APPENDIX 1

Consent Conditions Extract - Mandalong

105 . *The Applicant shall, throughout the life of the mine and for a period of at least five years after the completion of mining, prepare and submit an Annual Environmental Management Report (AEMR) to the satisfaction of the Director-General. The AEMR shall review the performance of the mine against the Environmental Management Strategy and the relevant Mining Operations Plans, the conditions of this consent, and other licences and approvals relating to the mine. To enable ready comparison with the EIS's predictions, diagrams and tables, the report shall include, but not be limited to, the following matters:*

(i) an annual compliance audit of the performance of the project against conditions of this consent and statutory approvals;
(ii) a review of the effectiveness of the environmental management of the mine in terms of OEH, NOW, DRE, and Council requirements;

(iii) results of all environmental monitoring required under this consent or other approvals, including interpretations and discussion by a suitably qualified person;
(iv) an assessment of any changes to agricultural land suitability resulting from the mining operations, including cumulative changes;
(v) a listing of any variations obtained to approvals applicable to the subject area during the previous year;
(vi) the outcome of the water budget for the year, the quantity of water used from water storages and details of discharge of any water from the site;

(vii) rehabilitation report; and
(viii) environmental management targets and strategies for the next year.

106. In preparing the AEMR, the Applicant shall:

(i) consult with the Director-General during preparation of each report for any additional requirements;
(ii) comply with any requirements of the Director-General or other relevant government agency; and
(iii) ensure that the first report is completed and submitted within twelve months of this consent, or at a date determined by the Director-General in consultation with the DRE and the OEH.

107. The Applicant shall ensure that copies of each AEMR are submitted at the same time to the Department, OEH, NOW, Council and the Community Consultative Committee, and made available for public information at Council within fourteen days of submission to these authorities.

APPENDIX 1

Consent Conditions Extract - Delta

15 The Applicant shall submit an Annual Report to the Department. This report must provide:

(a) monthly records of the amount of coal transported on the Mandalong coal delivery system; and

(b) an annual Groundwater Monitoring Report detailing:

- *the interpretation of data and discussion of monitoring results, compared to groundwater and salinity impact predictions*
- *the level of compliance with the groundwater monitoring and trigger levels established in the Groundwater Management Plan; and*
- *identification of trends in monitoring data from the Groundwater Management Plan and comparison with the predictions over the life of the underground conveyor*

Note: the Annual Report should be included in the Mandalong coal Mine AEMR.

APPENDIX 2
Bank Guarantee

ANZ
ABN 11 005 357 522
TSC Operations-Australia Guarantees
Level 20, 55 Collins Street
Melbourne, VIC 3000
Tel: 1300 091 233
Fax: 1300 072 851
SWIFT: ANZBAU3MXXX

Guarantee No: DG161033418

SECURITY CERTIFICATE

BY Australia and New Zealand Banking Group Limited (ABN 11 005 357 522)
20/55 Collins Street Melbourne Victoria 3000

TO: Minister for Resources and Energy for the State of New South Wales.

Sir,

At the request of Centennial Coal Company Limited (ABN 30 003 714 538) for and on behalf of Centennial Mandalong Pty Limited (ABN 74 101 508 892) (hereinafter called "the Holder") and in consideration of the Minister for Resources and Energy for the State of New South Wales (hereinafter called "the Minister") accepting this undertaking as the security required for the fulfillment by the Holder of obligations under the title referred to In the Schedule hereto (hereinafter called "the title") the Australia and new Zealand Banking Group Limited (hereinafter called "the Financial Institution) unconditionally undertakes to pay on demand any sum or sums which may from time to time be demanded by the Minister to a maximum aggregate sum of **$11,550,000.00 (Eleven Million Five Hundred and Fifty Thousand Dollars)**.

1. In the event that the Financial Institution is notified in writing by the Minister that he desires payment to be made of the whole or any part or parts of the said sum, the Financial Institution unconditionally agrees that such payment or payments shall be made to the Minister forthwith without any further reference to the Holder and notwithstanding any notice given by the Holder to the Financial Institution not to pay the same.

2. This Certificate shall continue in force until terminated by notification from the Minister provided that the Financial Institution may at any time without being required so to do pay to the Minister the said sum of **$11,550,000.00 (Eleven Million Five Hundred and Fifty Thousand Dollars)** less any amount or amounts it may previously have paid under this Certificate or such lesser sum as may be specified by the Minister as representing full satisfaction for the undertaking and covenant herein and thereupon the liability of the Financial Institution hereunder shall immediately cease and determine.

3. The liability of the Financial Institution under these presents shall not be in any way discharged or impaired by reason of any variation or variations (with or without the knowledge or Consent of the Financial Institution) in any of the obligations of the Holder under the title aforesaid or by reason or any breach or breaches (willful or otherwise) of the said obligations committed (with or without the knowledge or consent of the Financial Institution) by or on behalf of the Holder with the knowledge or consent of the Minister or of any agent or servant of the Crown, or by the granting by the Minister or by others on his behalf of any time credit forbearance or indulgence to the Holder or persons who have contracted with the Holder.

4. The Financial Institution shall obtain for itself on its own responsibility and its own expense its own information on all matters affecting the obligations of the Holder under the title aforesaid or any variation thereof (including any failure by the Holder to fulfill the said obligations) **AND** the Minister shall not be under any obligation to the Financial Institution to have communicated to or at any time hereafter to communicate to the Financial Institution any such matter as aforesaid or any facts relating to such matters (whether within the knowledge of the Minister or of any agent or servants of the Crown or not);

5. Any payment required to be or that may be made by the Financial Institution hereunder shall be made to the Director-General of the Department of Primary Industries, and the official receipt of the Department shall be a full discharge to the Financial Institution for the amount so paid;

6. Any demand notice or communication required to be or that may be given by the Minister to the Financial Institution under this Certificate shall be sufficiently given or served if signed by an officer of the Department on behalf of the Director-General and if left at or sent by post to the address shown on the Certificate or the principal office of the Financial Institution in the said State and any such demand notice or communication sent by post shall be deemed to have been given or served when it would in the ordinary course of post have been delivered;

7. That this Certificate shall be construed in accordance in all respects with the law of the State of New South Wales;

8. That except to the extent that such interpretation shall be excluded by or repugnant to the context, words importing the singular number or plural number shall include the plural number and singular number respectively.

9. The Financial Institution certifies that it is prudentially supervised by the Australian Prudential Regulation Authority (APRA).

SCHEDULE

Consolidated Coal lease CCL762 (1973), Mining purpose Leases MPL191 and MPL329 (1973) and Mining Leases ML1431, ML1443, ML1543 and ML1553 (1992) together with any future Mining Leases granted or transferred to the Holder provided that any such Mining Leases are granted or transferred to the Holder on the condition that the security required for the fulfillment by the Holder of obligations under the Mining Leases listed above is extended to apply to any such future Mining Leases

Dated this 25th day of June 2012

Executed for and on behalf of Australia and New Zealand Banking Group Limited ABN 11 005 357 522 under Power of Attorney dated 18 November 2002 registered in New South Wales, Book 4376 No.410 by ...Michael George............... who certifies that he/she is a Manager and that he/she has received no notice of revocation of that Power in the presence of	)	.... Signature of Attorney
.... Prakash Jattan Full name of Witness	)	.... Signature of Witness

APPENDIX 3
Mandalong Compliance Audit Of Consent Conditions

Condition No	Purpose	Trigger for Compliance	Status 31st December 2013
Initial			
1, 1A & 1B	General		Ongoing
5-6	Environmental Officer	Employment	Complete
102	Funds for Committee Facilitation	Prior to First Meeting	Complete
Three Months From Consent			
42	Land Management	Three months from Consent	Complete
		Annual Update	Completed
Six Months From Consent/Six Monthly			
25-26	Valuation	Six Months from Consent	NT 2013
67	Flood Study	Six Months from Consent	Complete
79	Landscaping and Visual Amenity	Six Months from Consent or Council Requirements	Complete
94	Monitoring Report	Six Monthly	No longer required
Twelve Months From Consent			
105-107	Annual Environmental Management Report	Twelve Months from Consent	Complete - Oct 1999, Oct 2000, Oct 2001, Oct 2002, Oct 2003, Dec 2004, Dec 2005, Dec 2006, Dec 07, Dec 08, Dec 09, Dec 10, Dec 11, Dec 12 & Dec 13.
Prior to Commencement of Construction			
3	Notification of Works	Commencement of Surface Construction	Complete - Letter 08/08/00
4(i)	Statutory Requirements	Commencement of Surface Construction	Complied in 2008 – DECC Licence no. 365 current
45	Noise Monitoring Program	Commencement of Construction	Complete
50-54	Air Quality Management Plan	Commencement of Construction	Complete
61-64	Water	Commencement of Construction, update as required	Complete
68-69	Erosion and Sediment Control	Commencement of Construction	Complete
77-78	Waste	Commencement of Construction	Complete
93 (i)	Compliance Reports	Commencement of Construction	Complete
95-96	Meteorological Station	Commencement of Construction	Complied in 2013
100-101	Community Consultative Committee	Commencement of Construction	Three meetings in 2013.
103	Community Information	Commencement of Construction	Completed in 2013
(One Month From Modification			

Condition No	Purpose	Trigger for Compliance	Status 31st December 2013
13(i)	Landowner Communication and Consultation Plan	One Month From Modification (dated 29/8/01)	Complete
During Construction			
43	Noise	Construction of the Mine Access Site	Completed
46, 46A	Noise VAMRAB	Operation Commissioning Report	NYT
49	Blasting	During Construction	Complied 2013
52	Dust monitoring	During Construction	Complied for 2013
80	Lighting	During Construction	Completed
84	Heritage and Archaeology	During Construction	NT in 2013
91	Intersection	During Construction	Completed – approved by RMS in 2012.
Mining Operation Plan			
7-9	Env Management Strategy	First Mining Operations Plan	Complete
86	Utilities and Services	During MOP Preparation	Complied in 2013
Mining Operations			
44	Noise	During operations	One noise exceedance recorded in 2013.
46B	Cooranbong Truck Loading Noise Mitigation	During operations	Complete
46C	Noise Audit	By 30 April 2013	Complete
46D	CHP Noise Mitigation	By 31 August 2013	Extension granted by DoPI until 30 June 2014.
52 - 53	Dust monitoring and mitigation	During operations	Complete
66	Minewater Discharge	Mining in ML1443	Completed
68-69	Erosion and Sediment Control	Commencement of Mining	Completed
85	Hazards	During operations	Complied in 2013
		Operation of Gas Drainage Plant	Completed in 2013.
85A	Hazards	Hazard assessment prior to commissioning VAMRAB	NYT
90	Local Roads	Mining	Complied in 2013
Six Months Prior to Section 138 Application			
112-113	Information available on website	Data and Management Plans approved by NSW DoPI to be made available on Company website and to CCC members.	Complied in 2013
SMP Applications			
13	Subsidence Management Measures	Offset costs of subsidence on third party no recoverable through MSB	Complied in 2013

Condition No	Purpose	Trigger for Compliance	Status 31st December 2013
18-19	End of Panel Report	End of Panel report and subsidence results in AEMR	Complied in 2013 – LW13 & LW14 End Panel Report & AEMR
Commencement of Secondary Workings			
3	Notification of Works	Commencement of Secondary Workings	Complete
4	Statutory Requirements	Commencement of Longwall Mining	Complied in 2008 (DECC Licence No. 365, Part 5 Water Licences, Cl 88 approved LW1-14)
10,11,12	Mining Operations Plan	Application for Secondary Workings	Complied in 2013 – (MOP approved Dec 2013)
20	Subsidence Monitoring	Mining	Complied in 2013 - (AEMR section 5.10)
81-82	Heritage	Commencement of Secondary Workings	Completed - (AEMR Monitoring Section 5.10)
83	NPWS Requirements	Commencement of Secondary Workings	NYT
93 (ii)	Compliance Reports	Commencement of Secondary Workings	Complete in 2013
20	Subsidence Monitoring	Subsidence resulting from Mining	Complied in 2013 – (AEMR section 5.10)
65	Floodpath Monitoring	Monitoring of floodpath areas of Section 138 Approval	Complied in 2013 – (AEMR section 5.10)
Mining Act Obligations			
24	Bank Guarantee	Obligations under the Mining Act [Subsidence]	Complied in 2013 – (AEMR Appendix 2)
Commencement of Work/Mining In Particular Areas			
74	Wetland Management	Mining that may effect wetland hydrological regime	Complied in 2013–wetlands management plan and monitoring reported in AEMR section 5.8.3
108-110	Independent Environmental Audit	Prior to March 31 and every 3 yrs an independent audit of the consent.	Complied in 2013 – Submission of IEA in June 2013.
Commencement of Coal Processing (washery)			
3	Notification of Works	Commencement of Coal Processing (washery)	NYT
Greenhouse Gas			
60A	Monitor & Investigate Greenhouse Gas Reduction Measures	Prior to 30 June 2005	Complied. Letter to NSW DoP reporting on GHG reduction investigations. Ongoing monitoring and reporting in AEMR.
60B	Report on VAMRAB Trial	3 months following trial completion.	NYT
Construction of Haul Rd			
68-69	Erosion and Sediment Control	Commencement of the Haul Rd	Completed –Water management plan haul rd approved in 2009 prior to

