-1.2	-1.1	-0.6	-5.9	-4.5	-0.9
Aluminium - Filtered	mg/L	0.1/0.01	0.055									
Arsenic - Filtered	mg/L	0.01/0.001	0.013									
Barium - Filtered	mg/L	0.01										
Cadmium - Filtered	mg/L	0.005/0.0001	0.0002									
Chromium - Filtered	mg/L	0.01/0.001	ID									
Cobalt - Filtered	mg/L	0.01										
Copper - Filtered	mg/L	0.01/0.001	0.0014									
Lead - Filtered	mg/L	0.01/0.001	0.0034									
Manganese - Filtered	mg/L	0.01	1.9									
Nickel - Filtered	mg/L	0.01/0.001	0.011									
Selenium - Filtered	mg/L	0.01	0.005									
Silver - Filtered	mg/L	0.001	0.00005									
Zinc - Filtered	mg/L	0.01/0.001	0.008									
Boron - Filtered	mg/L	0.1/0.01	0.37									
Iron - Filtered	mg/L	0.1	ID	0.73	7.72	26.00	0.10	2.49	6.80	272.00	630.50	1425.00
Mercury - Filtered	mg/L	0.0001	0.00006									
Ammonia as N	mg/L	0.01	0.9									
Nitrite as N	mg/L	0.01										
Nitrate as N	mg/L	0.01	0.7									
Total Kjeldahl Nitrogen as N	mg/L	0.1										
Total Phosphorus as P	mg/L	0.01										
Reactive Phosphorus as P	mg/L	0.01										
Total Cations (reported)	meq/L	0.01										
Total Anions (reported)	meq/L	0.01										
Anion-Cation Difference (reported)	meq/L	0.01										
Allowable Anion-Cation Difference (reptd)	meq/L	0.01										
Anion-Cation Difference (reported)	%											
Allowable Anion-Cation Difference (reptd)	%											
Total Cations (calculated)	meq/L	0.01										
Total Anions (calculated)	meq/L	0.01										
% Difference (calculated)	%	0.01										
Allowed % Difference (calculated)	%	0.01										

Table 1-1: Groundwater Quality Data - Statistical Summary

			Bore	BL01	BL04	BL01	BL04	SP2-1	SP2-2	SP3-1	SP4-1	SP4-2
			No of samples	1	1	1	1	1	1	1	1	1
				Bloomfield	Bloomfield	Bloomfield	Bloomfield	Bloomfield	Bloomfield	Bloomfield	Bloomfield	Bloomfield
Parameter	**Units**	**LOR**	**ANZECC (2000) Guideline Value for**					27-May-07	27-May-07	27-May-07	27-May-07	27-May-07
pH Value		0.01		6.58	7.11	6.58	7.11	6.61	6.21	6.40	7.44	6.65
pH (insitu)												
Sodium Adsorption Ratio				13.22	13.72	13.22	13.72	9.49	19.41	8.80	23.25	31.42
Conductivity @ 25°C	µS/cm	1		2700	2970	2700	2970	6840	5530	6390	13100	16800
Conductivity (insitu)	µS/cm											
Total Dissolved Solids (TDS)	mg/L	1		2020	2110	2020	2110	5820	3750	4000	7760	11100
Total Suspended Solids (TSS)	mg/L											
Hardness (calculations)												
Calcium	mg/L	1		67.0	76.0	67.0	76.0	373.0	33.0	280.0	188.0	49.0
Magnesium	mg/L	1		41.0	61.0	41.0	61.0	285.0	112.0	320.0	298.0	398.0
Sodium	mg/L	1		557.0	662.0	557.0	662.0	1000.0	1040.0	908.0	2200.0	3030.0
Potassium	mg/L	1		11.0	19.0	11.0	19.0	24.0	30.0	32.0	40.0	53.0
Hydroxide Alk as $CaCO_3$	mg/L	1		1.0	1.0	<1	<1	<1	<1	<1	<1	<1
Carbonate Alk as $CaCO_3$	mg/L	1		1.0	1.0	<1	<1	<1	<1	<1	<1	<1
Bicarbonate Alk as $CaCO_3$	mg/L	1		288.0	753.0	288.0	753.0	314.0	185.0	444.0	498.0	198.0
Alkalinity (total)	mg/L											
Sulphate	mg/L	1		573.0	247.0	573.0	247.0	3050.0	1780.0	2870.0	464.0	631.0
Chloride	mg/L	1		573.0	757.0	573.0	757.0	474.0	598.0	401.0	4250.0	5520.0
Flourides	mg/L											
CaCO3 Saturation Index												
Aluminium - Filtered	mg/L	0.1/0.01	0.055					<0.01	<0.01	<0.01	<0.01	<0.01
Arsenic - Filtered	mg/L	0.01/0.001	0.013					0.00200	0.00600	0.00200	<0.001	<0.001
Barium - Filtered	mg/L	0.01										
Cadmium - Filtered	mg/L	0.005/0.0001	0.0002					0.00010	<0.0001	<0.0001	<0.0001	0.00290
Chromium - Filtered	mg/L	0.01/0.001	ID					<0.005	<0.005	<0.005	<0.005	<0.005
Cobalt - Filtered	mg/L	0.01										
Copper - Filtered	mg/L	0.01/0.001	0.0014					0.00200	0.00200	0.00200	0.08500	0.78900
Lead - Filtered	mg/L	0.01/0.001	0.0034					<0.001	<0.001	<0.001	<0.001	<0.001
Manganese - Filtered	mg/L	0.01	1.9					1.23000	0.41300	3.44000	0.28400	0.92600
Nickel - Filtered	mg/L	0.01/0.001	0.011					0.01600	0.00700	0.06500	0.01300	0.05000
Selenium - Filtered	mg/L	0.01	0.005					<0.01	<0.01	<0.01	<0.01	<0.01
Silver - Filtered	mg/L	0.001	0.00005					<0.001	<0.001	<0.001	<0.01	<0.01
Zinc - Filtered	mg/L	0.01/0.001	0.008					0.007	0.051	0.058	0.151	0.228
Boron - Filtered	mg/L	0.1/0.01	0.37					0.24000	0.07000	0.15000	0.11000	<0.05
Iron - Filtered	mg/L	0.1	ID					14.90	18.70	16.70	<0.05	<0.05
Mercury - Filtered	mg/L	0.0001	0.00006					<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Ammonia as N	mg/L	0.01	0.9					1.28	0.247	0.349	0.342	0.173
Nitrite as N	mg/L	0.01						<0.01	0.025	<0.01	<0.01	<0.01
Nitrate as N	mg/L	0.01	0.7					0.035	0.046	0.031	0.042	0.112
Total Kjeldahl Nitrogen as N	mg/L	0.1						2.3	0.5	1	2.5	4.6
Total Phosphorus as P	mg/L	0.01						0.02	0.37	0.08	0.07	1.21
Reactive Phosphorus as P	mg/L	0.01						<0.01	0.078	<0.01	0.01	0.036
Total Cations (reported)	meq/L	0.01		31.3	38.1	31.3	38.1	86.4	57	80.6	130	168
Total Anions (reported)	meq/L	0.01		33.8	41.5	33.8	41.5	83.2	57.5	79.9	139	173
Anion-Cation Difference (reported)	meq/L	0.01										
Allowable Anion-Cation Difference (reptd)	meq/L	0.01										
Anion-Cation Difference (reported)	%			4.00%	4.32%	4.00%	4.32%	1.86%	0.49%	0.45%	3.33%	1.38%
Allowable Anion-Cation Difference (reptd)	%											
Total Cations (calculated)	meq/L	0.01						86.17	56.87	80.61	130.62	168.34
Total Anions (calculated)	meq/L	0.01						83.15	57.63	79.94	139.50	172.81
% Difference (calculated)	%	0.01						1.79%	-0.66%	0.42%	-3.29%	-1.31%
Allowed % Difference (calculated)	%	0.01						2.00%	2.00%	2.00%	2.00%	2.00%







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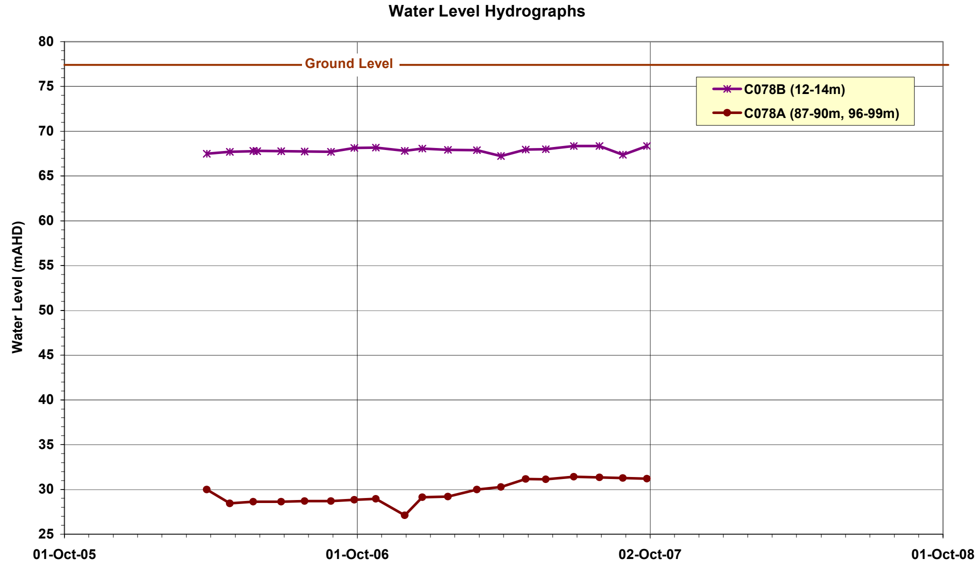
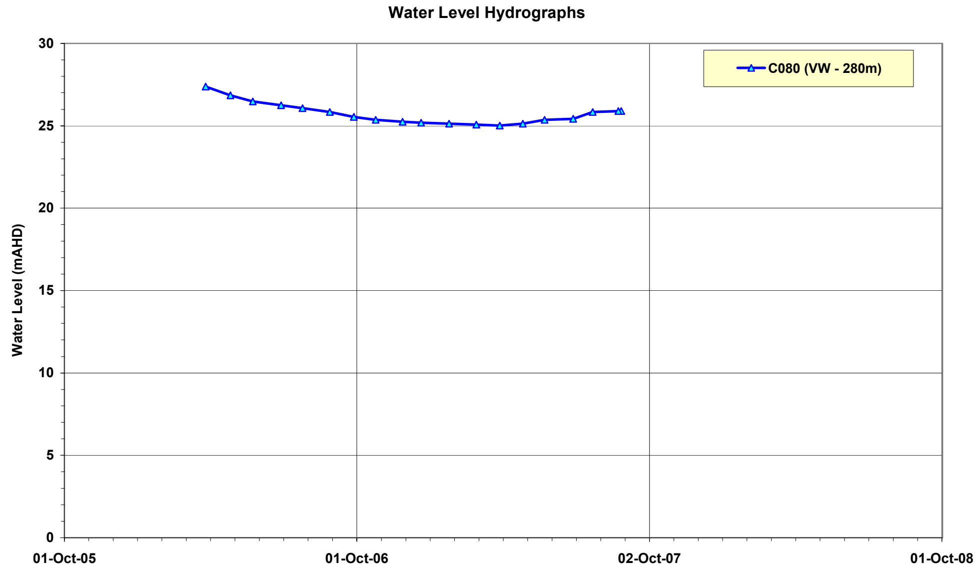
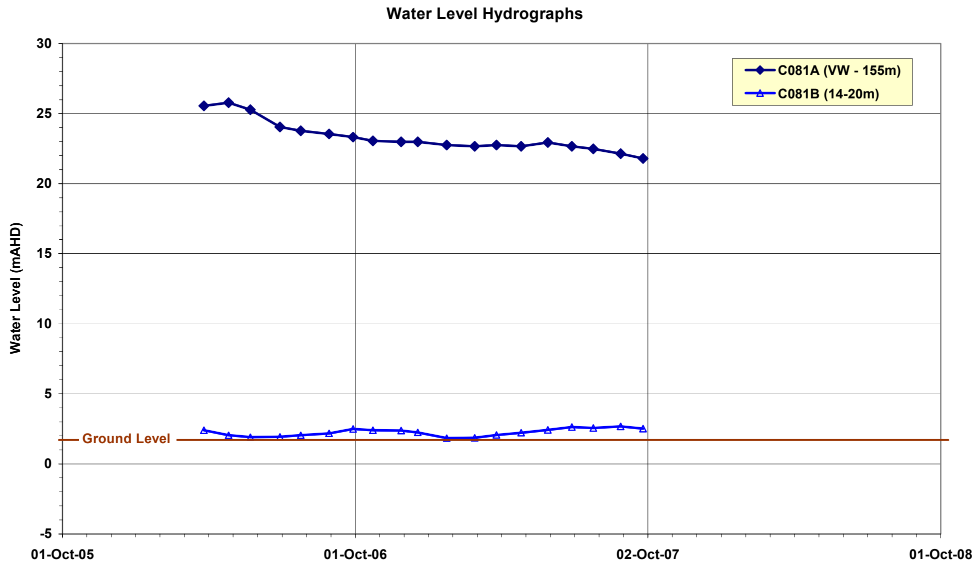
Peter Dundon & Associates Pty Limited				**Figure 1-1**







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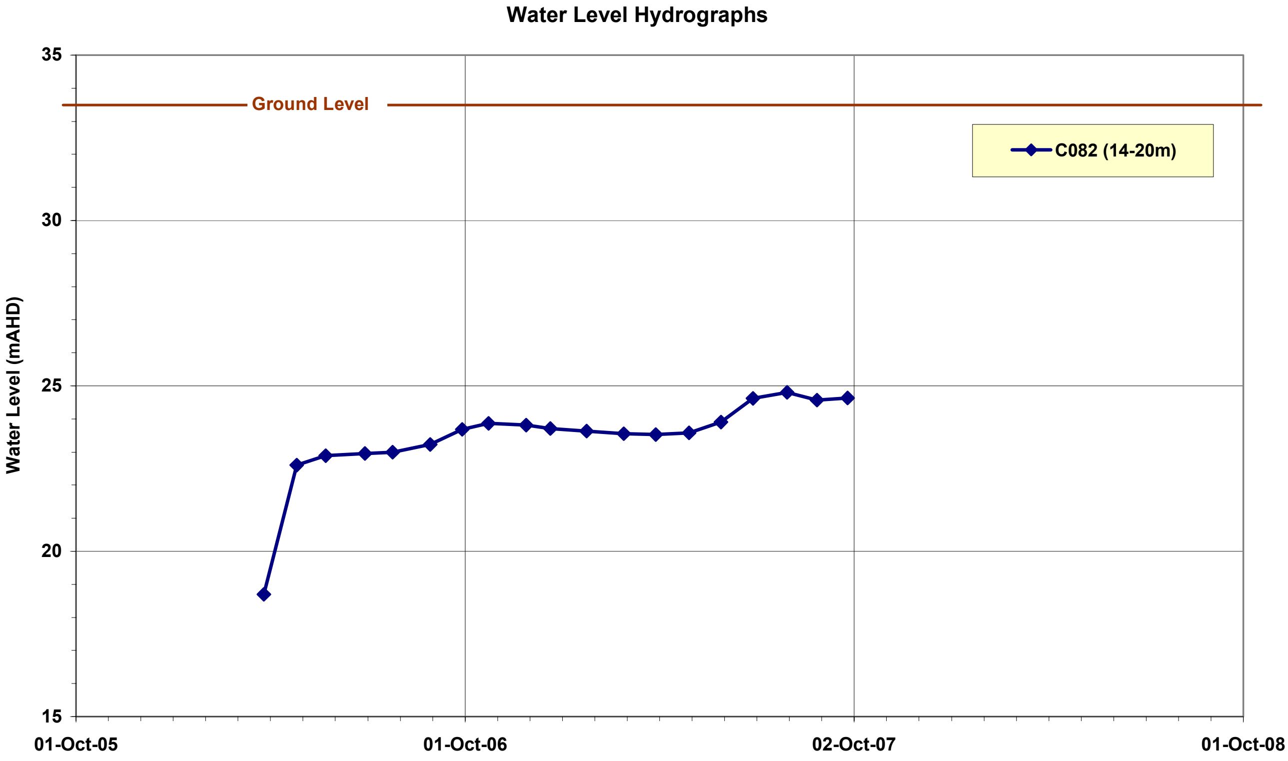
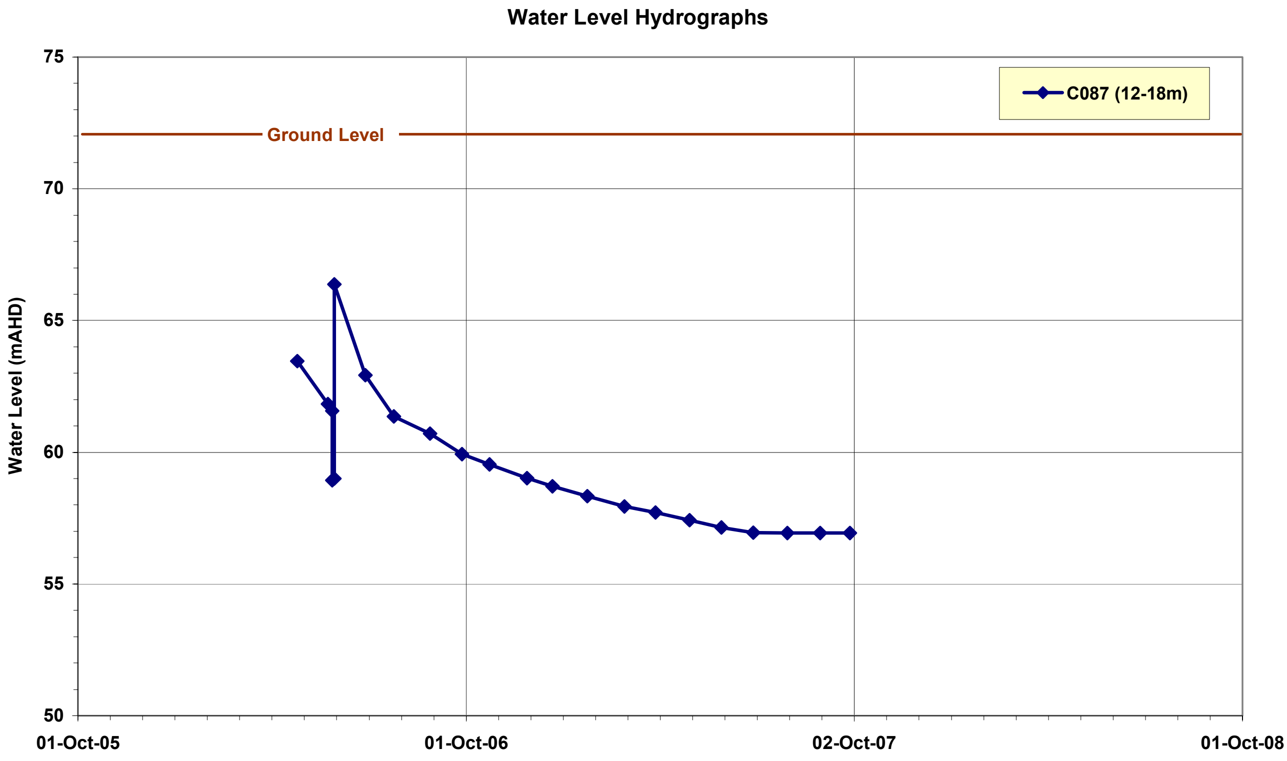
Peter Dundon & Associates Pty Limited		**Figure 1-2**





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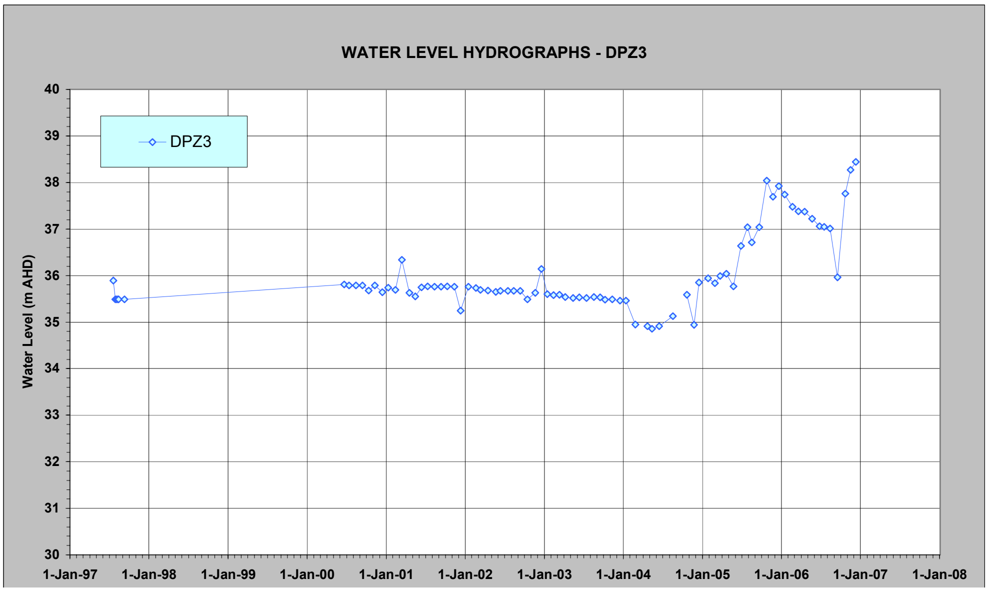
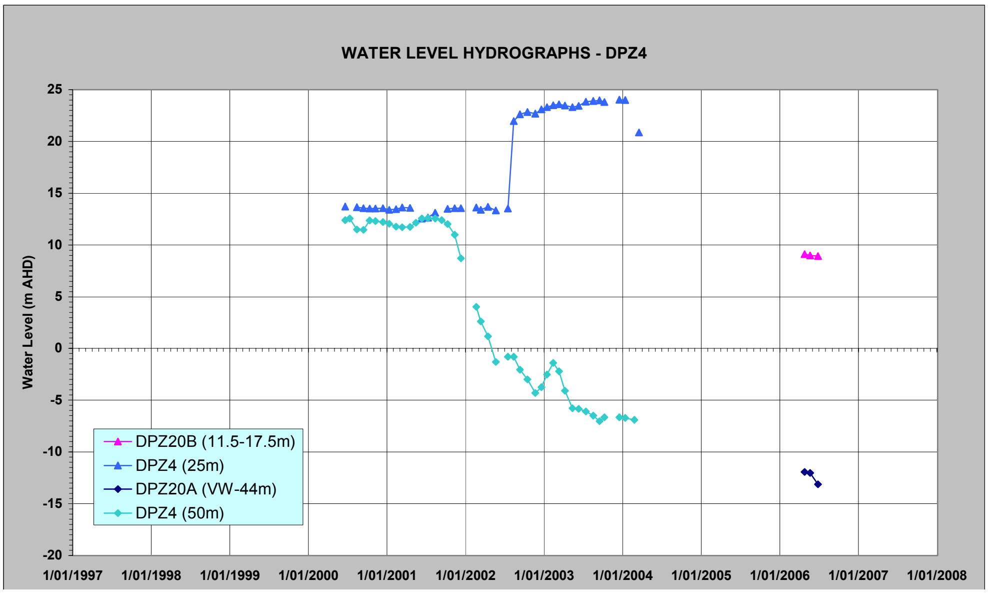
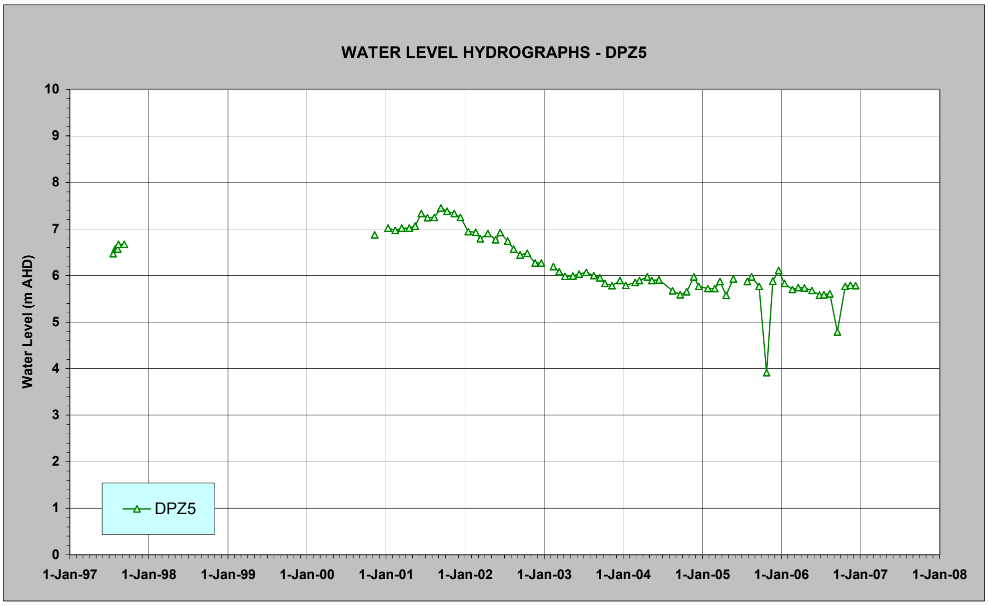
Peter Dundon & Associates Pty Limited				**Figure 1-3**