Condition No	Purpose	Trigger for Compliance	Status 31st December 2013
			construction
88	Coal Transport	Construction of the Haul Rd	Completed –design and construction management plans haul rd approved LMCC in 2009 prior to construction
Six Months From Construction of Haul Rd			
76,	Threatened Species	Six months from the Construction of the Haul Rd	Completed – Construction Management Plans for flor and fauna approved by LMCC prior to haul rd construction in 2009.
76A	Rehabilitation outside VAMRAB area	Within one month of clearing.	Triggered January 2012. Rehabilitation commenced with land preparation and tree planting.
Construction of Coarse Rejects Area			
68-69	Erosion and Sediment Control	Commencement of Coarse Rejects Area	NYT
Landowner Written Request			
27-33	Acquisition	Receipt of Notification under 21(ii)	NYT
34-35,37	Independent Valuation	If required, three months from written request to purchase	NYT
36	Independent Valuation and Survey Assessments	As requested by DG	NYT
47-48	Noise	As required	NYT
55-56	Dust	As required	NYT
57-60	Dust/Noise	Independent Monitoring as required	NYT
Compensable Loss/Subsidence			
23	Compensation	Compensable Loss	NYT
Under the Direction of the Director-General/Director General Requirements			
2	Cease Activities	Under the Direction of the Director-General (DoP)	NYT - No direction
38-41	Independent Panel	Issue of PSMP's detailing subsidence effects	Commenced (DoP)
89	Coal Haulage	Director-General (DoP) Requirements	NYT
92	Compliance	Director-General (DoP) Requirements	Ongoing
110	Compliance assessment (audit)	Director-General (DoP) Requirements	NYT
Council Requirements			
111	Floodplain Management Plan	Council satisfaction	Completed – assistance provided to LMCC - flood model data supplied
As Required/ Throughout Development			
70-73	Flora & Fauna	Throughout Development	Complied in 2013 – section 5.8.3 & 9.4

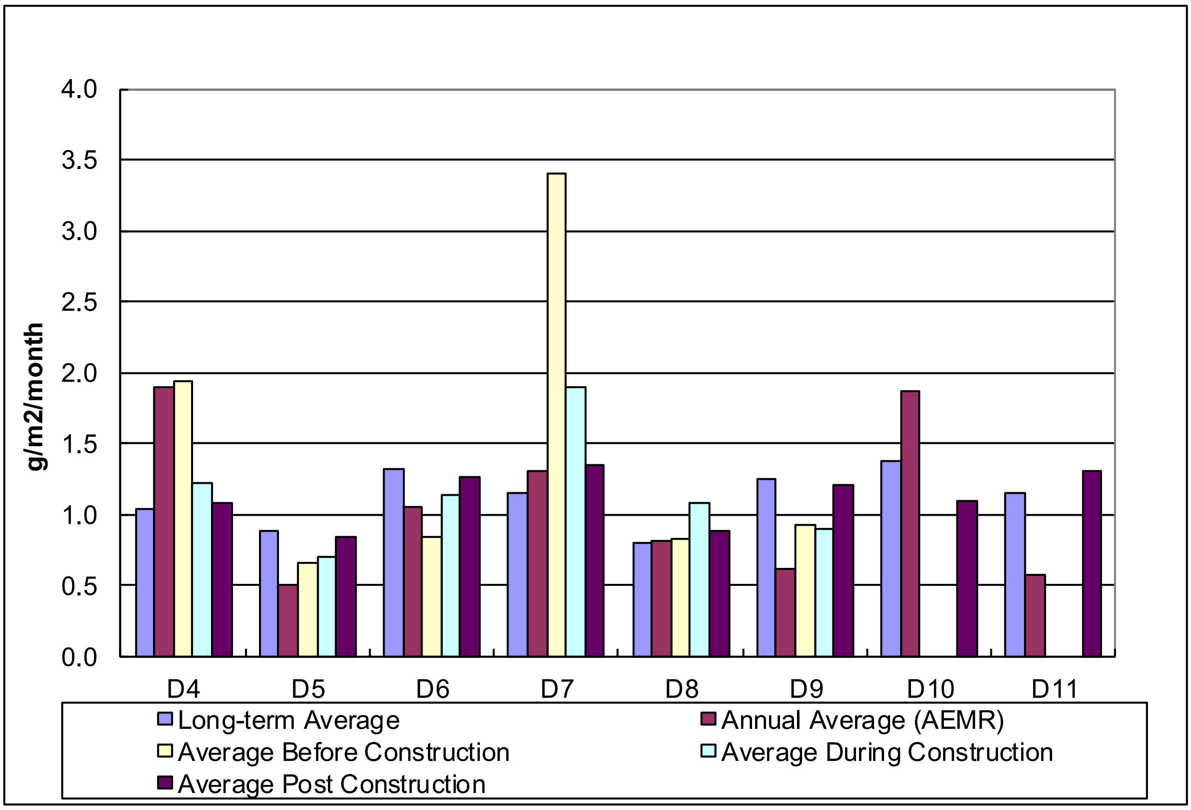
Condition No	Purpose	Trigger for Compliance	Status 31st December 2013
75	Mine Access Site Track Upgrade	Throughout Development	Completed
87	Rehabilitation	Mining	Completed
97	Quality Assurance	As per individual Requirements for Monitoring	Completed - (Addressed in individual management plans)
98	Complaints	Throughout Development	Complied in 2013
99	Dispute Resolution	Throughout Development	NYT
104	Community Support	Throughout Development	NYT

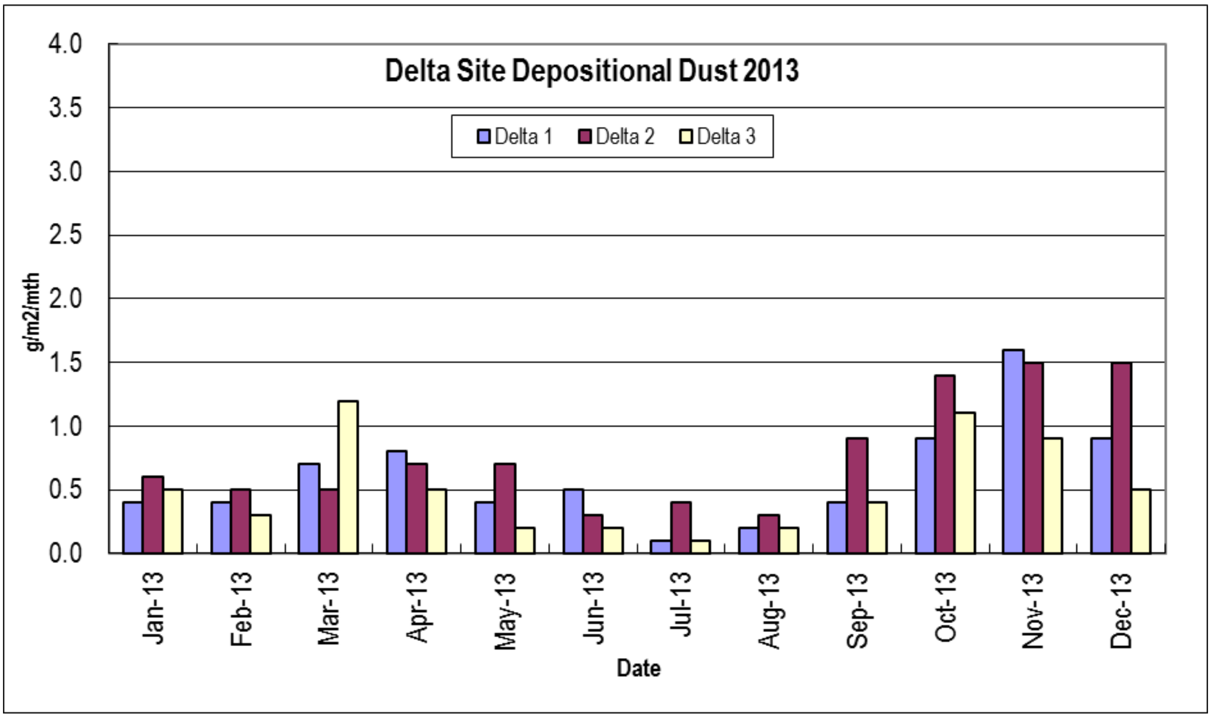
Abbreviations

NT Not Triggered
NYT Not Yet Triggered

APPENDIX 4
Depositional Dust Monitoring

Mandalong Mine & Cooranbong Depositional Dust Data





APPENDIX 5

AGE Consulting Pty Ltd "Groundwater Monitoring Review For 2013 AEMR"






Australasian
Groundwater & Environmental
Consultants Pty Ltd

REPORT on

MANDALONG LONGWALL COAL MINE

GROUNDWATER MONITORING REVIEW FOR AEMR 2013

prepared for
CENTENNIAL MANDALONG PTY LTD

Project No. G1455/J
January 2014

AGE

ABN:64 080 238 642

Australasian
Groundwater & Environmental
Consultants Pty Ltd

REPORT on

MANDALONG LONGWALL COAL MINE

GROUNDWATER MONITORING REVIEW FOR AEMR 2013

prepared for
CENTENNIAL MANDALONG PTY LTD

Project No. G1455/J
January 2014

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REPORT ON

MANDALONG LONGWALL COAL MINE
GROUNDWATER MONITORING REVIEW FOR AEMR 2013

1 INTRODUCTION

Centennial Mandalong Pty Ltd (CMPL), a subsidiary of Centennial Coal Company Ltd, operates the Mandalong Coal Mine located in the Mandalong Valley on the central part of the Newcastle Coalfield of New South Wales. Development consent to extend the underground mining operations from the Cooranbong Colliery into the Mandalong Valley was obtained in 1998 and mining of the first longwall panel commenced in January 2005. Mining is achieved using the longwall mining method, with coal being extracted from the converged Wallarah/Great Northern (WGN) Seam. Mining ceased on longwall 14 (LW14) in July 2013 and progressed through half of LW15 by the end of the year.

This report provides a review of the groundwater monitoring undertaken during 2013, and was prepared by Australasian Groundwater and Environmental Consultants Pty Ltd (AGE) at the request of CMPL, for the Annual Environmental Management Report (AEMR).

2 RAINFALL

Mean annual rainfall for the period 1904 to September 2010 and again from October 2012 to present was obtained from the Australian Bureau of Meteorology (BOM) station at Cooranbong/Avondale (Station no. 61012). Monthly rainfall data for the period October 2010 – September 2012 was obtained from the BOM station at Cooranbong/Lake Macquarie AWS (Station No. 61412) as limited data was available from the station at Cooranbong/Avondale during this period.

Rainfall data for 2013 was also provided by CMPL from the Mandalong Automatic Weather Station (MAWS), Site 411601. Table 1 shows a summary of the rainfall data. With respect to total annual rainfall, Table 1 also shows that 2013 was wetter than an average year. However, rainfall was unevenly spread throughout the year and it was also below average for most months.

Table 1: SUMMARY OF RAINFALL DATA (mm)

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean Rainfall (Stn 61012)	108.9	132.0	125.9	120.0	97.7	102.0	69.1	59.1	58.6	67.4	81.4	98.2	1137.0
2013 Rainfall (Stn 61012)	239.0	199.0	167.0	118.0	79.0	135.0	12.0	14.0	21.0	37.0	279.0	31.0	1331.0
2013 Rainfall (MAWS)	222.0	195.4	131.9	111.6	75.6	169.6	10.6	13.8	21.2	43.0	292.2	31.6	1318.5

Notes: Stn Bureau of Meteorology weather station
MAWS Mandalong Automatic Weather Station

The rainfall totals suggest recharge of groundwater was above average during the year, particularly in summer. Groundwater levels are likely to have increased in the unconfined aquifers as a result.

3 GROUNDWATER MONITORING NETWORK

An extensive groundwater monitoring network has been developed by CMPL at the Mandalong Mine, with monitoring undertaken on many of the established bores since August 1997. Table 2 provides a brief summary of the establishment timeframe and purpose of the network, and Table 3 provides a summary of the relevant details of each monitoring bore. Figure 1 shows the bore locations.