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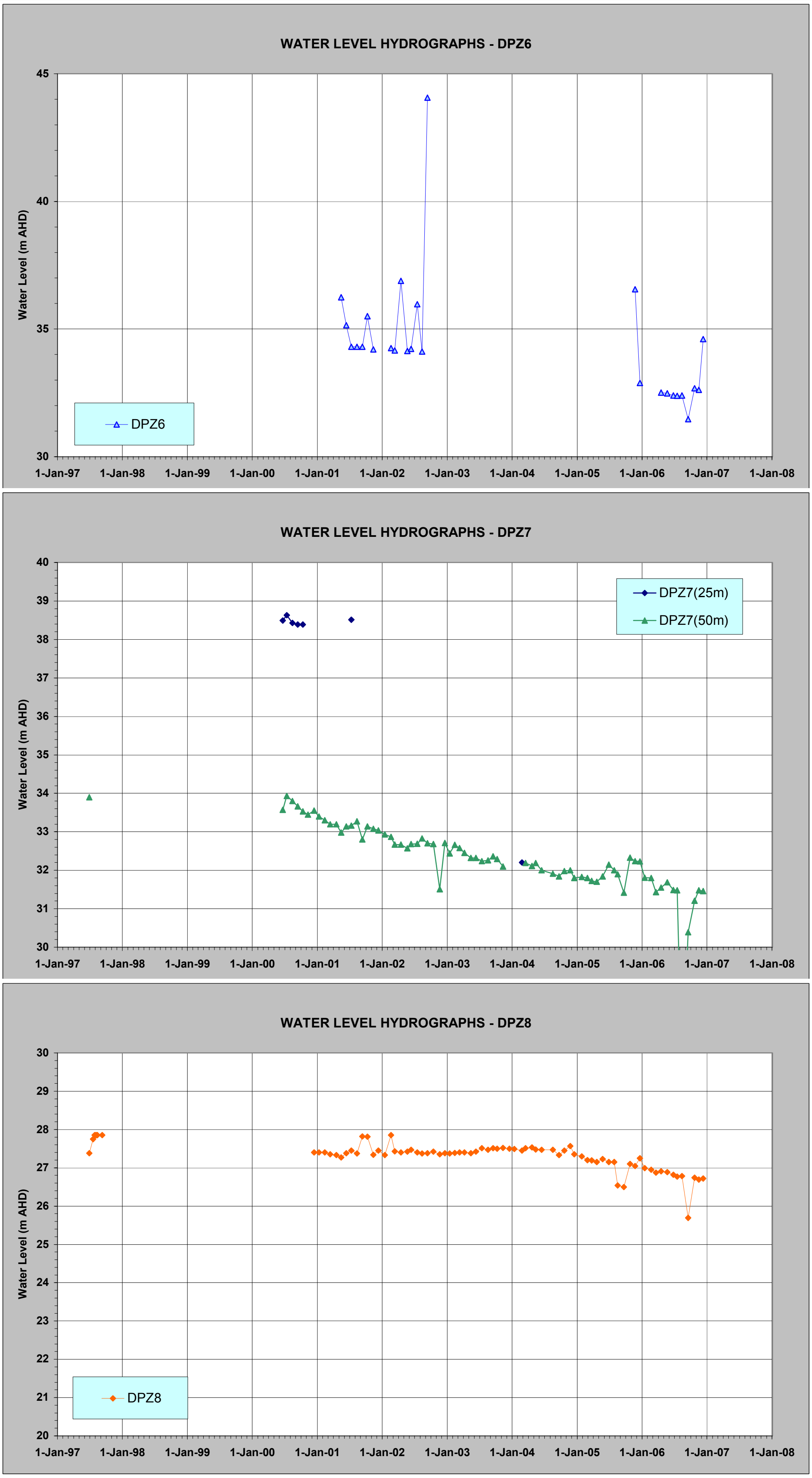

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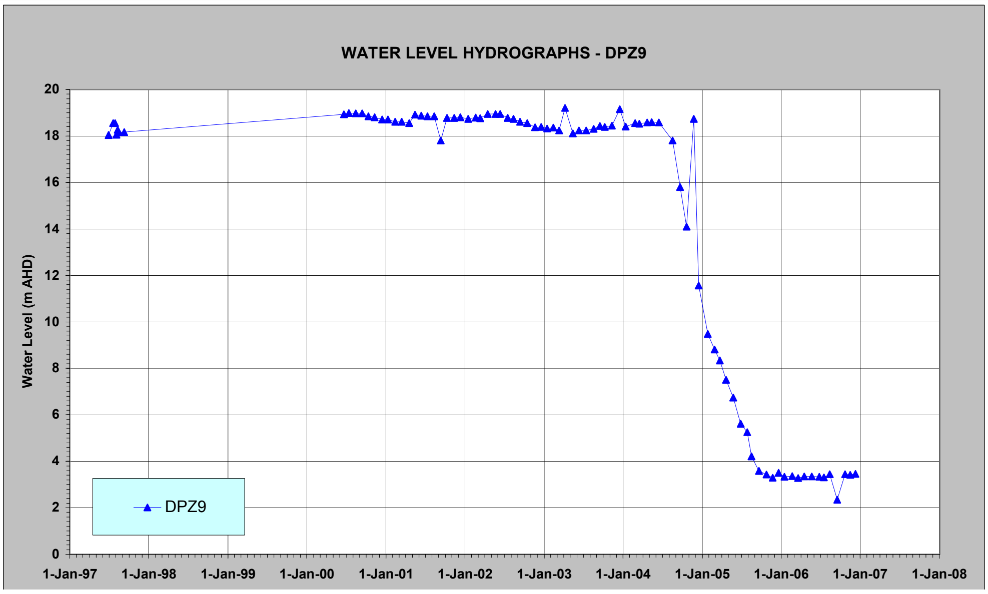

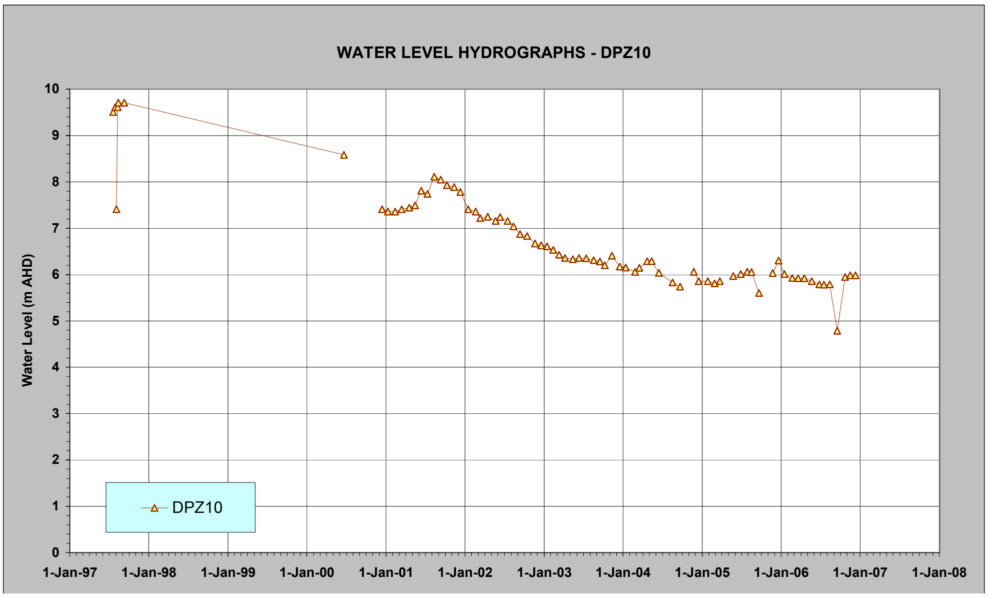

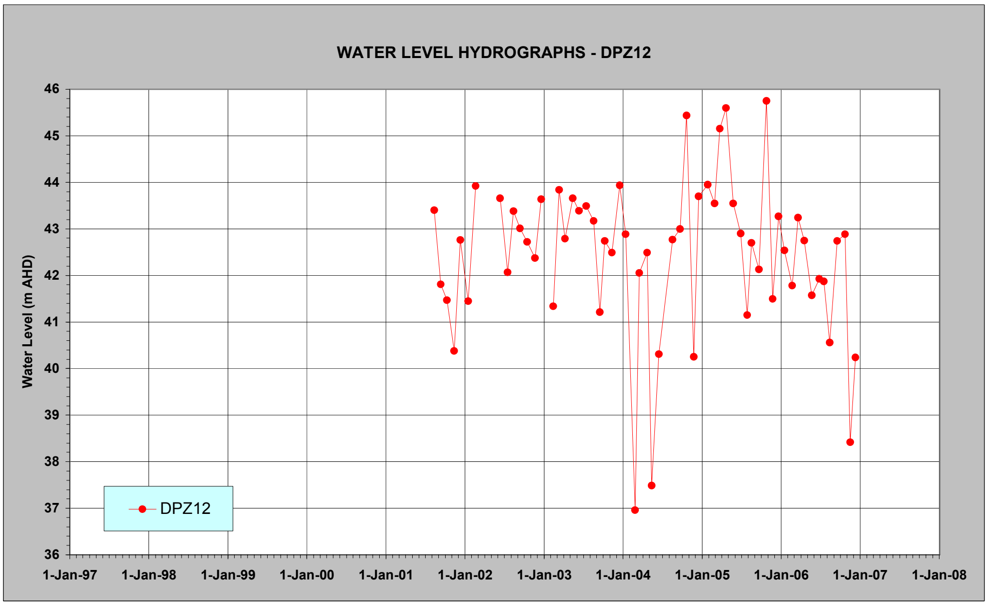

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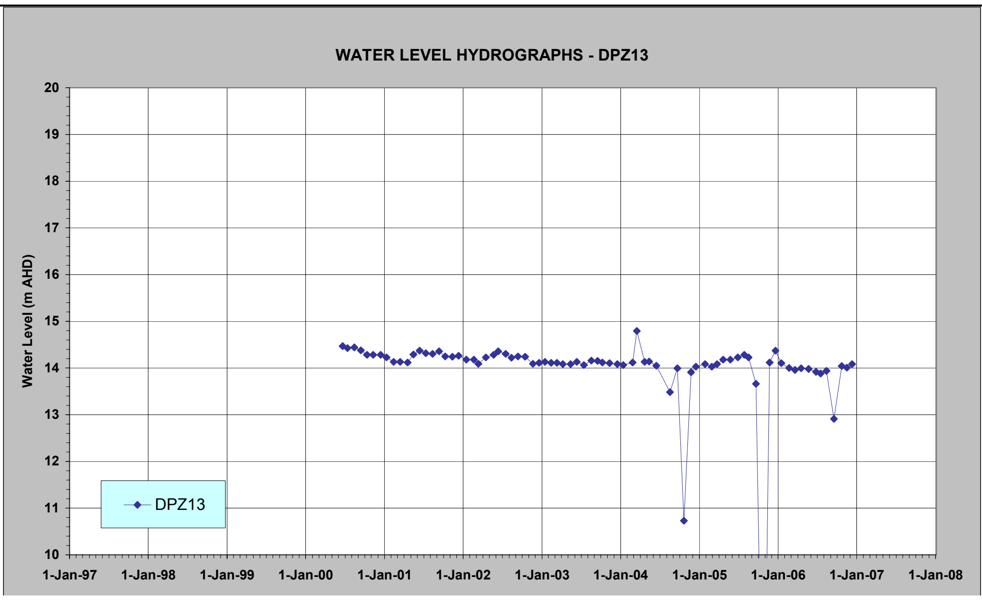
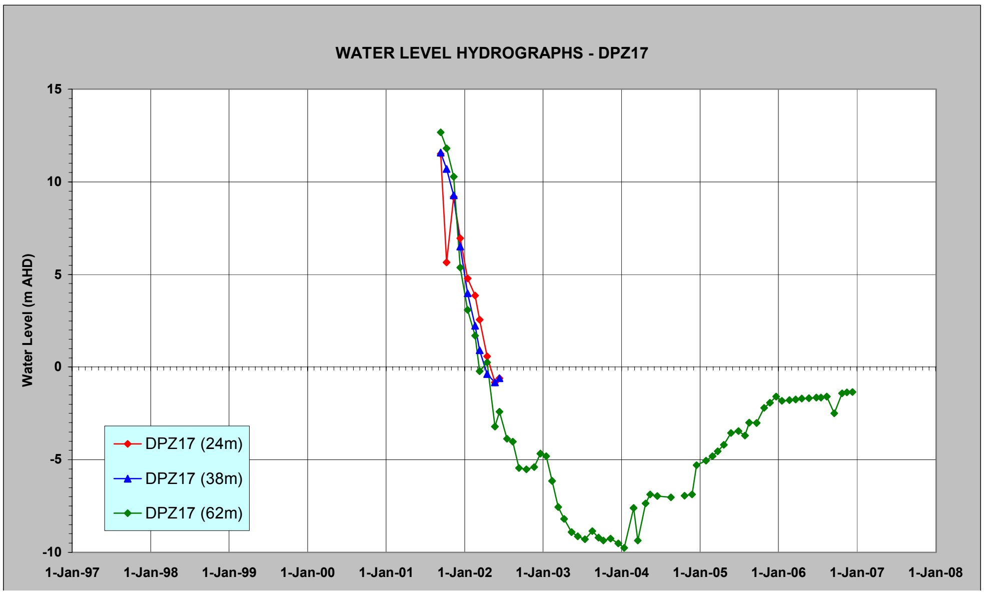
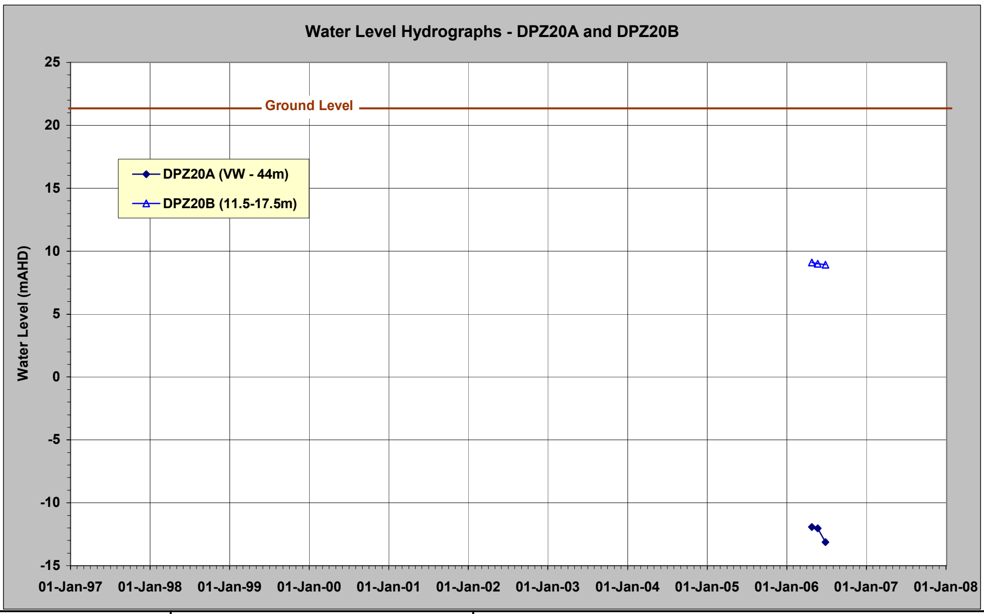
Peter Dundon & Associates Pty Limited		**Figure 1-6**