Some bores went dry in past years and have remained dry, or the water level dropped below the length of the measuring tape, that is, to greater than 100 m below ground level. No additional bores have gone dry during 2013. A blockage occurred in BH9B and BH15 during 2013. The water level can be still be measured in these bores with water quality sampling not possible. Table 3 shows the status of the bores.

All bores are constructed with 50 mm diameter uPVC casing with the exception of bores BH15 and BH16, which were test bores drilled into the Fassifern Seam and Great Northern Seam respectively. All bores were gravel packed, and completed with a bentonite plug above the gravel pack. The annulus of all bores are grouted, except of the alluvial monitoring bores BH1 to BH14. Bailers became stuck in bores BH20 and BH22C during 2008 due to bending of the casing, and as a result, water quality samples have not been able to be taken since, although water levels could still be measured.

Baseline monitoring data collected to date from all bores is summarised in the following sections.

Table 2: SUMMARY OF MONITORING BORE NETWORK ESTABLISHMENT

Bores	Established	Location	Purpose
BH1 – 14	June 1997	Mandalong Valley alluvium.	To monitor groundwater levels and quality in the alluvium.
BH15 – 16	February 1998	Private property 1km south-east of mine.	To monitor groundwater levels and the impact of mining on the coal seam.
BH17 – 19	Sept-Oct 2002	Over longwall panels LW4 and LW5.	To monitor groundwater levels and the impact of mining on the overburden sediments.
BH20, 20A, 20B BH21, 21A	October 2003	Nested bores over longwall panels LW1 and LW2.	To monitor the impact of mining LW1 and LW2 on the alluvial and overburden sediments.
BH2A, 2B, 2C BH3A, 3B BH6A, 6B BH7A, 7B BH17A1 BH22, 22A, 22B BH23, 23A, 23B	Sept-Oct 2005	Nested monitoring bores over longwall panels.	To provide a broader coverage of groundwater level monitoring of the impact of longwall mining on the alluvial and overburden sediments.
BH9A, 9B BH10A, 10B BH24A, 24B, 24C BH25A, 25B, 25C	May 2010	Nested monitoring bores over longwall panels	To provide a broader coverage of monitoring of the impact of longwall mining on the alluvial and overburden sediments.

Note: BH22 referenced in past reports is also referred to as BH22C.

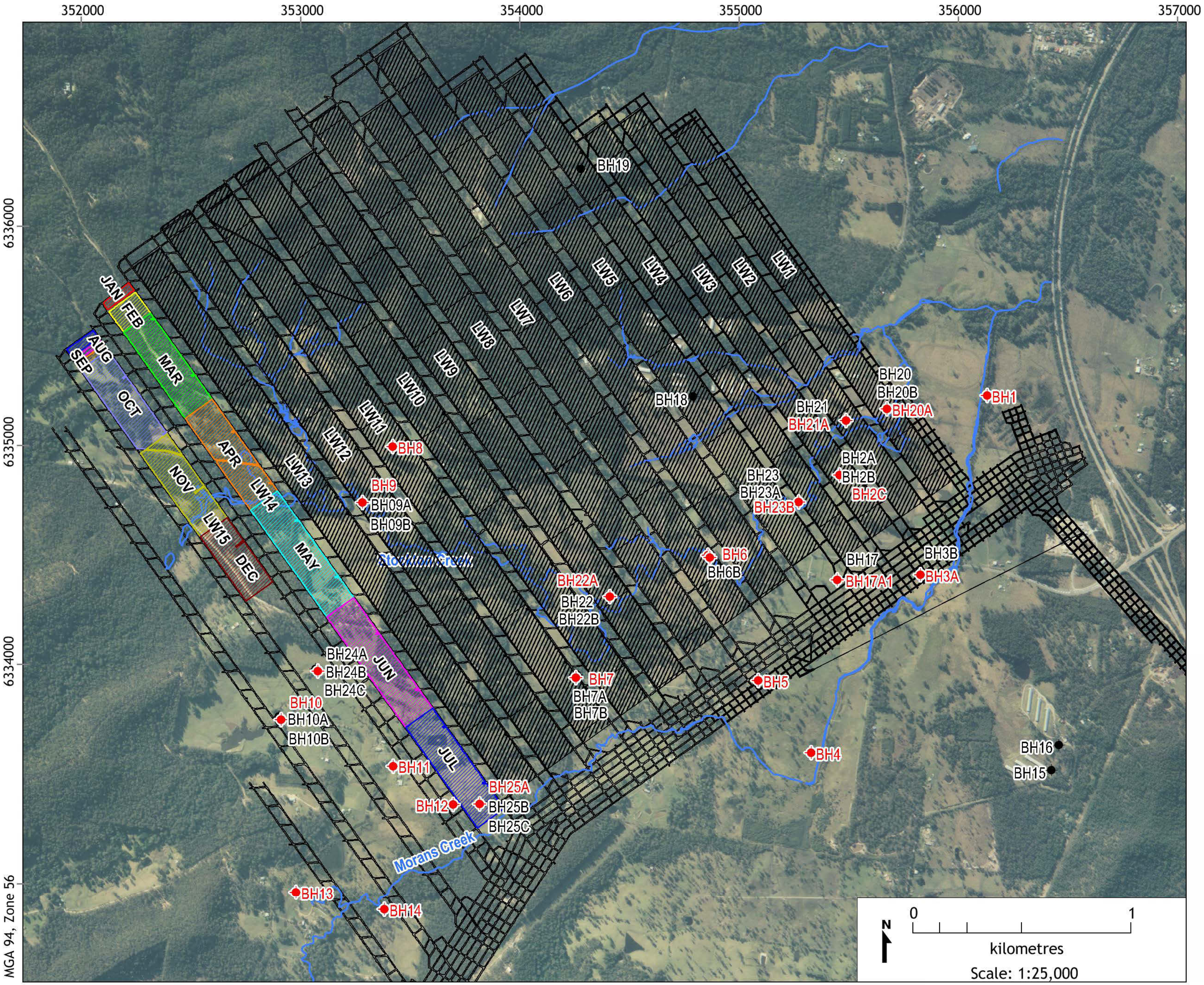
Table 3: SUMMARY OF MONITORING BORE DATA

Monitoring Bore No.	NOW iii)		MGA ii)		Ground Level RL(m)	Measure Point RL(m)	Depths		Water Level i)		Lithology	Status
	Bore No.	Licence No.	Easting (m)	Northing (m)			Bore (m)	Screen (m)	Depth (mbgl)	RL (m)		
BH1	GW078136	20BL166760	356128.4	6335288.6	6.20	7.22	9	6.0 – 9.0	3.51	2.69	Alluvium	
BH2	GW078137	20BL166761	355444.8	6334892.7	8.78	9.66	5.5	2.5 – 5.5	2.15	6.63	Alluvium	Replaced by BH2C
BH2A			355463.25	6334867.31	8.76	9.55	37.0	33.6 – 36.6	21.17	-12.41		
BH2B			355460.44	6334867.25	8.78	9.55	21.0	17.0 – 20.0	2.95	5.83		
BH2C			355456.82	6334867.35	8.80	9.64	9.6	5.6 – 8.6	2.40	6.40	Alluvium	
BH3	GW078114	20BL166765	355842.9	6334449.9	8.65	9.65	12	9.0 – 12.0	3.41	5.36	Alluvium	Replaced by BH3A
BH3A			355825.84	6334412.47	8.30	9.01	15.0	11.0 – 14.0	2.62	5.68	Alluvium	
BH3B			355828.66	6334414.27	8.31	9.05	32.5	28.5 – 31.5	18.03	-9.73		
BH4	GW078115	20BL166766	355329.0	6333603.6	9.49	10.61	10.4	7.4 – 10.4	0.85	8.64	Alluvium	
BH5	GW078116	20BL166767	355087.5	6333932.0	10.87	10.82	8.5	5.5 – 8.5	0.70	10.17	Alluvium	
BH6	GW078139	20BL166762	354857.11	6334501.39	12.37	13.81	15.0	12.0 – 15.0	2.85	9.43	Alluvium	
BH6A			354866.36	6334491.18	12.27	12.94	26.5	22.5 – 25.5	8.61	3.66	Sandstone	
BH6B			354866.71	6334502.36	12.13	12.58	75.0	71.0 – 75.0	-	-	Sandstone	dry since June 2009
BH7	GW078117	20BL166768	354257.4	6333944.5	12.76	13.71	13.7	10.7 – 13.7	1.24	11.52	Alluvium	
BH7A			354262.94	6333953.84	12.79	13.57	50.0	46.0 – 49.0	9.47	3.42		
BH7B			354262.74	6333951.71	12.89	13.47	100.0	96.0 – 99. 0	-	-	Sandstone	dry since Nov 2011
BH8	GW078118	20BL166769	353421.2	6334995.1	17.30	18.33	15.8	12.8 – 15.8	1.94	15.36	Alluvium	
BH9	GW078119	20BL166770	353284.1	6334743.0	18.11	19.18	9.1	6.1 – 9.1	1.94	16.17	Alluvium	
BH09A		20BL172480	353281.89	6334736.91	18.07	19.52	32.85	28.9 – 32.9	16.15	1.92	Mudstone/ Sandstone	
BH09B		20BL172480	353280.12	6334731.58	17.95	19.64	60.0	54.0 – 60.0	19.61	-1.66	Mudstone/ Sandstone	Blocked at 12m since May'13; sampling impossible
BH10	GW078113	20BL166764	352915.6	6333752.5	20.02	20.80	12.2	9.2 – 12.2	1.67	18.35	Alluvium	
BH10A		20BL172479	352904.49	6333760.0	20.11	20.11	30.1	25.1 – 30.1	4.71	15.40	Mudstone/ Sandstone	
BH10B		20BL172479	352909.06	6333755.78	20.05	20.05	63.0	54.0 – 63.0	14.44	5.61	Sandstone	
BH11	GW078131	20BL166771	353426.1	6333541.9	16.23	17.18	12.5	9.5 – 12.5	0.89	15.34	Alluvium	
BH12	GW078132	20BL166772	353700.7	6333367.9	15.16	16.20	14.6	11.6 – 14.6	1.41	13.75	Alluvium	

Table 3: SUMMARY OF MONITORING BORE DATA												
Monitoring Bore No.	**NOW [iii]**		**MGA [ii]**		**Ground Level RL(m)**	**Measure Point RL(m)**	**Depths**		**Water Level [i]**		**Lithology**	**Status**
	Bore No.	**Licence No.**	**Easting (m)**	**Northing (m)**			**Bore (m)**	**Screen (m)**	**Depth (mbgl)**	**RL (m)**		
BH13	GW078110	20BL166773	352984.4	6332967.9	16.55	16.55	7.3	4.3 – 7.3	0.73	15.82	Alluvium	
BH14	GW078111	20BL166774	353387.8	6332890.1	16.25	16.25	12.2	9.2 – 12.2	0.91	15.34	Alluvium	
BH15	GW079772	20BL166740	356424.8	6333518.4	16.69	17.27	234		2.76	13.93	Fassifern Seam	Blocked since Oct'13; sampling impossible
BH16	GW078140	20BL166740	356458.0	6333633.2	23.09	23.62	180		-	-	Great Northern Seam	Too deep - below 111m depth since Jan 2006
BH17 (CM01)	TBA	20BL169546	355445.60	6334391.20	9.58	9.73	56.0	37.0 – 52.0	-	-	Sandstone	Sealed up, last visited 14 May 2008
BH17A1			355447.68	6334390.16	9.48	10.24	16.0	12.0 – 15.0	2.59	6.89	Alluvium	
BH18 (CM02)	TBA	20BL169547	354788.78	6335217.36	13.98	14.32	96.0	78.0 – 93.0	-	-	Conglomerate	Bore dry & removed Sealed up Nov. 2007
BH19 (CM03)	TBA	20BL169548	354277.28	6336254.92	67.71	68.01	192.0	167 – 185	-	-	Sandstone	Too deep - below 100m Sealed up March 2008
BH20	TBA	20BL169549	355671.28	6335167.47	6.13	6.79	54.0	51.0 – 54.0	52.21	-46.08	Conglomerate	Bailer stuck since Aug 2008
BH20A	TBA	20BL169549	355672.02	6335168.29	6.14	6.78	15.0	12.0 – 15.0	1.97	4.17	Alluvium	
BH20B	TBA	20BL169549	355673.89	6335166.36	6.06	6.70	30.0	27.0 – 30.0	1.60	4.46	Siltstone	
BH21	TBA	20BL169549	355485.31	6335114.53	8.12	8.80	54.0	51.0 – 54.0	53.45	-45.34	Conglomerate	Bore dry after a few bails since Dec 2008
BH21A	TBA	20BL169549	355486.17	6335115.30	8.12	8.79	15	12.0 – 15.0	3.15	4.97	Alluvium	
BH22[iv]			354406.43	6334314.36	12.89	13.56	60.0	56.0 – 59.0	-	-	Sandstone	Bailer stuck Nov '07 – removed, not sampled since Nov '07, logger dry since 30 Jun '11
BH22A			354411.99	6334313.61	12.83	13.53	17.0	13.0 – 16.0	2.14	10.77	Alluvium	
BH22B			354408.86	6334314.01	12.91	13.57	35.0	31.0 – 34.0	10.23	2.60		
BH23			355263.69	6334742.58	9.78	10.43	100.0	96.0 – 99. 0	57.03	-47.25	Sandstone	Bore discontinuously dry after few bails since 8/2007
BH23A			355266.60	6334743.99	9.72	10.38	50.0	46.0 – 49.0	16.27	-6.55	Sandstone	
BH23B			355269.94	6334745.55	9.70	10.39	18.3	14.3 – 17.3	2.99	6.71	Alluvium	

Table 3: SUMMARY OF MONITORING BORE DATA												
Monitoring Bore No.	NOW [iii]		MGA [ii]		Ground Level RL(m)	Measure Point RL(m)	Depths		Water Level [i]		Lithology	Status
	Bore No.	Licence No.	Easting (m)	Northing (m)			Bore (m)	Screen (m)	Depth (mbgl)	RL (m)		
BH24A		20BL172481	353082.56	6333975.23	18.19	18.19	21.0	25.0 – 21.0	1.71	16.48	Sandstone/ Mudstone	
BH24B		20BL172481	353077.61	6333976.48	18.28	18.28	34.1	28.1 – 34.1	10.53	7.75	Sandstone	
BH24C		20BL172481	353071.88	6333977.84	18.31	18.31	60.0	55.0 – 60.0	18.71	-0.4	Mudstone/ Sandstone	
BH25A		20BL172477	353821.20	6333369.76	14.34	14.34	9.0	2.5 – 9.0	0.89	13.45	Alluvium	
BH25B		20BL172477	353820.56	6333363.99	14.31	14.31	30.0	20.0 – 30.0	4.42	9.89	Sandstone	
BH25C		20BL172477	353819.62	6333357.77	14.43	14.43	58.0	51.5 – 58.0	9.30	5.13	Mudstone/ Sandstone	

Notes:
i) Water level as at 11, 12 and 13th December 2013, measured in metres below ground level (mbgl)
ii) Easting and Northing co-ordinates are MGA Zone 56
iii) NOW – New South Wales Office of Water
iv) BH22 is also referred to as BH22C



Mandalong - Groundwater Monitoring Review 2013 (G1455J)

Mine Plan 2013 and Monitoring Bore Locations

DATE:
17/1/2014

FIGURE No:
1

4 IMPACT OF MINE INDUCED SUBSIDENCE ON GROUNDWATER

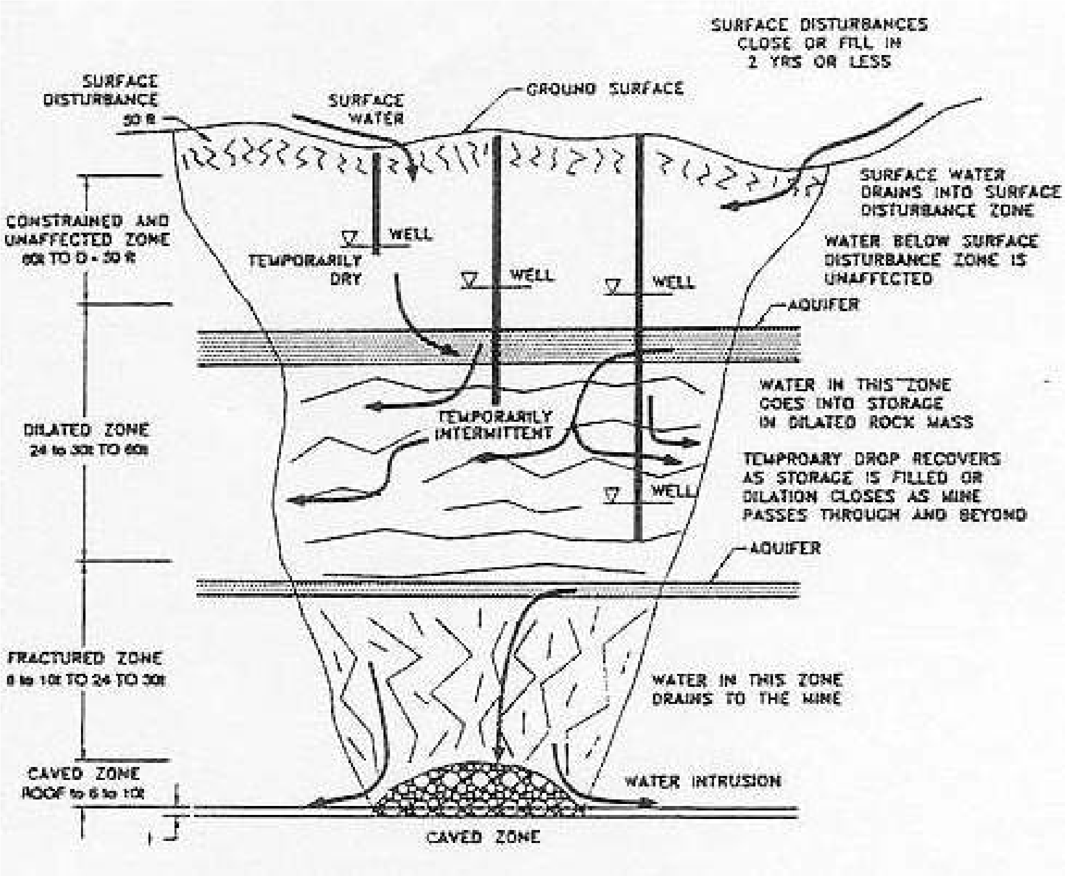
This generic description of strata disturbance and the impact of longwall mining on the permeability of overburden strata and groundwater are provided to assist the reader in understanding the results described in the following sections.

Longwall extraction results in collapse of the overlying rock strata into the void left by coal extraction. The collapsed or disturbed overburden material is referred to as the goaf. The collapse propagates upwards from the extracted seam until bulking of the goaf limits vertical movement and the tensile strength of the rock strata is sufficient to hold up the overburden without failure. The concept of the strata disturbance zone as discussed by Kendorski (1993)[1] is illustrated on Figure 2.

Kendorski (1993)[1] defines 5 zones in the goaf as summarised below:

- Caved Zone: This is the zone of complete disruption of broken and rubble-sized strata extending to 2 to 10 times (2 t to 10 t) the seam thickness in height above the caving roof.
- Fractured Zone: This zone occurs above the caved zone to a height of 24 t to 30 t. The strata does not fall and detach but cracks and settles, resulting in fractures extending through individual beds, opening of bedding planes and shearing and dislocation of beds. The caved and fractured zones have increased vertical and horizontal transmissivity and storativity and both attributes decrease exponentially with height above the seam roof.
- Dilated Zone: This zone is often referred to as the “Aquiclude Zone”. In this zone, the strata sag allowing bed separations, but not allowing connecting fracturing and drainage into the mine. It occurs at a height of 30 t to 60 t or greater. The water level of aquifers located in this zone may be lowered in response to the relatively rapid increases in void space laterally, that is, due to an increase in storage volume, but the water level generally recovers given sufficient time, as the voids are filled.
- Constrained Zone: This zone occurs where the extracted seam is deeper than 60 t plus about 15 m, and is characterised by overall tensile strains of less than 1 mm/m, a stress level at which rock masses are not disrupted sufficiently to increase their permeability. Hence there is no significant change in transmissivity or storativity and therefore aquifers, which occur in this zone, are largely unaffected.
- Surface Fracture Zone: The surface fractures generally relate to panel and trough edges and extend to a depth of about 15 m. If transmitted into soils, the soil properties may allow little or no crack development due to the plastic and non-brittle nature of many soils. If in rock, the natural pre-existing fracturing will be dilated, having little effect on continuity. The cracks are transmissive zones and the increased void space may result in a temporary lowering of shallow groundwater levels as the voids fill. The cracks will not provide pathways for deeper migration of groundwater unless extending into the “fracture zone”. This may happen where the “dilated zone” is absent due to shallow mining, that is, shallow overburden thickness. Surface cracks also generally fill quickly with sediment or close due to spalling.

[1] Kendorski F.S., (1993), *“Effect of High-Extraction Coal Mining on Surface and Ground Waters”,* 12th Conf. on Ground Control in Mining 3-5 Aug 1993.



after Kendorski (1993)

Figure 2: Schematic Subsidence - Groundwater Inflow Model

The subsidence zones of Kendorski described above are generic and are based on super critical extraction. They provide a general overview of what can occur, however the depth of cover, the overlying stratigraphy, and the panels widths will vary between mines, and each of these factors have to be taken into account in assessing the subsidence impact at a specific mine site.

In the Pacific Power International groundwater study in 1997 of the overburden strata of the Cooranbong Colliery Life Extension Project, now referred to as the Mandalong Mine, (Forster & Wall 1997)[2] concluded that "*the height of interconnected fracturing above the extracted seam would range from 60 to 90 metres depending on the seam thickness and overburden lithology".* At the Mandalong Mine, the depth of cover ranges from 160 m to 350 m.

It should also be noted that the longwall panels at Mandalong Mine have been designed as relatively narrow in order to limit vertical fracturing and the potential to impact the alluvial aquifers and associated water courses.

[2] Forster I. and Wall B., (June 1997), *"Cooranbong Colliery Life Extension Project – Overburden Strata Groundwater Study",* Pacific Power International.

5 WATER LEVEL HYDROGRAPHS – BASELINE DATA AND IMPACT ASSESSMENT

5.1 Alluvial Bore Hydrographs

The alluvial bores have been grouped based on their location in the catchments as shown on Figures A1 to A4 in Appendix A. The broad groupings are:

- lower catchment of Morons Creek adjacent to (BH1) or above the longwall panels (BH2, BH3, BH17A1, BH20A, BH21A, BH23B);
- middle catchment of Stockton Creek (BH6, BH7, BH22A) and Morans Creek (BH4, BH5); and;
- upper catchments of Stockton Creek (BH8, BH9) and Morans Creek (BH10 to BH14, BH25A) respectively.

The hydrographs of all bores in the alluvium indicate a regular seasonal fluctuation in water level. The bores in the lower catchment, (Figure A1) show a seasonal fluctuation of around 0.5 m, whereas those in the middle to upper catchment areas show a fluctuation of between 1.5 m to 2.0 m (Figures A2-A4).

Groundwater levels in relatively shallow wells or bores constructed in alluvium are generally highly dependent on rainfall recharge and can rise or decline quite rapidly in response to rainfall events. A standard groundwater technique for assessing groundwater level trends in unconfined alluvial aquifers is to compare the hydrographs with the Cumulative Rainfall Departure (CRD)[3]. The CRD is the cumulative difference between average monthly and actual observed monthly rainfall and can be used to indicate if a change in groundwater level is due to natural or unnatural stresses.

The CRD graph shown on Figure is produced from the equation:

$$CRD_n = CRD_{n-1} + (R_n - R_{av})$$

Where:	CRD_n	=	CRD for a given month
	CRD_{n-1}	=	CRD for a preceding month
	R_n	=	actual rainfall for given month
	R_{av}	=	long term average rainfall for a given month

Figure 3 indicates that:

- between 1951 and 1979, rainfall alternated between wetter and drier periods, but on average was relatively uniform;
- there was an extended dry period between 1979 and the beginning of 1985, followed by an above average period between 1985 and 1990;
- from 1990 until 2007, the rainfall alternated between wetter and drier periods, but was below average in the long-term as shown by the downward trend; and
- from 2007 until 2013, rainfall alternated between wetter and drier periods, but was above average in the long-term as shown by the upward trend.

[3] Bredenkamp D.B., Botha L.J. and van Tonder G.J., June (1995), *"Manual on Estimation of Groundwater Recharge and Aquifer Storativity",* Water Research Commission, Pretoria.

In 2013, the total rainfall was above average; 1318 mm at Mandalong Mine weather station compared to a long-term average annual rainfall of 1137 mm (refer to Table 1).