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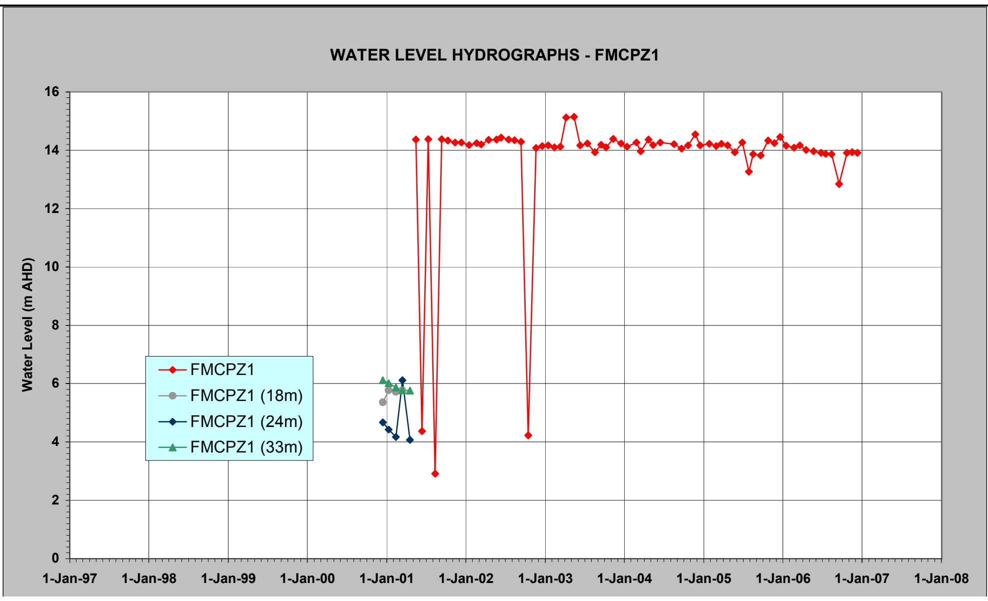
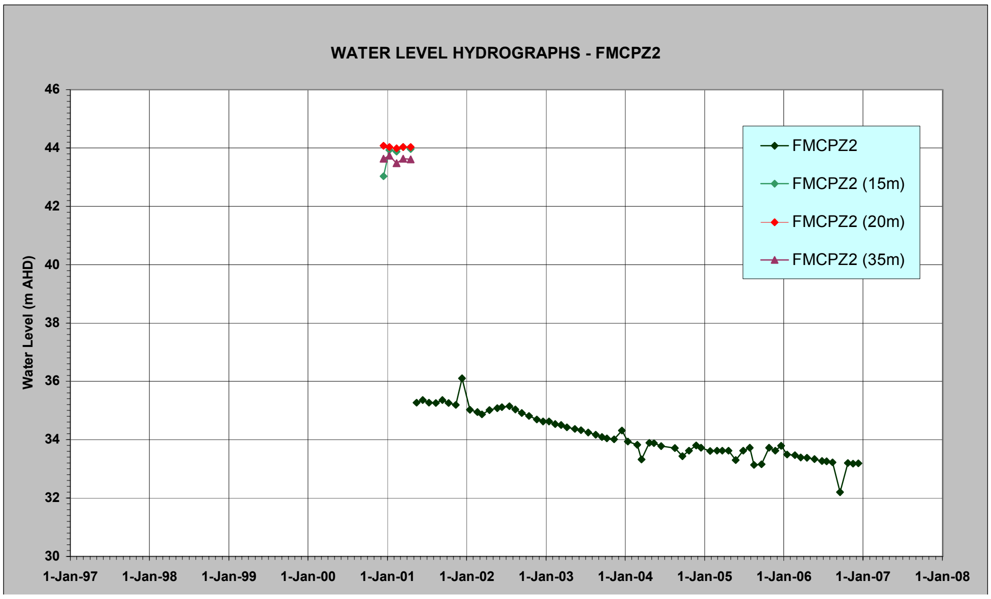
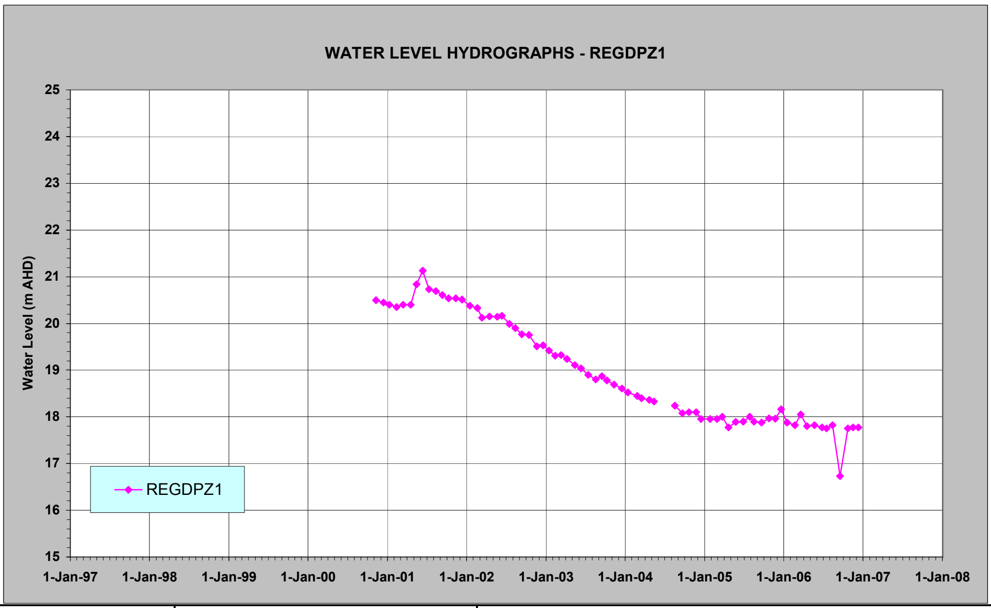
Peter Dundon & Associates Pty Limited				**Figure 1-7**







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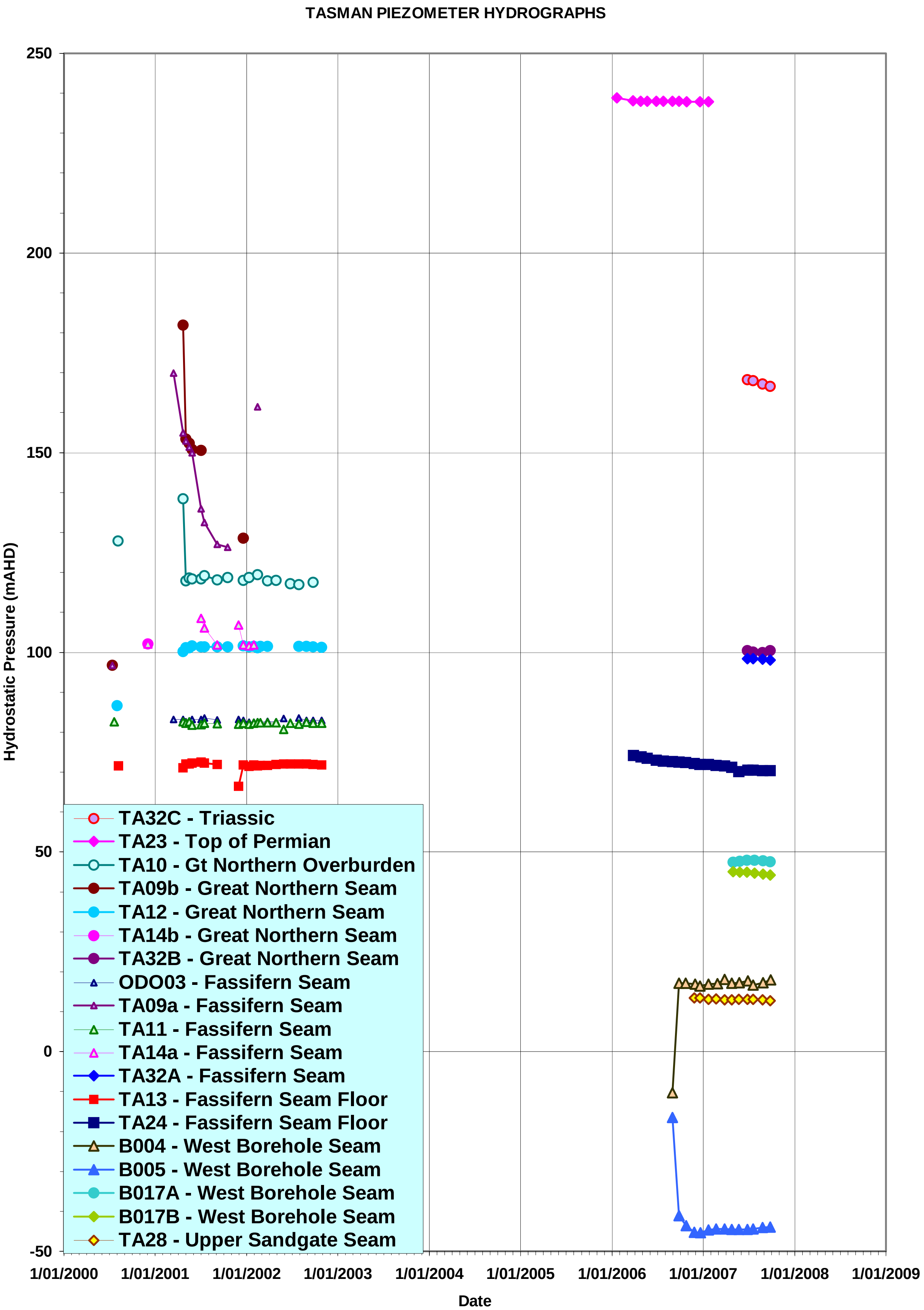