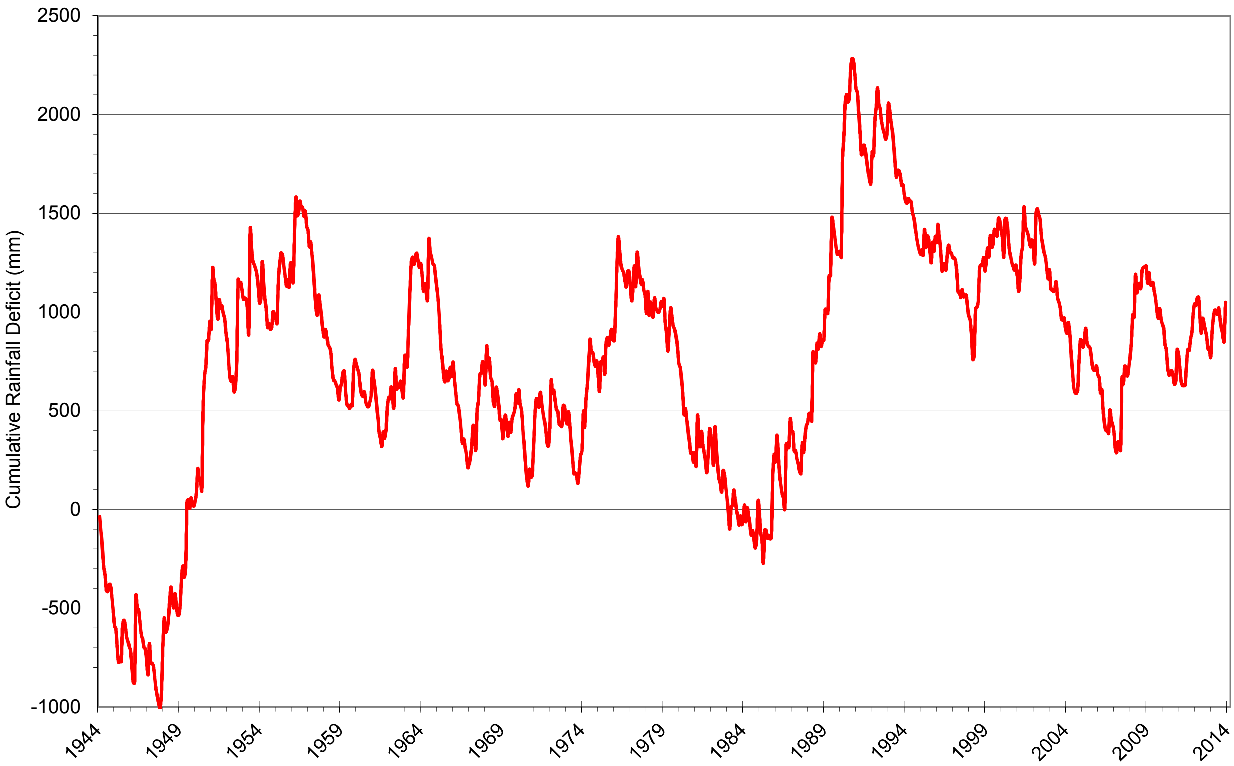


Figure 3: Cumulative Rainfall Departure Graph, 1944 – 2013
Cooranbong Stations 61012 (1944-2010, 2013) and 61412 (2011-2012)

The CRD and the hydrographs of the alluvial monitoring bores were compared. Figures A1 to A4 in Appendix A show the hydrographs of the monitoring bores and the CRD for the corresponding period.

The CRD compares very favourably with the hydrographs of all alluvial monitoring bores, lower middle and upper catchments, and demonstrates a close correlation between groundwater levels and rainfall. There does not appear to be a measurable drop in groundwater levels in any bore. It is concluded that groundwater level fluctuations in the alluvial aquifers are related to rainfall conditions, and not to longwall mining.

5.2 Coal Seam Hydrographs

Bores BH15 and BH16 are located in the Fassifern Seam and Great Northern Seam respectively, about 1.2 km to the south of the longwall panels (Figure 1). Figure A5 in Appendix A shows the hydrograph for BH15. The water level in BH16 is difficult to measure as it is very deep, but was recorded on 20 January 2006 as being 111.5 m below ground level (RL-88.4 m). This would indicate that the seam has been depressurised by mining at the neighbouring Cooranbong Colliery, or through development of the headings and mining of the longwall panels of the Mandalong Mine.

The water level in the deeper Fassifern Seam (bore BH15) fluctuated around RL12.9 m until 2011 and around 14 m from 2011 to 2013. This indicates that there has been no leakage/ depressurisation because of the overlying Great Northern Seam being depressurised.

Groundwater levels in BH15 followed the increasing trend of the CRD between 2011 and 2013; and therefore, this upward trend is likely due to rainfall recharge.

A current piezometric head of RL13.93 m (Figure A5), also confirms an upward gradient beneath the lower catchment area of the Mandalong Valley, where the alluvial water levels are around RL3 m to RL7 m (Figure A1).

5.3 Overburden Hydrographs

Figure A6 shows the hydrographs of bores set in the overburden (BH17-19). Figure 1 shows that the bores are located above either LW4 or LW5, in a line parallel with the panels. Bores BH18 and BH19 (Figure A6), indicate an immediate response to the commencement of longwall mining with a steady reduction of piezometric head.

The piezometric head of BH19, declined rapidly subsequent to the passage of LW4 beneath the bore in November 2006 indicating that the bore, which is 192 m deep, is probably in the fractured zone of the goaf and groundwater has completely drained into the mine.

Monitoring bore BH18, which is 96 m deep, became dry in November 2007 after LW5 passed beneath it and it is likely to be in a fractured zone in the goaf. The borehole has subsequently been removed from sampling.

Bore BH17, which is located in sandstone at 56 m depth, showed a steady decline in water level of about 8 m, from commencement of monitoring in April 2003 to June 2005 (Figures A6). Figure A6 shows that a steep decline in water level of about 38 m has occurred since July 2005. The steep decline in water level coincided with LW1 intersecting a fault in the outbye end of the panel, during which there was a higher inflow of water to the longwall panel. The water level declined to below the base of Bore BH17 (56 m depth) in November 2006. BH17 remained dry until end of monitoring in May 2008 and was sealed thereafter.

5.4 Nested Monitoring Bores Hydrographs

Nested monitoring bores have progressively been installed above the longwall panels to monitor the impact as mining progressed to the west. At each site, a bore was set in the alluvium and one or two bores in the overburden. The bores were designed to monitor groundwater levels at increasing depths in the stratigraphic column, to assess the vertical depressurisation profile and the potential for leakage from the alluvium.

Figures A7 to A24 present the hydrographs of the nested bores at each site, and Figures A25 and A26 show the hydrographs of the alluvium at each of the nested sites on a larger scale.

Site BH20 – Overlying LW1

The hydrographs of the three monitoring bores set at increasing depth above LW1 at site BH20, (Figure A7), indicate that the mine has had no impact on water levels in the alluvium (BH20A) and underlying siltstone (BH20B). Figure A25 shows that the groundwater level in the alluvium trends closely with the CRD, correlating well with rainfall trends compared to the underlying strata.

Groundwater monitoring results show that site BH20 has not gone dry following mine expansion, but rather water levels have declined and stabilized since mid-2006. These results suggest that there has not been a hydraulic connection between the mine and BH20. These results indicate that BH20 is therefore likely screened within the dilated zone at a depth of 51 m to 54 m.

Site BH21 – Overlying LW2

The groundwater level monitored in BH21A (alluvium) trends closely with the CRD and hence correlates well with rainfall compared to the underlying strata, as shown on Figure A25. There is no downward trend indicating leakage to mining. Therefore, the alluvium at BH21 has not been impacted by mining (Figure A8).

The hydrograph of site BH21 screened across the conglomerate layer at 54 m reacts similar to BH20. As for site BH20, the decline in groundwater level at site BH21 is assessed to be due to dilation of the overlying rock mass as a result of bed separation above the goaf. Water levels in BH21 have stabilised at about RL-45m since late 2008, where they remained consistent during 2013.

Site BH2 – Overlying LW3

The hydrographs of the nested monitoring bores at site BH2 above LW3 indicate that there has been no impact on groundwater levels in the alluvium or shallow bedrock bore immediately underlying the alluvium (Figures A9 and A10). There has been; however, a reduction in water levels in bore BH2A, which is monitoring the overburden at a depth of 33.6 m to 36.6 m.

Generally, as longwall panels (LW2 to LW6) approached the piezometer, it would appear that there was compression of the overburden resulting in a temporary rise in water level in BH2A followed by a decline as the overburden subsequently dilated as the longwalls passed. The effect is shown on Figure A9, and in detail from the data-logger set in the bore on Figure A10. Water levels appear to have stabilised during 2008 and 2009, and show a slight downward trend from 2010 to 2013.

As discussed, it is assessed that the response of BH2A is due to compression and subsequent dilation of the overlying bedrock as a result of bed separation above the goaf and is not due to hydraulic connection with the mine.

Site BH23 – Between LW4 and LW5

Groundwater levels from the nested monitoring bore site at BH23 above and between LW4 and LW5 indicate that there has been no impact on groundwater levels in the alluvium (Figures A11 and A12). However, there does appear to be an impact on the bedrock bore BH23A set between 46 mbgl and 49 mbgl. A rise in potentiometric level occurred with the passage of both LW4 and LW5 past the piezometer nest as shown on Figure A11, and in detail from the data-logger set in the bore, Figure A12.

The potentiometric level within BH23A has gradually declined following the passing of LW4 and LW5. The decline is most likely a response to dilating strata. Recently, the potentiometric level within BH23A stabilised and was about -6.5 mRL during 2013.

BH23 is set between 96 mbgl and 99 mbgl, and as such is much closer to the mine workings than BH23A. However, unexpectedly, groundwater levels in BH23 did not show the declining trend observed between 2007 and 2012 in BH23A. The reason for this is unknown, but does suggest limited drawdown in this unit related to mining.

Hydrographs show very stable water levels in all three bores at site BH23 during 2013.

Sites BH3 and BH17 – Overlying Main Headings

In general, the groundwater level in the alluvium over the Main Headings, monitored in BH17A1 and BH3A, trends closely with the CRD as shown on Figure A25. Therefore, water levels in the alluvium over this area appear to not be affected by mining. (Figures A13 and A14).

Water levels in the bedrock at a depth of up to 31.5 m, monitored in BH3B, have gradually declined by approximately 6 m since mining of LW3 (Figure A13). This decline may indicate dilation or a tenuous hydraulic connection with the mine. Water levels appear to have stabilised by the end of 2010 and fluctuated around RL-9.5 m since 2011 and throughout 2013.

A more significant response occurred in BH17, located in sandstone at a depth of 52 m. The decline coincided with LW1 intersecting a fault in the outbye end of the panel, during which a higher inflow of water to the longwall panel occurred. The overburden at the southern end of LW1 was depressurised and probably drained when mining intersected the fault. BH17 was last monitored in May 2008 and was subsequently sealed.

Site BH6 – Overlying LW7

Similar to other alluvial bores, the groundwater level in bore BH6 trends closely with the CRD, as also shown on Figure A25. The hydrographs of the nested monitoring bores at site BH6 located above LW7 indicate that there has been no impact as a result of mining on the alluvial aquifer, even though LW7 passed under the bores in March 2009 (Figure A15).

There does appear to be some limited depressurisation of the intermediate bedrock aquifer within the sandstone unit at BH6A, (22.5 m to 25.5 m depth), following the passage of LW6, which was adjacent to the bore in August 2008, and subsequently LW7 beneath the bore. This may indicate dilation or a tenuous hydraulic connection with the mine. However, the decline stabilized post July 2009, and the water level started to recover since 2012 and increased further by about 1 m during 2013, as shown on Figures A15 and A16.

Following LW6 passing by the deeper bedrock bore BH6B (71 m to 75 m) in August 2008, the groundwater level started to decline and the bore went dry in May 2009, subsequent to LW7 mining under it and creating hydraulic connection to the mine. BH6B remained dry during 2013.

Site BH7 – Overlying LW11

Figure A17 show the hydrographs of the nested monitoring bores at site BH7, which are located above LW11. Data-loggers were installed in all three bores in early August 2009 (Figure A18).

When LW11 was mined beneath site BH7 in September 2011, water levels declined in the sandstone (BH7B) and the intermediate strata (BH7A) by 11.5 m, with a small change of 1 m measured in the alluvium in BH7. The sandstone aquifer was depressurised and consequently the water level fell below the base of bore BH7B, which has remained dry since.

The water level in the intermediate strata (BH7A) recovered by about 7 m in late 2011/early 2012. However, it was impacted again by 1.7 m when LW12 passed the site in March/April 2012. The groundwater subsequently recovered to a stable level of about RL3.4 m during 2013.

The water level within the alluvium, monitored by BH07, closely follows the CRD trend during 2013. This correlation indicates that the alluvium at BH7 was not impacted in 2013.

Site BH22 – Overlying LW9

Figures A19 and A20 show the hydrographs of the nested monitoring bores at site BH22. BH22 overlies LW9. LW9 passed under the site in late June 2010.

The water level in BH22 declined sharply to below the water level sensor in June 2011 (Figure A20), which is four months after the passage of LW10 adjacent to site BH22. These effects did not coincide with the passing of mining activities, but may be related to completion of fracturing that started earlier. The water level did not recover since.

Generally, as longwall panels LW8 to LW11 approached the piezometer, it would appear that there was compression of the overburden resulting in a temporary rise in water level in BH22A and BH22B followed by a decline as the overburden subsequently dilated as the longwalls passed. The passage of LW11 south-west of BH22A and BH22B in September 2011 caused a water level decline of 1 m in the intermediate layer and about 1.8 m in the alluvium; however, water levels in both strata recovered in late 2011/early 2012. The water level within the alluvium (BH22A) retained a close correlation with the CRD since. The water level changes appear to be dilating strata beneath the alluvium following mining.

The hydrograph from the data logger installed in alluvial bore BH22A (Figure A20), indicate that permanent hydraulic connection to the mine workings has not occurred.

Site BH9 – Overlying Current Working Longwall (LW12)

Monitoring of the intermediate and deeper strata at site BH9 commenced in June 2010, much later than monitoring of the alluvium in BH9. Hence, the hydrographs for the bedrock layers cover only a relatively short time period, as shown on Figure A21. Site BH9 overlies LW12. The active mining face of LW12 passed under the site in late January 2012.

As for most of the bores discussed above, the alluvium monitored in BH9 has not been impacted by mining (Figure A21). The groundwater level in the alluvium trends closely with the CRD (Figure A26).

Water levels in the intermediate and lower layers appear to be impacted by the passing of each longwall face (Figure A21). Water levels in the intermediate layer fluctuate around RL2m since November 2012. When LW14 passed south-west of the site BH9 in May 2013, water levels temporarily rose by about 1.5 m in the intermediate layer (BH9A).

Water levels in the lower layer (BH9B) remained stable at around RL-1m during the passing of LW14. However, during early workings on LW15, water levels rose quickly from August to October 2013 by about 11 m, where after, water levels decreased sharply by 12.4m

The response of BH9A and BH9B is likely due to compression and subsequent dilation of the overlying bedrock.

Site BH10 – To West of LW14

Site BH10 lies in unmined ground approximately 400 m south-west of LW14. Monitoring of the intermediate and deeper strata at site BH10 started in June 2010 within BH10A and BH10B respectively. Monitoring of the alluvial aquifer (BH10) commenced in 1997.

The alluvium monitored in BH10 has not been impacted by mining (Figure A22). The groundwater level in the alluvium trends closely with the CRD (Figure A26).

The hydrograph of BH10A shows a slight downward trend for the complete monitoring period. Water levels in BH10A and BH10B recovered from their decline after passing of LW13, and temporarily increased by about 0.6m and 3.3m in BH10A and BH10B respectively when LW14 was passing in June 2013.

Similar to BH9, water levels in the intermediate layer appear to re-stabilise after passing of LW14 and show only a slight downward trend, while those for the deeper strata show a further decline.

During passing of LW14, the hydrograph increased by up to 3.3 m during the approach, and declined after mining activities passed. The water level changes – similar to effects at BH22B - appear to reflect piezometric pressure changes related to the changing strain regime in the roof sequence. This has been caused by the approach and subsequent passing of each longwall panel.

Sites BH24 – To West of Current Working Longwalls (LW12-LW13)

Site BH24 lies in unmined ground approximately 150 m south-west of LW14. Monitoring started in June 2010. The alluvium is not monitored at this site; BH24A is installed in a shallow sandstone/ mudstone sequence. Bores BH24B (28 m to 34 m) and BH24C (55 m to 60 m) monitor the intermediate and deeper strata, respectively.

The water level in the shallow layer (BH24A) is relatively stable around 16.7 m, whereas the water level in the intermediate strata (BH24B) declined since the bore installation by about 3 m (Figure A23).

The water levels were relatively stable between January and May 2013 at about RL8.2m and RL1.7m in BH24B and BH24C respectively. Water levels increased rapidly by about 6 m (BH24B) and 13.30 m (BH24C) during/after LW14 passing north-east of the site. While water levels in the intermediate layer re-stabilised at about RL8.2 m, those in the deeper strata declined further until December 2013, when they reached RL-0.4 m.

The cause of the hydrograph of BH24B and BH24C appears to partly correlate with mining activities north-east of the site. As for other bores discussed above, the response is likely due to compression and subsequent dilation during approaching and passing of the longwalls.

The hydrographs do not give any indication that the shallow sandstone/mudstone sequence has been impacted by mining at site BH24.

Sites BH25 – Overlying Longwall LW14)

Site BH25 overlies LW14 near the Main Headings. Monitoring at site BH25 started in June 2010. The alluvium is monitored at this site within BH25A (2.5 m to 9 m). Bores BH25B (20 m to 30 m) and BH25C (51.5 m to 58 m) monitor the intermediate and deeper strata respectively.

The groundwater level in the alluvium, monitored in BH25A, trends closely with the CRD (Figure A25 and Figure A26). The alluvial hydrograph is relatively stable with little fluctuation between RL12.5 m and RL14 m, and appears not to be impacted by mining (Figure A24).

Water levels in the intermediate and deeper strata, BH25B and BH25C, are relatively stable at around RL11 m and RL8 m respectively until September 2012. After passing of LW13 in November 2012, water levels declined slightly below their long-term levels. After LW14 passed, water levels inclined by 1.7m (BH25B) and declined by 5 m (BH25C). While BH25B stabilises at about RL10 m just 1 m below its long-term water level, the levels in BH25C appear to stabilise at about RL5 m, which is about 3 m below its previous long-term water level.

These effects are likely responses due to compression and subsequent dilation during approaching and passing of the longwalls. During 2013 and for the deeper strata it appears, that water went into storage in the dilated rock mass causing a (temporary) decline in water level, followed by some recovery.

5.5 Summary of Groundwater Level Monitoring

The data indicates that there has been no impact from mining of LW1 to LW15 on the alluvial groundwater levels. The exception being a temporary decline of 1.8 m at site BH22A in December 2009 (Section 5.4), and a second temporary decline in September 2011. Similar minor temporary effects were identified in BH7, the closest bore to BH22, when longwall mining passed the bore. During 2013, all alluvial bores correlated closely with the CRD, indicating there has been no impact by mining.

The shallow overburden has been impacted on various levels by mining at most monitoring sites due to bedding parting. Water levels, however, generally stabilised or recovered, especially in bores away from active mining, and there was no change in 2013 compared to previous years.

Mining of the longwall panels, however, has resulted in depressurisation of the deeper overburden. At these deeper levels, the bedrock has probably been depressurised/dewatered when mining intersected a fault and/or goafing provided hydraulic connection with the mine. While some bores remained dry and water levels in some bores continued to decline, the water levels of others stabilised during 2013.

The data also indicates that the Great Northern Seam to the south of the Mandalong Mine may have been depressurised as a result of mining in the area, but that the deeper Fassifern Seam has not been impacted.

In summary, the monitoring data indicates that although mining has impacted groundwater levels in overburden rocks, there has been no long-term impact, even in faulted areas, on groundwater levels in the alluvial aquifers.

6 GROUNDWATER QUALITY MONITORING

6.1 Alluvial Water Quality

Electricitical conductivity (EC) fluctuations for the alluvial bores are shown graphically in Appendix B. The graphs are of groups of bores with similar EC levels and trends rather than similar location, as was presented for the hydrographs.

Figure B1 shows EC data for two bores BH1 and BH9, both of which have low salinity groundwater in the range 200 µs/cm to 700 µs/cm. The bores are about 3 km apart (Figure 1). In 2013, the EC level of both bores fluctuated around the long-term average.

The remaining bores in the alluvium monitor poor quality water in the range 4,000 µs/cm to 18,000 µS/cm (as shown on Figures B2 to B5). During 2013, EC levels in bores BH4, BH7 and BH14 (Figure B2) fluctuated between about 4,000 µs/cm and 15,000 µs/cm, but remained within the historic range. Salinity in BH5 was on a very low level of 350 µs/cm to 450 µs/cm during February, March, May and December 2013, which was due to the top of casing being inundated, and fresh surface water / stormwater has likely entered the bore. Salinity in BH5 increased in late 2013 to about 3,000 µs/cm. It is considered that the increase in EC in BH5 is a result of the surface water/stormwater being flushed overtime during sampling.

Bores BH6, BH8, BH11, BH12 and BH25A (Figure B3) indicate a natural fluctuation range without an increasing or decreasing trend in EC, historically and through 2013. Three short periods of reduced EC during occurred during March/April 2011, June/July 2012 and July/August 2013. The reduced EC may be due to inundation of the bore (top of casing of BH25A is at ground level), and/ or recharge of the shallow water table (0.9mbgl to 2.8mbgl) during periods of above average rainfall.

Salinity in BH3 was on a downward trend for most of 2013. However, levels have remained within the historic range (Figure B4). Salinity levels in BH10 fluctuated around 2,000 µs/cm (Figure B4) within the historic range.

Bores BH2 and BH13 continue to show a very large fluctuation range in 2013 (Figure B5), suggesting surface water ingress has occurred for most of 2013.

In summary, the review of the EC data trends indicate that the fluctuation range since the commencement of mining is within the baseline, pre-mining range. As such, it is concluded that to date, mining does not appear to have impacted on water quality in the alluvial aquifer.

6.2 Coal Seam and Overburden Water Quality

Figure B6 shows the EC fluctuation of the overburden and Fassifern Seam. The data indicates a wide range from about 1,500 µS/cm in a sandstone layer at BH19, to about 10,000 µS/cm in a sandstone layer at BH17, with the EC of the Fassifern Seam being between these two levels.

CMPL monitor Mandalong Mine water discharge at the Cooranbong licensed discharge point (LDP001). The average Total Dissolved Solids (TDS) is 3,000 mg/L, equivalent to an EC of about 4,500 µS/cm. Most of this water from the mine would have been derived from the coal seam.

Given the low yield and general poor quality of the groundwater in the coal seams and overburden, the environmental value has been classified as “primary industry” with the main potential use being for stock watering.

6.3 Water Quality in Nested Monitoring Bores

Figures B7 to B14 show graphically the EC fluctuation data for the nested monitoring bores at sites BH20, BH21, BH17, BH23, BH9, BH10, BH24 and BH25. Water quality monitoring of bores BH9A, 9B, 10A, 10B and sites BH24 and BH25 commenced in June 2010 and as such, the hydrograph covers a comparably short period.

The graphs indicate similar poor quality water in both the alluvium and the overburden, in the range 5,000 µs/cm to 9,000 µS/cm, with the alluvium containing the poorest quality water in BH20 (Figure B7) and BH21 (Figure B8).

Water quality levels at sites BH17, BH20, BH21, BH23, BH24 and BH25 fluctuate within the long-term range.

Salinity in BH9 and BH10 is stable with little fluctuation around the long-term average (Figure B11).

Water quality monitoring at sites BH24 and BH25 commenced in June 2010, and as such, there is a comparably short period of historical data. Water levels within both bores show a stable trend since the start of monitoring with three short periods of reduced EC (Figures B12 to B14) during March/April 2011, June/July 2012 and July/August 2013. The reduced EC during July/August 2013 may be due to inundation of the bore.

The Mandalong Mine received above long-term mean rainfall from March-July 2011, during the first half of 2012, and during January-March, June and November 2013 according to MAWS rainfall data (Table **1**). With the top of casing being at ground level, it is likely that rainwater entered the bores during the inundation of BH24 and BH25, leading to the temporary reduced EC levels. However, it is concluded that alluvial water quality at sites BH24 and BH25 was not adversely affected.

It should be considered that some of the fluctuations shown in the EC graphs may be related to:

- very wet months and/or flood waters entering the bore;
- the bores not being properly purged prior to sampling;
- the field EC meter not being properly calibrated prior to the sampling round; or
- a combination of the above.