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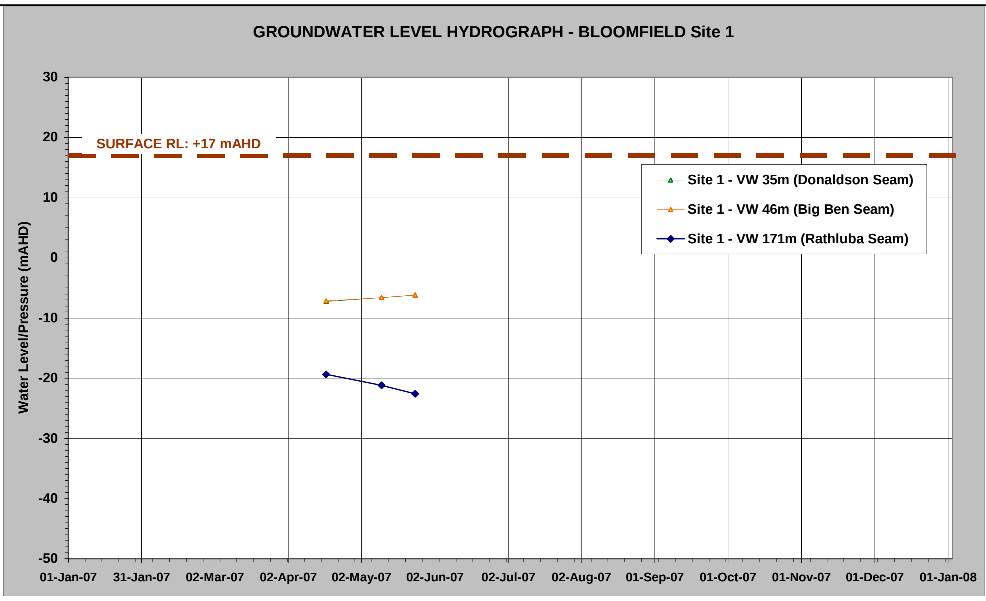
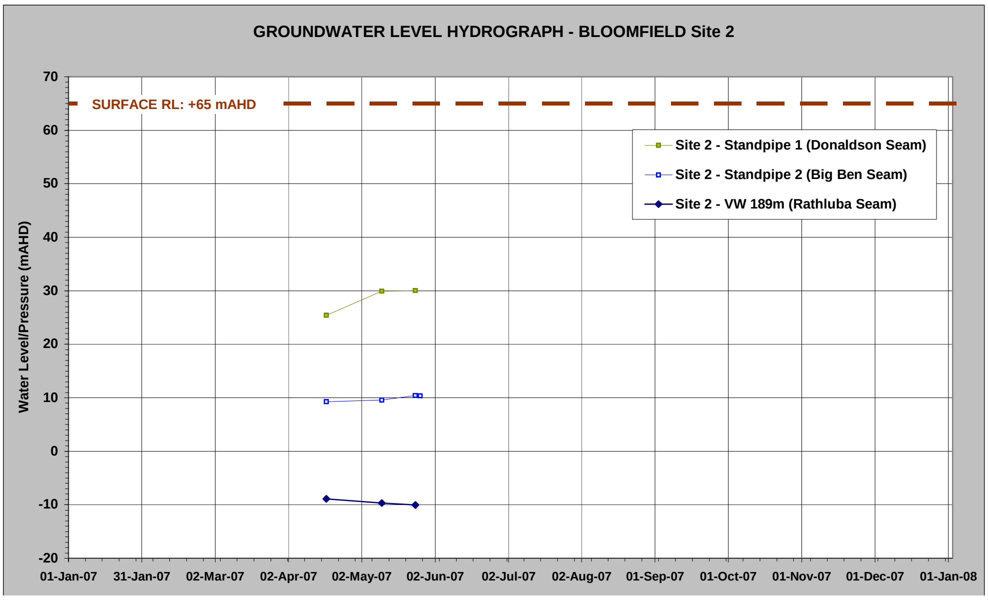
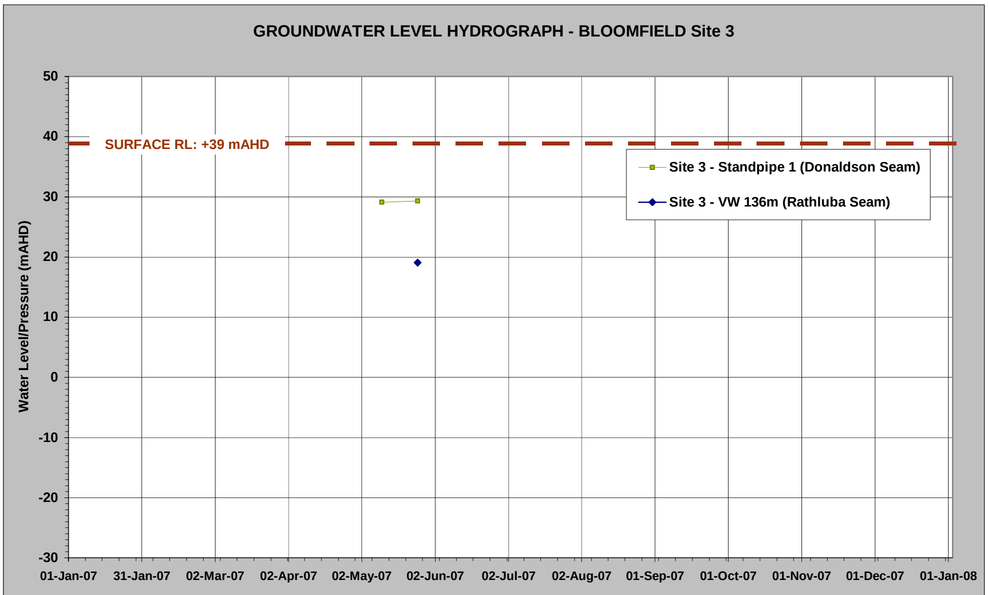
Peter Dundon and Associates Pty Limited				**Figure 1-9**







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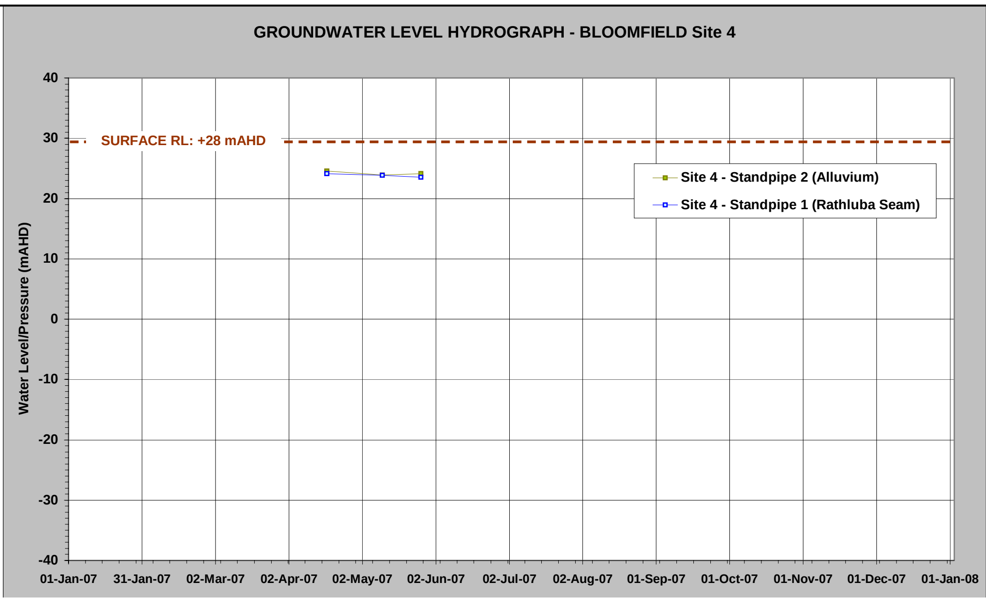
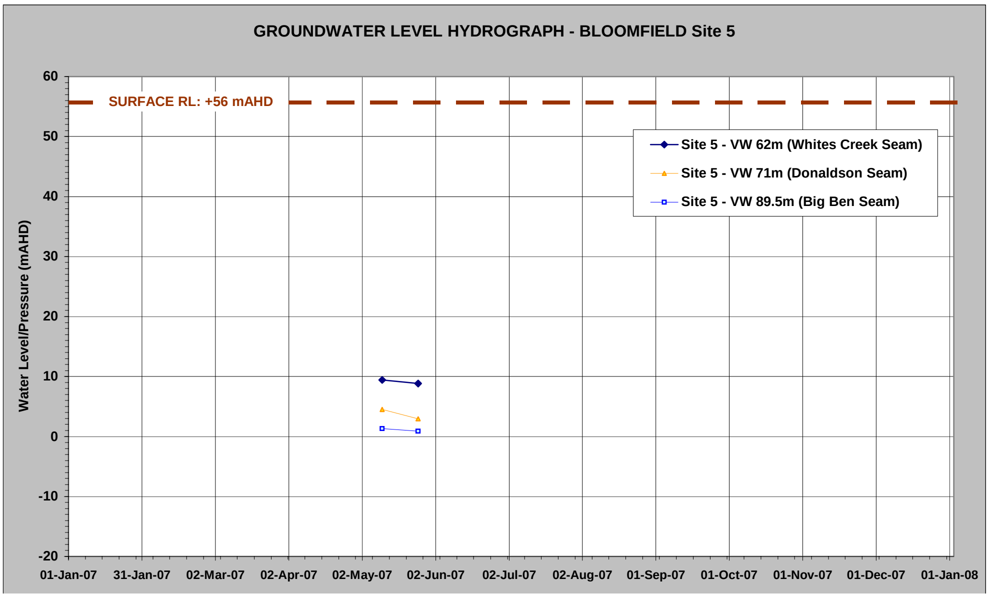
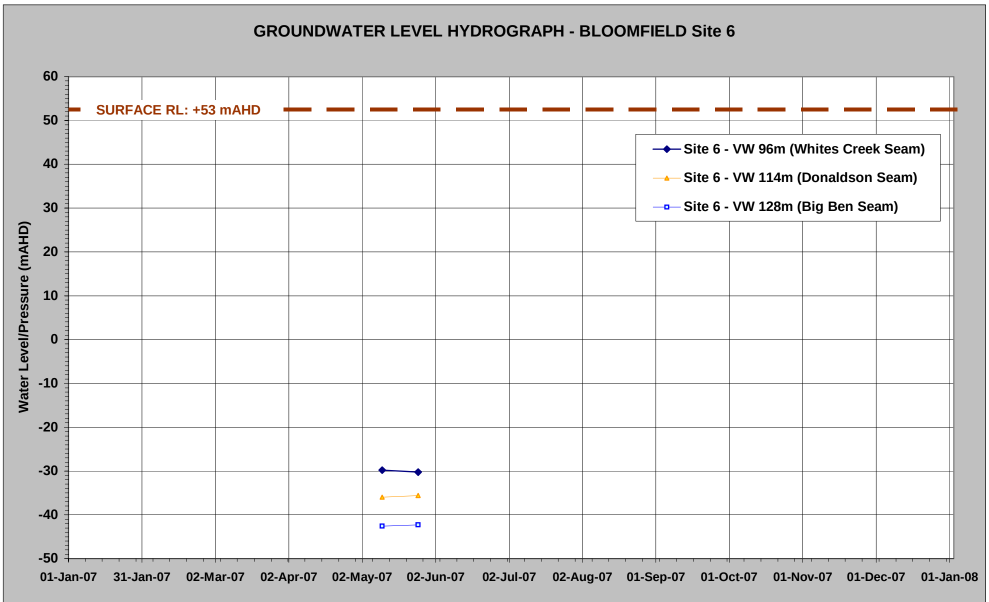
Peter Dundon and Associates Pty Limited		**Figure 1-10**