The information is due to additional details provided by CMPL as follows:

- inundation of bores occurred in BH5 (July and November 2013), BH13 (June/July/November 2013), and probably occurred in bores at sites BH24 and BH25 (in January-March, June and November 2013);
- localised flooding occurred during June/July 2013 at/near BH2, BH4, and BH9; and
- BH21 (for most of 2013) and BH23 (December 2013) were not properly purged prior to sampling due to slow recovery.

In summary, the EC in the bores indicate that the fluctuation range since the commencement of mining is within the baseline, pre-mining range. The fluctuations are considered to be related to natural environmental conditions such as flooding, with EC levels eventually stabilising and returning to historic levels. It can be concluded that the salinity in the alluvium was not adversely impacted.

6.4 Summary of Water Quality Monitoring

The water quality monitoring data confirms that there are isolated pockets of fresh shallow groundwater in the upper alluvium, but the majority of the groundwater, which is within the basal alluvial silty sands, is of poor quality sourced from the Permian strata. Groundwater in the coal and overburden material is also of poor quality.

The data confirms that the alluvial and bedrock aquifers are not a significant groundwater resource as yields are low and quality is generally poor.

Monitoring of the nested piezometers above and to the immediate west of LW1 to LW15 indicates that mining of these panels has not affected water quality in the overlying aquifers in 2013.

7 SUMMARY AND CONCLUSIONS

An extensive groundwater monitoring network has been established, and a monitoring program implemented at the Mandalong Mine. This program has been established to provide timely warnings of deviations from natural or background levels, so that if necessary, remedial measures and/or management strategies can be put in place.

The current monitoring network consists of 45 bores; 20 alluvial monitoring bores, 23 overburden monitoring bores and two coal seam monitoring bores. The bores consist of 12 nests of two or three bores monitoring strata at increasing depth at the same site, and 13 single bore sites. The bores are monitored every month with the water level, EC and pH being measured.

The monitoring data has confirmed the Kendorski (1993) model and previous assessments of the potential impact of goafing associated with longwall mining on the overlying aquifers, viz:

- water levels in the alluvium and shallow overburden are not impacted by mining, the exception being a temporary decline of 1.8 m (Section 5.4), at site BH22 followed by a period of fluctuating water levels. The data indicates that a hydraulic connection has not been established from the alluvium at BH22A to the workings, and that the decline and temporary declines occur as a result of short-term depressurisation of the dilated zone. Similarly, one temporary water level change of about 1 m occurred at site BH7.
- water bearing overburden strata to depths in excess of 50 m are impacted by compression and dilation of the strata due to the passage of mining along the longwall panel, resulting in an increase or decrease in water level, but without hydraulic connection to the mine. Water levels are expected to recover within this zone over time;
- water bearing overburden strata at depths of greater than 90 m below ground level are depressurised/dewatered as a result of hydraulic connection with the longwall panel; and
- the coal seam aquifer that is being mined is locally depressurised/dewatered.

We conclude, based on the analysis of the groundwater monitoring data, that there has been no adverse long-term impact on the alluvial aquifers or shallow overburden from longwall mining of panels LW1 to LW14. However, it is acknowledged that dewatering of the goafed zones in addition to the depressurisation of the deeper overburden has occurred due to mining.

AUSTRALASIAN GROUNDWATER AND ENVIRONMENTAL CONSULTANTS PTY LTD

Reviewed by:

Thomas Muehe

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Senior Environmental Scientist

DOUGLAS MCALISTER
Principal Hydrogeologist

LIMITATIONS OF REPORT

Australasian Groundwater and Environmental Consultants Pty Ltd (AGE) has prepared this report for the use of Centennial Mandalong Pty Ltd in accordance with the usual care and thoroughness of the consulting profession. It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this report. It is prepared in accordance with the scope of work and for the purpose outlined in the Proposal emailed on the 9 December 2013.

The methodology adopted and sources of information used by AGE are outlined in this report. AGE has made no independent verification of this information beyond the agreed scope of works and AGE assumes no responsibility for any inaccuracies or omissions. No indications were found during our investigations that information contained in this report as provided to AGE was false.

This study was undertaken between 6 January 2014 and 31 January 2014 and is based on the conditions encountered and the information available at the time of preparation of the report. AGE disclaims responsibility for any changes that may occurred after this time.

This report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties. It may not contain sufficient information for the purposes of other parties or other users. This report does not purport to give legal advice. Legal advice can only be given by qualified legal practitioners.

This report contains information obtained by inspection, sampling, testing and other means of investigation. This information is directly relevant only to the points in the ground where they were obtained at the time of the assessment. Where borehole logs are provided they indicate the inferred ground conditions only at the specific locations tested. The precision with which conditions are indicated depends largely on the frequency and method of sampling, and the uniformity of the site, as constrained by the project budget limitations. The behaviour of groundwater is complex. Our conclusions are based upon the analytical data presented in this report and our experience.

Where conditions encountered at the site are subsequently found to differ significantly from those anticipated in this report, AGE must be notified of any such findings and be provided with an opportunity to review the recommendations of this report.

Whilst to the best of our knowledge, information contained in this report is accurate at the date of issue, subsurface conditions, including groundwater levels can change in a limited time. Therefore this document and the information contained herein should only be regarded as valid at the time of the investigation unless otherwise explicitly stated in this report.

Appendix A

MONITORING BORE HYDROGRAPHS

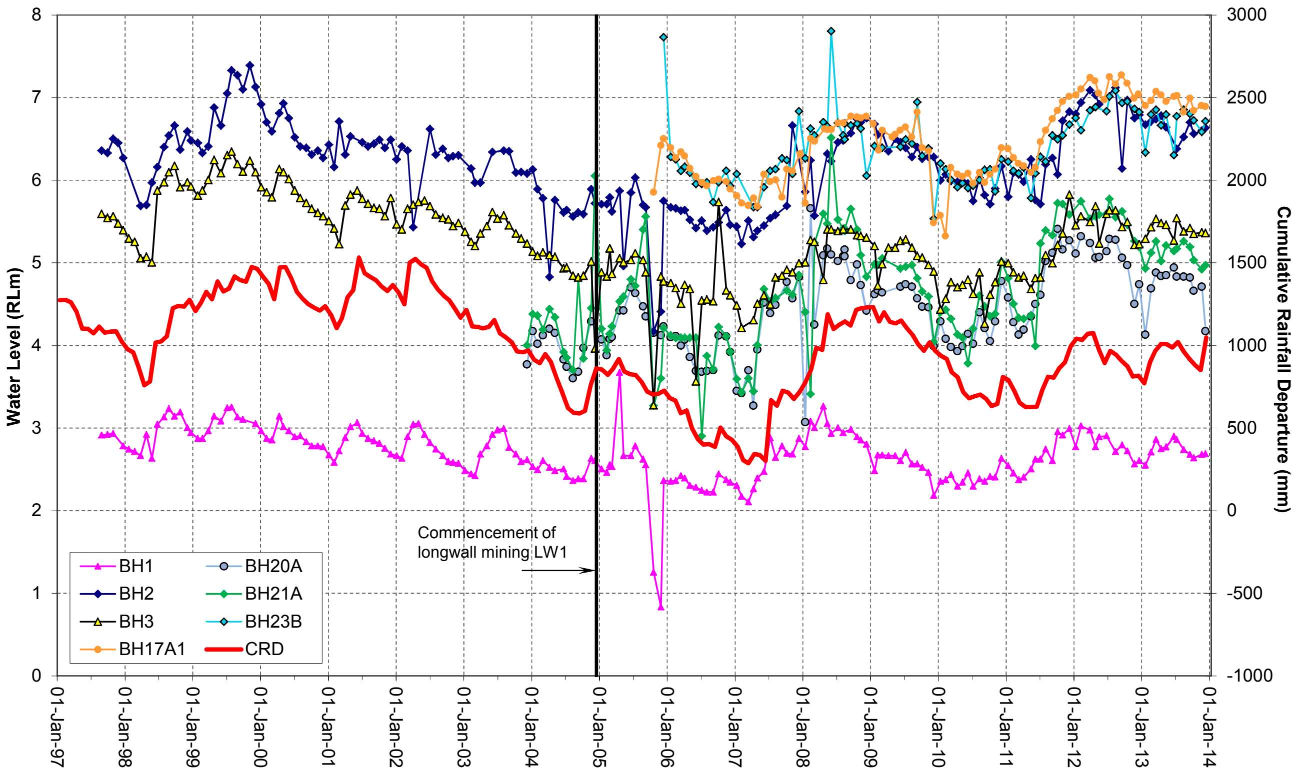


Figure A1: Hydrographs of Monitoring Bores BH1-3, BH17A1, BH20A, BH21A, BH23B (Lower Catchment) compared to CRD

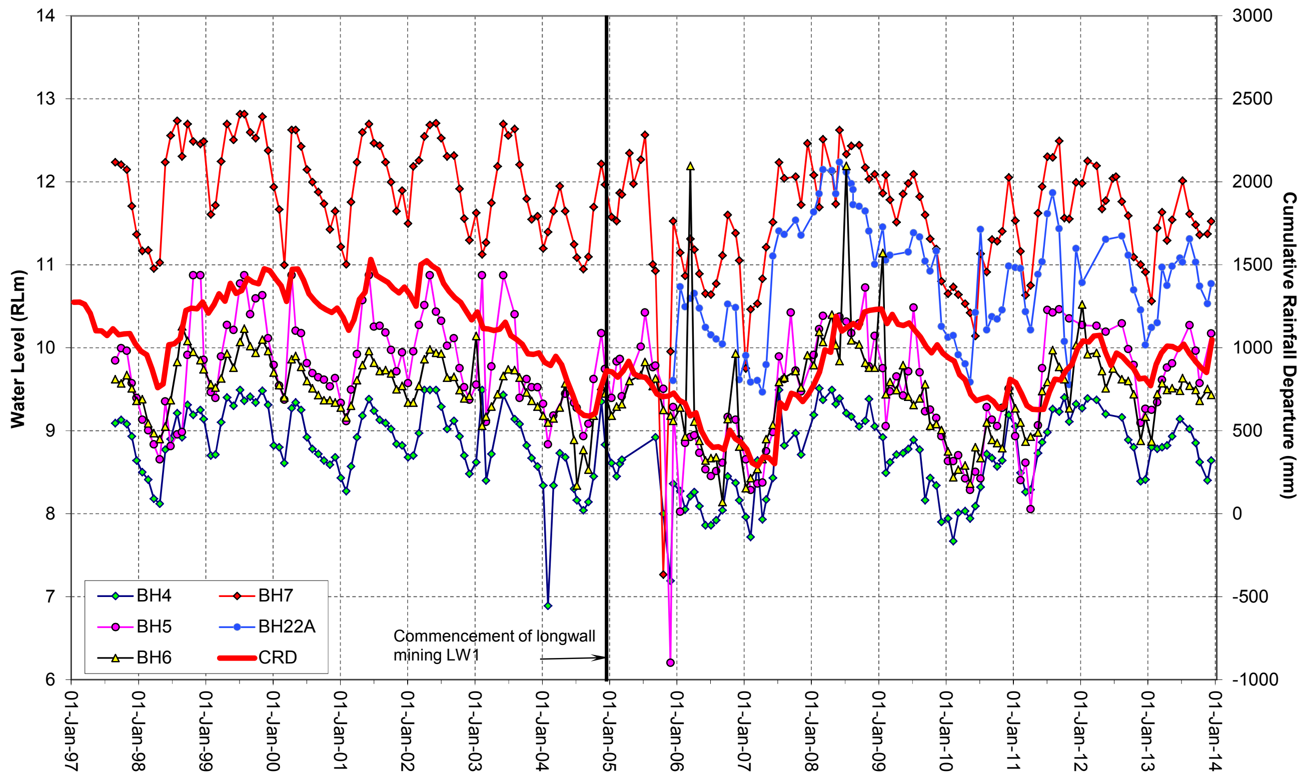


Figure A2: Hydrograph of Monitoring Bores BH4-7, BH22A (Middle Catchment) compared to CRD