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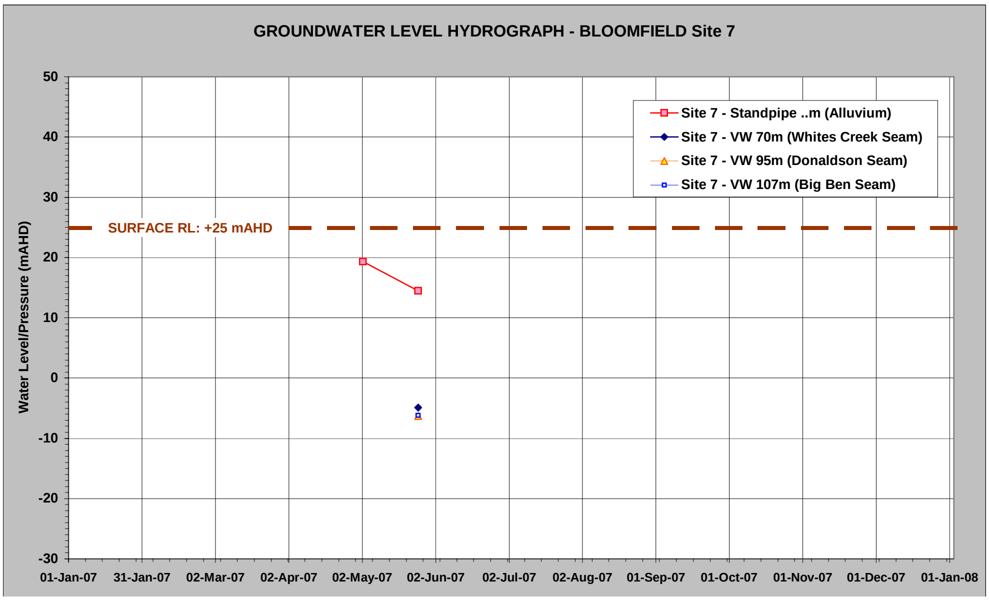
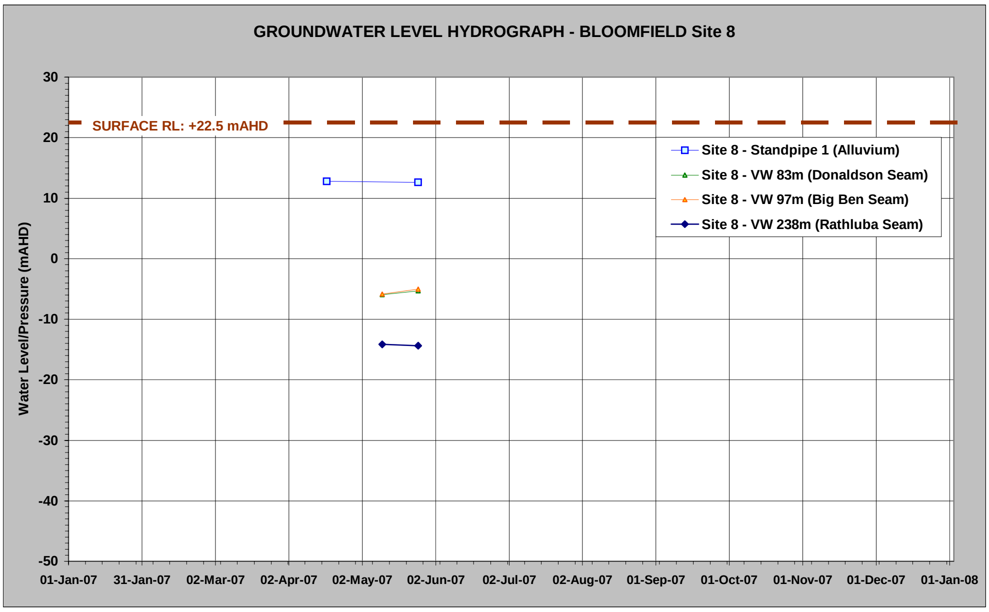
Peter Dundon and Associates Pty Limited		**Figure 1-11**





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Drawing No:	08-0197-013	Rev:	0	
Peter Dundon and Associates Pty Limited				**Figure 1-12**

Appendix 2

Water Balance Modelling

Appendix 2

Water Balance Modelling

DONALDSON COAL

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TABLES

FIGURES

1.0 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 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 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.

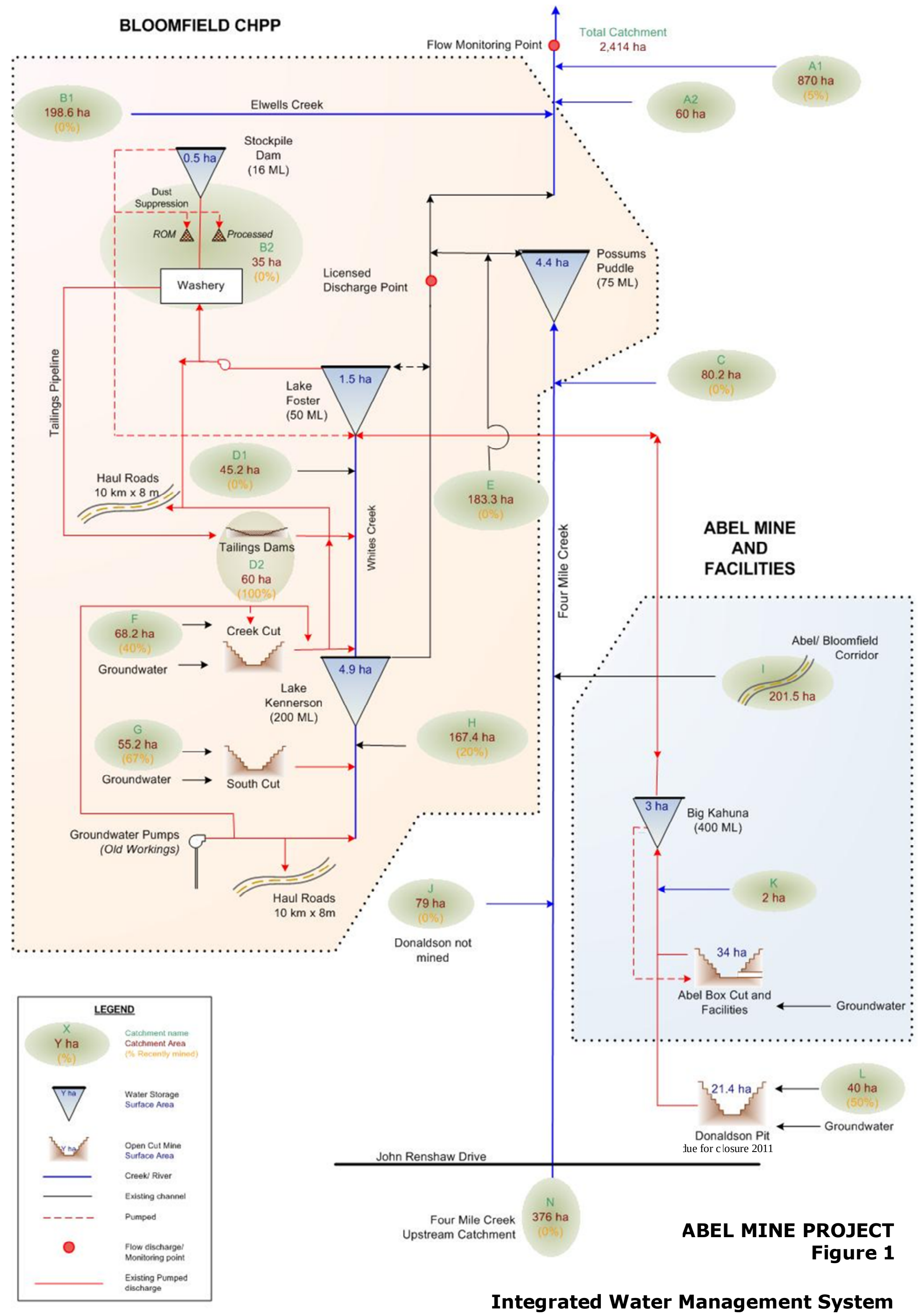
The model for assessment of water balance for the Abel Mine project includes:

- 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 or controlled gravity flow between storages;
- water losses as a result of 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.

To demonstrate the capacity of the water management system to cater for anticipated future conditions, the model has been operated for a range of climatic scenarios at key stages in the life of the project, representing different stages of mine production, the associated groundwater inflow to the workings and the requirements for water in the CHPP.

DONALDSON COAL



ABEL MINE PROJECT
Figure 1

Integrated Water Management System
Abel, Bloomfield and Donaldson Mines

2.0 SURFACE RUNOFF MODELLING

A variety of different land surfaces contribute to flow in Four Mile Creek including "natural" bushland areas, areas cleared for grazing, mine overburden dumps and various mine stockpile areas and haul roads. The hydrologic response of these land surfaces to rainfall and evapotranspiration has been represented in the water balance model for the Four Mile Creek catchment using the AWBM model. AWBM is a catchment water balance model, developed for Australian conditions, that uses rainfall and evaporation data to generate catchment daily runoff. The model represents a catchment as three surface moisture stores with different storage and runoff characteristics. Each of the three surface stores is assigned 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.

At each time step (daily in this case), rainfall is added to each of the three surface moisture stores and evapotranspiration and deep drainage is subtracted from the stores. Runoff occurs when there is excess moisture in any of the stores. The model also calculates baseflow as a function of baseflow storage and a baseflow recession constant.

Lyall & Macoun Consulting Engineers (LMCE) (1998) utilised the AWBM model as the basis for a catchment management study of the Morpeth-Tenambit, Woodberry and Millers Forest catchments on behalf of the Maitland Landcare Group. The catchments studied by LMCE adjoin the Four Mile Creek catchment and contain a similar range of land uses. For the LMCE study, the AWBM model was calibrated using 11 years of flow records from Pokolbin Creek. 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. 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 2.1.**

Table 2.1: Land Use and Runoff Data from the AWBM Model Prepared by LMCE (1998)

Land Use Type	Impervious (%)	Average Runoff (% of rainfall)
1. Bushland	0	12
2. Grazing	5	15
3. Rural Industry	10	21
4. Urban Residential	35	29
5. Urban Industrial	90	58

Table 2.1 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.

3.0 WATER BALANCE MODEL

3.1 Climate Data

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

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

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 various 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 3.1 summarises the catchment areas and characteristics used in the Four Mile creek water balance model.

Table 3.1: 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 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
Four Mile Catchment north of John Renshaw Drive outside Bloomfield &	I	202	0	0	202

Table 3.1: 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)
Donaldson Leases					
Donaldson not mined	J	79	0	0	79
Catchment to Big Kahuna Dam	K	2	0	0	2
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 1

3.3 Water Storages

The model includes five key water storages that form part of the Bloomfield, Donaldson and Abel water management systems. For modelling purposes, a number of small storages that feed the key storages have been ignored. The characteristics of the key storages have been derived from data provided by each mine and are summarised in **Table 3.2**.

Table 3.2: 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 loss from the storages.

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 (2010, 2015, 2020 and 2027 – see

Section 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.

Table 3.3 below summarises the annual ROM coal production, coarse and fine tailings production and water requirements for the CHPP for the expected production from the Abel Underground Mine and other mines feeding the Bloomfield CHPP. In the case of Abel, production is expected to increase from 0.35 million tonnes per year ROM coal in 2008 to 4 million tonnes per year in 2013 after which production would remain constant until 2021 and then gradually decrease to 0.5 million tonnes per year by 2027.

Table 3.3: Projected Annual Coal Production, Tailings Disposal and Water Requirements

Year	ROM Coal Production (t x 1,000)							Coarse Rejects (t x 1,000)	Fine Tailings (t x 1,000)	Cumulative Tailings & Rejects (m^3 x 1,000)	Annual Water Req'd (ML)
	Bloomfield O/C	Donaldson O/C	Other O/C	Tasman U/G	Abel U/G	Other U/G	Total				
2008	800	2,250		800	350		4,200	779	519	3,023	2,655
2009	800	2,250		975	750		4,775	848	565	4,256	2,896
2010	800	1,200		975	1,250		4,225	687	458	5,256	2,356
2011			800	975	2,000	200	3,975	549	366	6,054	1,898
2012			800	975	3,000	200	4,975	669	446	7,028	2,316
2013			800	975	4,000	200	5,975	789	526	8,176	2,734
2014			800	975	4,000	200	5,975	789	526	9,324	2,734
2015			800	900	4,000	200	5,900	780	520	10,459	2,703
2016			800	760	4,000	200	5,760	763	509	11,569	2,644
2017			800	600	4,000	200	5,600	744	496	12,652	2,577
2018			800	450	4,000	200	5,450	726	484	13,708	2,515
2019			800		4,000	200	5,000	672	448	14,686	2,327
2020			800		4,000	200	5,000	672	448	15,664	2,327
2021			800		4,000	200	5,000	672	448	16,641	2,327
2022			800		3,000	200	4,000	552	368	17,445	1,908
2023			800		2,500	200	3,500	492	328	18,160	1,699
2024			800		2,000	200	3,000	432	288	18,789	1,490
2025			800		1,500	200	2,500	372	248	19,330	1,281
2026			800		1,000	200	2,000	312	208	19,784	1,072
2027			800		500	200	1,500	252	168	20,151	863

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%

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.

3.5.1 Abel Underground Mine

The average inflows quoted in **Table 3.4** below are the average daily rates for each year, derived from the groundwater modelling results provided by Aquaterra Simulations.

Table 3.4: Estimated Groundwater Inflow into Abel Underground Workings

Calendar Year	Average Inflow (ML/day)	Annual Inflow (ML/year)
2008	0.02	4
2009	0.02	7
2010	0.10	21
2011	0.17	49
2012	0.35	95
2013	0.52	158
2014	0.75	231
2015	0.97	313
2016	1.19	394
2017	1.40	472
2018	1.56	541
2019	1.72	600
2020	1.90	661
2021	2.07	724
2022	2.19	778
2023	2.32	824
2024	2.56	891
2025	2.79	977
2026	2.97	1,053
2027	3.15	1,118

(Source - Aquaterra Simulations, June 2006)

3.5.2 Donaldson Open Cut Mine

Table 3.5: Estimated Groundwater Inflow into Donaldson Open Cut

Date	Inflow (ML/day)
Feb-07	0.27
Feb-08	0.275
Feb-09	0.28
Feb-11	0.3

(Source: Donaldson Water Balance Review:
Hughes Trueman + Peter Dundon & Associates, 2003)
Note: Donaldson Open Cut due for closure in 2011

3.5.3 Bloomfield Open Cut Mine

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

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. Groundwater pumping is undertaken under two circumstances:

- when groundwater pumping is required to control groundwater levels and thereby reduce groundwater inflow to the Bloomfield mine pit.
- when water is not available from surface runoff sources or pit inflow.

As shown in **Table 3.4,** it is predicted that groundwater inflow to the Abel underground workings will progressively increase from 21 ML/year in 2010 to 1,118 ML/year in 2027. It is proposed that once all requirements for operation of the Abel Mine have been satisfied (dust suppression and water for the mining process) any excess water will be transferred to Bloomfield. This water will be substituted for water that has, in the past, been drawn from the groundwater pumps on Bloomfield. The model assumes that excess water from the Abel project is given priority for supply of the CHPP. Water is only taken from the Bloomfield underground workings to make up for any shortfall.

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;
- Minimise discharge from Big Kahuna;
- Minimise discharge from the Bloomfield Stockpile Dam;
- Minimise discharge from 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.

3.7 Model Validation

For validation purposes, the water balance model 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 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.

Further details of the model validation are provided in Appendix 4 of the Environmental Assessment report for the Abel Project (November 2006).

4.0 MODEL SCENARIOS AND RESULTS

4.1 Climate 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 has been run to represent mining and operating conditions (as summarised in **Table 3.3**) for the following representative milestone years; 2010, 2015, 2020 and 2027.

For each milestone year the model was run for the 1974-89 climate sequence from which statistics were extracted for representative years as set out in **Table 4.1**.

Table 4.1: Climatic Scenarios Used in Water Balance Modelling

Rainfall Statistic	Average Annual Rainfall (mm)
Median rainfall year	892
10 percentile (dry) year	673
90 percentile (wet) year	1,198

4.2 Model Setup

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. 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 **Table 3.3**;
- Changes in groundwater inflows to open cut pits and underground workings (as set out in **Table 3.4** above) to reflect the status of the mines at that time.

For each milestone year 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 3.6**.

The operating parameters in the model (target water levels in storages and pumping rates) were adjusted until the system achieved satisfactory performance against the criteria listed above. **Table 4.2** summarises the adopted operational rules. As further operating experience is gained, it is anticipated that there will be regular reviews of the water management plan and further refinement of the operating rules.

Table 4.2: 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

As summarised in **Table 4.2** a target maximum operating level 75% of the capacity of Big Kahuna Dam has been adopted for the model 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. (Note that the pipeline has a design capacity of 10 ML/day to allow for additional pumping if necessary to avoid discharge from Big Kahuna).

The operating rules adopted for the Stockpile Dam are:

- target maximum operating level 25% of capacity above which water would be transferred to Lake Foster;
- pumping rate to Lake Foster of 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).

The detailed model results for specific years were consolidated into a summary for the major storages in the system (Big Kahuna, Lake Kennerson and Lake Foster) and the overall water balance for each of these storages was calculated for each year of the project life based on the surface runoff and dust suppression volumes derived from the detailed model and the predicted groundwater inflows (**Sections 3.5.1** to **3.5.3** above) and CHPP water requirements as set out in **Table 3.3**. Any shortfall in water for to meet all operational requirements (including the CHPP) was assumed to be sourced from the Bloomfield groundwater pumps that extract water from old underground workings within the Bloomfield mine lease area.

4.3 Model Results

Table 4.3 to **Table 4.5** below provide consolidated summaries of the estimated inflows, water uses and losses for the Big Kahuna Dam, Lake Kennerson and Lake Foster for each year of the Abel project for the three reference climatic years:

- Median rainfall year (892 mm) **Table 4.3**
- 1 in 10 dry year (673 mm) **Table 4.4**
- 1 in 10 wet year (1,198 mm) **Table 4.5**

Table 4.6 summarises the overall water balance for the whole of the Abel/Donaldson/Bloomfield combined water management system for each of the three climate years represented in **Table 4.3**, **Table 4.4** and **Table 4.5**. The column "Balance Check" for each of the reference years provides a check that the total inputs (surface runoff and groundwater) equal the uses and losses.

Table 4.3 Estimated Water Balance for Each Year of the Abel Project in a Median Rainfall Year (892 mm)

				Abel/Donaldson Area - Big Kahuna								Bloomfield Area - Lake Kennerson					Bloomfield Area - Lake Foster								
				Inflow				Uses & Losses				Inflow		Uses & Losses			Inflow					Uses & Losses			
Year	Total ROM Production (t x 1000)	CHPP Water Demand (ML)	Abel U/G Demand (ML)	Pit Inflow (ML)	Underground Inflow (ML)	Surface Runoff (ML)	Import from Bloomfield (ML)	Net Evap and Seepage (ML)	Total Water Use (ML)	Transfer to Bloomfield (ML)	Overflow (ML)	Pit Inflow (ML)	Surface Runoff (ML)	Net Evap and Seepage (ML)	Transfer to L Foster (ML)	Controlled Discharge (ML)	Transfer from Big Kahuna (ML)	Transfer from Stockpile Net Evap and Seepage (ML)	Groundwater Pumping from Old Workings (ML)	Surface Runoff (ML)	Import from L Kennerson (ML)	Net Evap and Seepage (ML)	Dust Suppression Uses (ML)	CHPP and Lost in Product (ML)	Overflow (ML)
2008	4,200	-2,655	-9	299	4	127	0	-28	-52	-350	0	37	638	-46	-525	-103	350	408	1,572	68	525	-14	-255	-2,655	0
2009	4,775	-2,896	-19	299	7	127	0	-28	-62	-343	0	37	638	-46	-530	-98	343	408	1,815	68	530	-14	-255	-2,896	0
2010	4,225	-2,356	-31	299	21	127	0	-28	-74	-345	0	37	638	-46	-537	-91	345	408	1,266	68	537	-14	-255	-2,356	0
2011	3,975	-1,898	-50	0	49	88	0	-28	-93	-16	0	37	638	-46	-552	-77	16	408	1,123	68	552	-14	-255	-1,898	0
2012	4,975	-2,316	-75	0	95	88	0	-28	-118	-37	0	37	638	-46	-554	-75	37	408	1,518	68	554	-14	-255	-2,316	0
2013	5,975	-2,734	-100	0	158	88	0	-28	-143	-75	0	0	634	-46	-512	-76	75	408	1,939	68	512	-14	-255	-2,734	0
2014	5,975	-2,734	-100	0	231	88	0	-28	-143	-148	0	0	634	-46	-505	-83	148	408	1,873	68	505	-14	-255	-2,734	0
2015	5,900	-2,703	-100	0	314	88	0	-28	-143	-231	0	0	634	-46	-496	-92	231	408	1,768	68	496	-14	-255	-2,703	0
2016	5,760	-2,644	-100	0	394	88	0	-28	-143	-311	0	0	634	-46	-491	-97	311	408	1,634	68	491	-14	-255	-2,644	0
2017	5,600	-2,577	-100	0	472	88	0	-28	-143	-389	0	0	634	-46	-483	-105	389	408	1,497	68	483	-14	-255	-2,577	0
2018	5,450	-2,515	-100	0	541	88	0	-28	-143	-458	0	0	634	-46	-481	-107	458	408	1,368	68	481	-14	-255	-2,515	0
2019	5,000	-2,327	-100	0	600	88	0	-28	-143	-517	0	0	634	-46	-479	-109	517	408	1,123	68	479	-14	-255	-2,327	0
2020	5,000	-2,327	-100	0	661	88	0	-28	-143	-578	0	0	634	-46	-477	-111	578	408	1,064	68	477	-14	-255	-2,327	0
2021	5,000	-2,327	-100	0	724	88	0	-28	-143	-641	0	0	634	-46	-471	-117	641	408	1,007	68	471	-14	-255	-2,327	0
2022	4,000	-1,908	-75	0	778	88	0	-28	-118	-720	0	0	634	-46	-451	-137	720	408	529	68	451	-14	-255	-1,908	0
2023	3,500	-1,699	-63	0	824	88	0	-28	-106	-778	0	0	634	-46	-429	-159	778	408	284	68	429	-14	-255	-1,699	0
2024	3,000	-1,490	-50	0	891	88	0	-28	-93	-858	0	0	634	-46	-350	-238	858	408	74	68	350	-14	-255	-1,490	0
2025	2,500	-1,281	-38	0	977	88	0	-28	-81	-956	0	0	634	-46	-43	-545	956	408	74	68	43	-14	-255	-1,281	0
2026	2,000	-1,072	-25	0	1,053	88	0	-28	-68	-1,045	0	0	634	-46	0	-588	1,045	408	0	68	0	-14	-255	-1,072	-181
2027	1,500	-863	-13	0	1,118	88	0	-28	-56	-1,122	0	0	634	-46	0	-588	1,122	408	0	68	0	-14	-255	-863	-467

DONALDSON COAL

Table 4.4 Estimated Water Balance for Each Year of the Abel Project in a 1 in 10 Dry Year (673 mm)

				Abel/Donaldson Area - Big Kahuna								Bloomfield Area - Lake Kennerson					Bloomfield Area - Lake Foster								
				Inflow				Uses & Losses				Inflow		Uses & Losses			Inflow					Uses & Losses			
Year	Total ROM Production (t x 1000)	CHPP Water Demand (ML)	Abel U/G Demand (ML)	Pit Inflow (ML)	Underground Inflow (ML)	Surface Runoff (ML)	Import from Bloomfield (ML)	Net Evap and Seepage (ML)	Total Water Use (ML)	Transfer to Bloomfield (ML)	Overflow (ML)	Pit Inflow (ML)	Surface Runoff (ML)	Net Evap and Seepage (ML)	Transfer to L Foster (ML)	Controlled Discharge (ML)	Transfer from Big Kahuna (ML)	Transfer from Stockpile Net Evap and Seepage (ML)	Groundwater Pumping from Old Workings (ML)	Surface Runoff (ML)	Import from L Kennerson (ML)	Net Evap and Seepage (ML)	Dust Suppression Uses (ML)	CHPP and Lost in Product (ML)	Overflow (ML)
2008	4,200	-2,655	-9	299	4	105	0	-40	-59	-310	0	37	523	-65	-410	-85	310	345	1,812	63	410	-20	-264	-2,655	0
2009	4,775	-2,896	-19	299	7	105	0	-40	-69	-303	0	37	523	-65	-411	-84	303	345	2,059	63	411	-20	-264	-2,896	0
2010	4,225	-2,356	-31	299	21	105	0	-40	-81	-304	0	37	523	-65	-411	-84	304	345	1,518	63	411	-20	-264	-2,356	0
2011	3,975	-1,898	-50	0	49	72	0	-40	-100	19	0	37	539	-65	-454	-58	-19	345	1,339	63	454	-20	-264	-1,898	0
2012	4,975	-2,316	-75	0	95	72	0	-40	-125	-2	0	37	539	-65	-462	-50	2	345	1,728	63	462	-20	-264	-2,316	0
2013	5,975	-2,734	-100	0	158	72	0	-40	-150	-40	0	0	539	-65	-420	-55	40	345	2,150	63	420	-20	-264	-2,734	0
2014	5,975	-2,734	-100	0	231	72	0	-40	-150	-113	0	0	539	-65	-408	-67	113	345	2,089	63	408	-20	-264	-2,734	0
2015	5,900	-2,703	-100	0	314	72	0	-40	-150	-197	0	0	539	-65	-400	-75	197	345	1,983	63	400	-20	-264	-2,703	0
2016	5,760	-2,644	-100	0	394	72	0	-40	-150	-276	0	0	539	-65	-394	-81	276	345	1,850	63	394	-20	-264	-2,644	0
2017	5,600	-2,577	-100	0	472	72	0	-40	-150	-354	0	0	539	-65	-388	-87	354	345	1,711	63	388	-20	-264	-2,577	0
2018	5,450	-2,515	-100	0	541	72	0	-40	-150	-423	0	0	539	-65	-381	-94	423	345	1,587	63	381	-20	-264	-2,515	0
2019	5,000	-2,327	-100	0	600	72	0	-40	-150	-482	0	0	539	-65	-374	-101	482	345	1,347	63	374	-20	-264	-2,327	0
2020	5,000	-2,327	-100	0	661	72	0	-40	-150	-543	0	0	539	-65	-357	-118	543	345	1,303	63	357	-20	-264	-2,327	0
2021	5,000	-2,327	-100	0	724	72	0	-40	-150	-606	0	0	539	-65	-352	-123	606	345	1,245	63	352	-20	-264	-2,327	0
2022	4,000	-1,908	-75	0	778	72	0	-40	-125	-685	0	0	539	-65	-336	-139	685	345	763	63	336	-20	-264	-1,908	0
2023	3,500	-1,699	-63	0	824	72	0	-40	-113	-744	0	0	539	-65	-323	-152	744	345	509	63	323	-20	-264	-1,699	0
2024	3,000	-1,490	-50	0	891	72	0	-40	-100	-823	0	0	539	-65	-298	-177	823	345	245	63	298	-20	-264	-1,490	0
2025	2,500	-1,281	-38	0	977	72	0	-40	-88	-922	0	0	539	-65	-175	-300	922	345	61	63	175	-20	-264	-1,281	0
2026	2,000	-1,072	-25	0	1,053	72	0	-40	-75	-1,010	0	0	539	-65	0	-475	1,010	345	0	63	0	-20	-264	-1,072	-62
2027	1,500	-863	-13	0	1,118	72	0	-40	-63	-1,088	0	0	539	-65	0	-475	1,088	345	0	63	0	-20	-264	-863	-348

Table 4.5 Estimated Water Balance for Each Year of the Abel Project in a 1 in 10 Wet Year (673 mm)

				Abel/Donaldson Area - Big Kahuna								Bloomfield Area - Lake Kennerson					Bloomfield Area - Lake Foster								
				Inflow				Uses & Losses				Inflow		Uses & Losses			Inflow					Uses & Losses			
Year	Total ROM Production (t x 1000)	CHPP Water Demand (ML)	Abel U/G Demand (ML)	Pit Inflow (ML)	Underground Inflow (ML)	Surface Runoff (ML)	Import from Bloomfield (ML)	Net Evap and Seepage (ML)	Total Water Use (ML)	Transfer to Bloomfield (ML)	Overflow (ML)	Pit Inflow (ML)	Surface Runoff (ML)	Net Evap and Seepage (ML)	Transfer to L Foster (ML)	Controlled Discharge (ML)	Transfer from Big Kahuna (ML)	Transfer from Stockpile Net Evap and Seepage (ML)	Groundwater Pumping from Old Workings (ML)	Surface Runoff (ML)	Import from L Kennerson (ML)	Net Evap and Seepage (ML)	Dust Suppression Uses (ML)	CHPP and Lost in Product (ML)	Overflow (ML)
2008	4,200	-2,655	-9	299	4	173	0	-17	-46	-413	0	37	897	-27	-806	-101	413	429	1,176	88	806	-8	-249	-2,655	0
2009	4,775	-2,896	-19	299	7	173	0	-17	-56	-406	0	37	897	-27	-808	-99	406	429	1,422	88	808	-8	-249	-2,896	0
2010	4,225	-2,356	-31	299	21	173	0	-17	-68	-408	0	37	897	-27	-808	-98	408	429	880	88	808	-8	-249	-2,356	0
2011	3,975	-1,898	-50	0	49	126	0	-17	-87	-71	0	37	897	-27	-825	-82	71	429	743	88	825	-8	-249	-1,898	0
2012	4,975	-2,316	-75	0	95	126	0	-17	-112	-92	0	37	897	-27	-834	-73	92	429	1,131	88	834	-8	-249	-2,316	0
2013	5,975	-2,734	-100	0	158	126	0	-17	-137	-130	0	0	874	-27	-762	-84	130	429	1,582	88	762	-8	-249	-2,734	0
2014	5,975	-2,734	-100	0	231	126	0	-17	-137	-203	0	0	874	-27	-757	-89	203	429	1,514	88	757	-8	-249	-2,734	0
2015	5,900	-2,703	-100	0	314	126	0	-17	-137	-286	0	0	874	-27	-745	-101	286	429	1,412	88	745	-8	-249	-2,703	0
2016	5,760	-2,644	-100	0	394	126	0	-17	-137	-366	0	0	874	-27	-745	-101	366	429	1,273	88	745	-8	-249	-2,644	0
2017	5,600	-2,577	-100	0	472	126	0	-17	-137	-444	0	0	874	-27	-744	-102	444	429	1,129	88	744	-8	-249	-2,577	0
2018	5,450	-2,515	-100	0	541	126	0	-17	-137	-513	0	0	874	-27	-744	-102	513	429	998	88	744	-8	-249	-2,515	0
2019	5,000	-2,327	-100	0	600	126	0	-17	-137	-572	0	0	874	-27	-743	-103	572	429	752	88	743	-8	-249	-2,327	0
2020	5,000	-2,327	-100	0	661	126	0	-17	-137	-633	0	0	874	-27	-742	-104	633	429	692	88	742	-8	-249	-2,327	0
2021	5,000	-2,327	-100	0	724	126	0	-17	-137	-696	0	0	874	-27	-723	-123	696	429	648	88	723	-8	-249	-2,327	0
2022	4,000	-1,908	-75	0	778	126	0	-17	-112	-775	0	0	874	-27	-699	-147	775	429	174	88	699	-8	-249	-1,908	0
2023	3,500	-1,699	-63	0	824	126	0	-17	-100	-834	0	0	874	-27	-500	-346	834	429	106	88	500	-8	-249	-1,699	0
2024	3,000	-1,490	-50	0	891	126	0	-17	-87	-913	0	0	874	-27	-211	-635	913	429	106	88	211	-8	-249	-1,490	0
2025	2,500	-1,281	-38	0	977	126	0	-17	-75	-1,012	0	0	874	-27	-106	-635	1,012	429	0	88	106	-8	-249	-1,281	-201
2026	2,000	-1,072	-25	0	1,053	126	0	-17	-62	-1,100	0	0	874	-27	-106	-635	1,100	429	0	88	106	-8	-249	-1,072	-499
2027	1,500	-863	-13	0	1,118	126	0	-17	-50	-1,178	0	0	874	-27	-106	-635	1,178	429	0	88	106	-8	-249	-863	-785

Table 4.6 Overall System Water Balance for Median, 1 in 10 Dry Year and 1 in 10 Wet Year

				Median Rainfall Year						1 in 10 Dry Year						1 in 10 Dry Year					
				Inflows		Losses				Inflows		Losses				Inflows		Losses			
Year	Total ROM Production (t x 1000)	CHPP Water Demand (ML)	Abel U/G Demand (ML)	Groundwater Inflows (ML)	Surface Runoff (ML)	Net Evaporation & Seepage (ML)	Total all Uses (ML)	Total Discharge & Overflow (ML)	Water Balance Check (ML)	Groundwater Inflows (ML)	Surface Runoff (ML)	Net Evaporation & Seepage (ML)	Total all Uses (ML)	Total Discharge & Overflow (ML)	Water Balance Check (ML)	Groundwater Inflows (ML)	Surface Runoff (ML)	Net Evaporation & Seepage (ML)	Total all Uses (ML)	Total Discharge & Overflow (ML)	Water Balance Check (ML)
2008	4,200	-2,655	-9	1,911	1,241	-88	-2,962	-103	0	2,152	1,036	-124	-2,978	-85	0	1,516	1,587	-53	-2,950	-101	0
2009	4,775	-2,896	-19	2,157	1,241	-88	-3,213	-98	0	2,402	1,036	-124	-3,229	-84	0	1,765	1,587	-53	-3,201	-99	0
2010	4,225	-2,356	-31	1,623	1,241	-88	-2,685	-91	0	1,874	1,036	-124	-2,702	-84	0	1,237	1,587	-53	-2,674	-98	0
2011	3,975	-1,898	-50	1,209	1,202	-88	-2,246	-77	0	1,425	1,019	-124	-2,262	-58	0	829	1,540	-53	-2,234	-82	0
2012	4,975	-2,316	-75	1,650	1,202	-88	-2,689	-75	0	1,860	1,019	-124	-2,705	-50	0	1,263	1,540	-53	-2,677	-73	0
2013	5,975	-2,734	-100	2,097	1,199	-88	-3,132	-76	0	2,308	1,019	-124	-3,148	-55	0	1,740	1,517	-53	-3,120	-84	0
2014	5,975	-2,734	-100	2,104	1,199	-88	-3,132	-83	0	2,320	1,019	-124	-3,148	-67	0	1,745	1,517	-53	-3,120	-89	0
2015	5,900	-2,703	-100	2,082	1,199	-88	-3,101	-92	0	2,297	1,019	-124	-3,117	-75	0	1,726	1,517	-53	-3,089	-101	0
2016	5,760	-2,644	-100	2,028	1,199	-88	-3,042	-97	0	2,244	1,019	-124	-3,058	-81	0	1,667	1,517	-53	-3,030	-101	0
2017	5,600	-2,577	-100	1,969	1,199	-88	-2,975	-105	0	2,183	1,019	-124	-2,991	-87	0	1,601	1,517	-53	-2,963	-102	0
2018	5,450	-2,515	-100	1,909	1,199	-88	-2,913	-107	0	2,128	1,019	-124	-2,929	-94	0	1,539	1,517	-53	-2,901	-102	0
2019	5,000	-2,327	-100	1,723	1,199	-88	-2,725	-109	0	1,947	1,019	-124	-2,741	-101	0	1,352	1,517	-53	-2,713	-103	0
2020	5,000	-2,327	-100	1,725	1,199	-88	-2,725	-111	0	1,964	1,019	-124	-2,741	-118	0	1,353	1,517	-53	-2,713	-104	0
2021	5,000	-2,327	-100	1,731	1,199	-88	-2,725	-117	0	1,969	1,019	-124	-2,741	-123	0	1,372	1,517	-53	-2,713	-123	0
2022	4,000	-1,908	-75	1,307	1,199	-88	-2,281	-137	0	1,541	1,019	-124	-2,297	-139	0	952	1,517	-53	-2,269	-147	0
2023	3,500	-1,699	-63	1,108	1,199	-88	-2,059	-159	0	1,333	1,019	-124	-2,076	-152	0	930	1,517	-53	-2,048	-346	0
2024	3,000	-1,490	-50	965	1,199	-88	-1,838	-238	0	1,136	1,019	-124	-1,854	-177	0	997	1,517	-53	-1,826	-635	0
2025	2,500	-1,281	-38	1,051	1,199	-88	-1,616	-545	0	1,038	1,019	-124	-1,633	-300	0	977	1,517	-53	-1,605	-836	0
2026	2,000	-1,072	-25	1,053	1,199	-88	-1,395	-769	0	1,053	1,019	-124	-1,411	-537	0	1,053	1,517	-53	-1,383	-1,134	0
2027	1,500	-863	-13	1,118	1,199	-88	-1,173	-1,055	0	1,118	1,019	-124	-1,190	-823	0	1,118	1,517	-53	-1,162	-1,420	0

The water balance estimates in **Table 4.3**, **Table 4.4** and **Table 4.5** show the following features:

- Water supply for all mine purposes can be provided by the water management system without extracting water from the old Bloomfield underground workings at a greater rate than has be extracted historically.
- The demand for supply from the Bloomfield underground workings will gradually reduce as additional water becomes available from the Abel underground workings.
- The proposed operating rules for Big Kahuna lead to minimal risk of overflow to Four Mile Creek.
- Some discharge from Lake Kennerson is likely to continue under most climate conditions, reflecting the modelling assumption that all excess water held in "Big Kahuna" would be transferred to Bloomfield (rather than held in storage in the Abel underground workings). It can be seen that the volume that needs to be discharged from Lake Kennerson increases towards the end of the life of the mine reflecting the predicted increased groundwater inflow to the Abel workings in later years (see **Table 3.4**) and reduced water demand for the CHPP as throughput declines (see **Table 3.3**). However, once water storage capacity becomes available in the worked out areas of the Abel Underground Mine, some excess water from the "Big Kahuna" could be stored underground and thereby reduce the need for discharge from Lake Kennerson.
- The detailed model results (not identified separately in **Table 4.3**, **Table 4.4** and **Table 4.5**) indicate that the Stockpile Dam would not overflow in any of the three representative climate years.

5.0 CONCLUSIONS

The water balance model results presented above indicate that by adopting the proposed target operating water levels in the various storages and transfer pumping rates, 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.
- Minimise discharge from the Big Kahuna Dam.
- Minimise discharge from the Stockpile Dam.
- Minimise discharge from Lake Kennerson.

The water balance 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. It is anticipated that the operating rules will be regularly reviewed and refined in the light of operating experience.