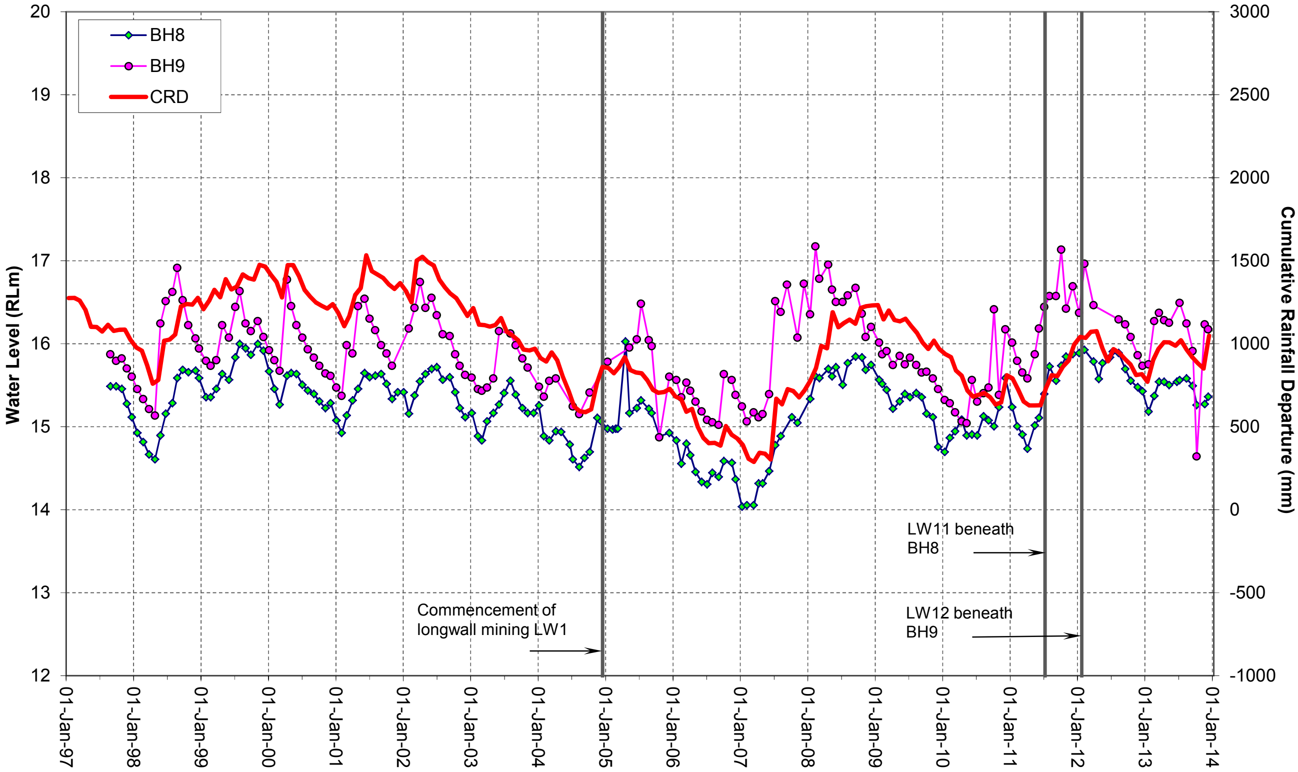


Figure A3: Hydrograph of Monitoring Bores BH8-9 (Upper Catchment Stockton Creek) compared to CRD

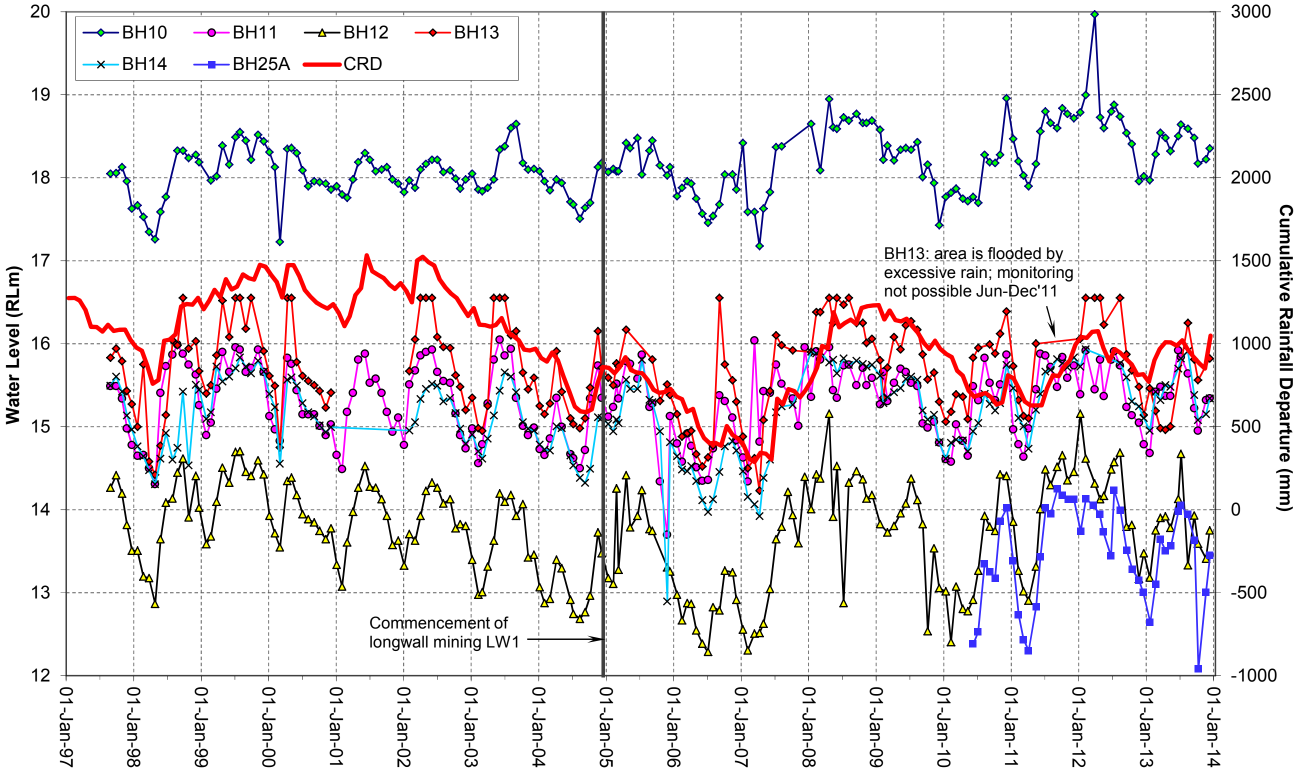


Figure A4: Hydrograph of Monitoring Bores BH10-14, BH25A (Upper Catchment Morans Creek) compared to CRD

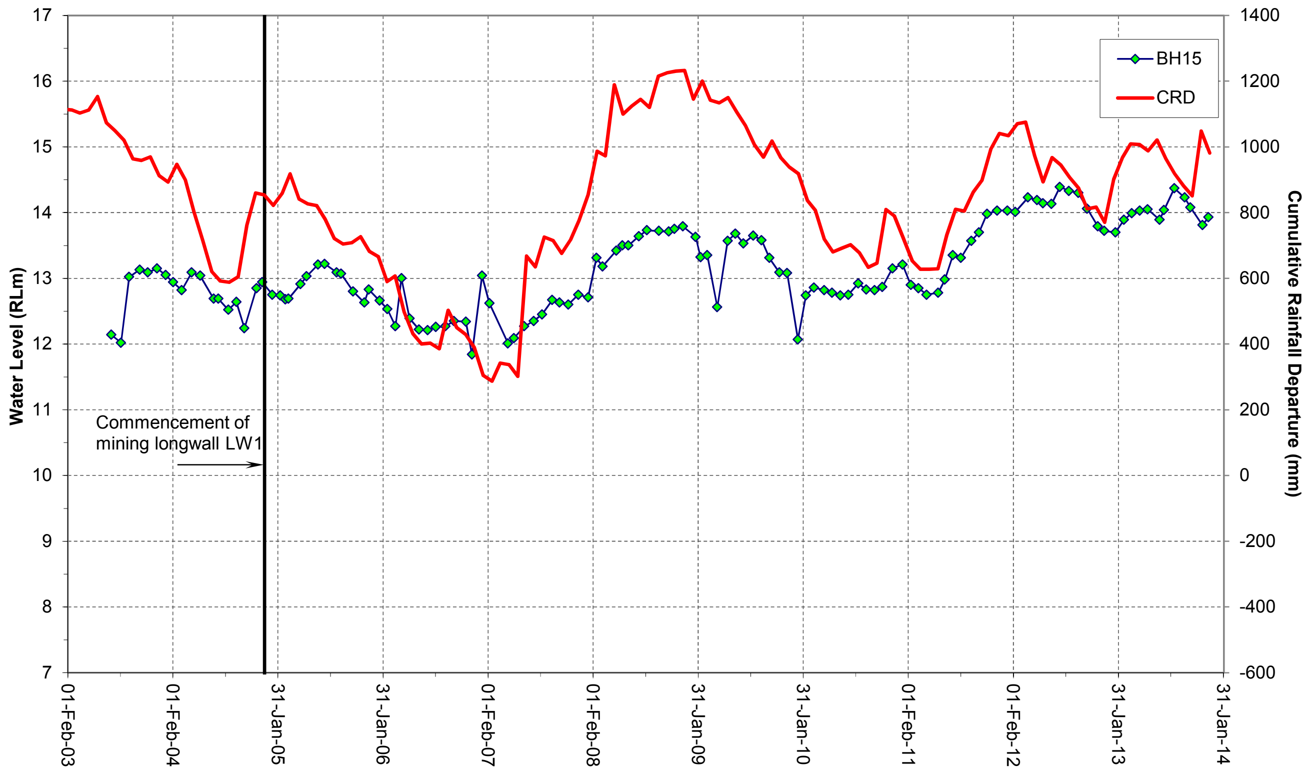


Figure A5: Fassifern Coal Seam – Hydrograph Bore BH15

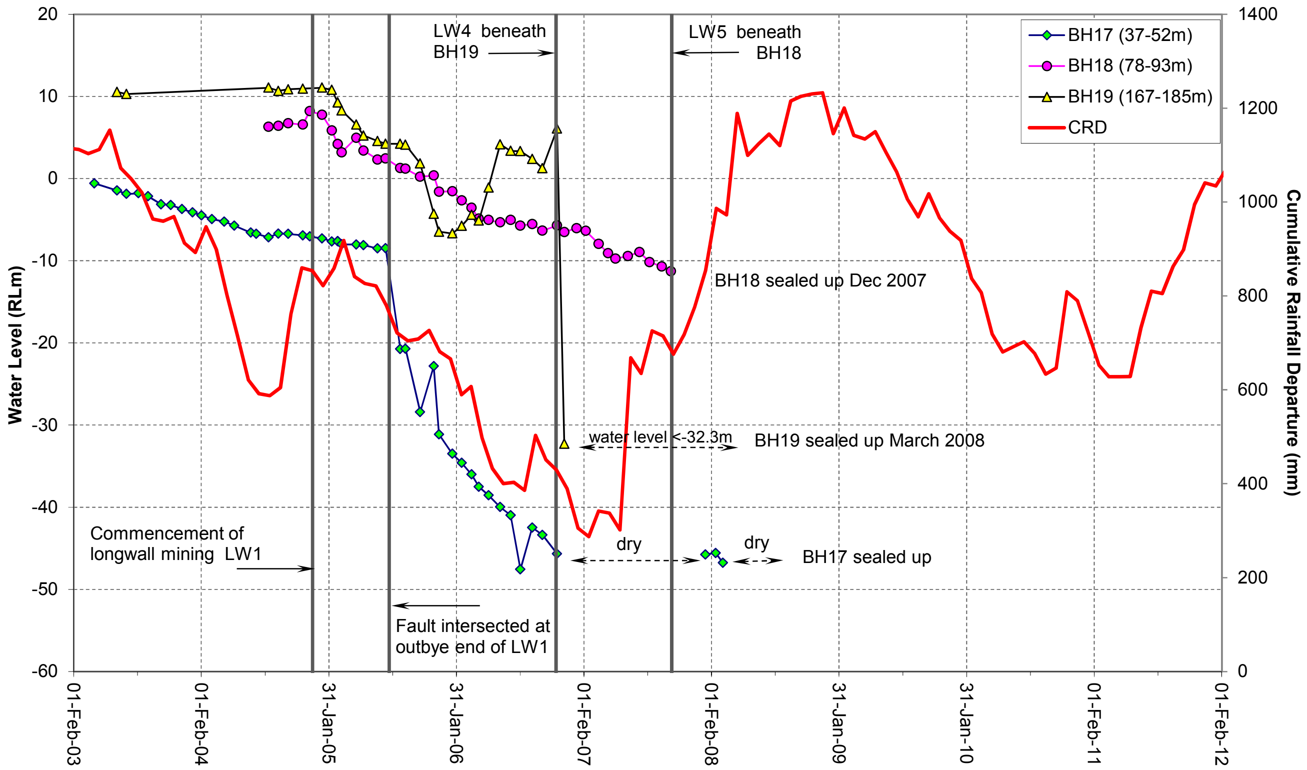


Figure A6: Overburden – Hydrograph Bores BH17 – 19

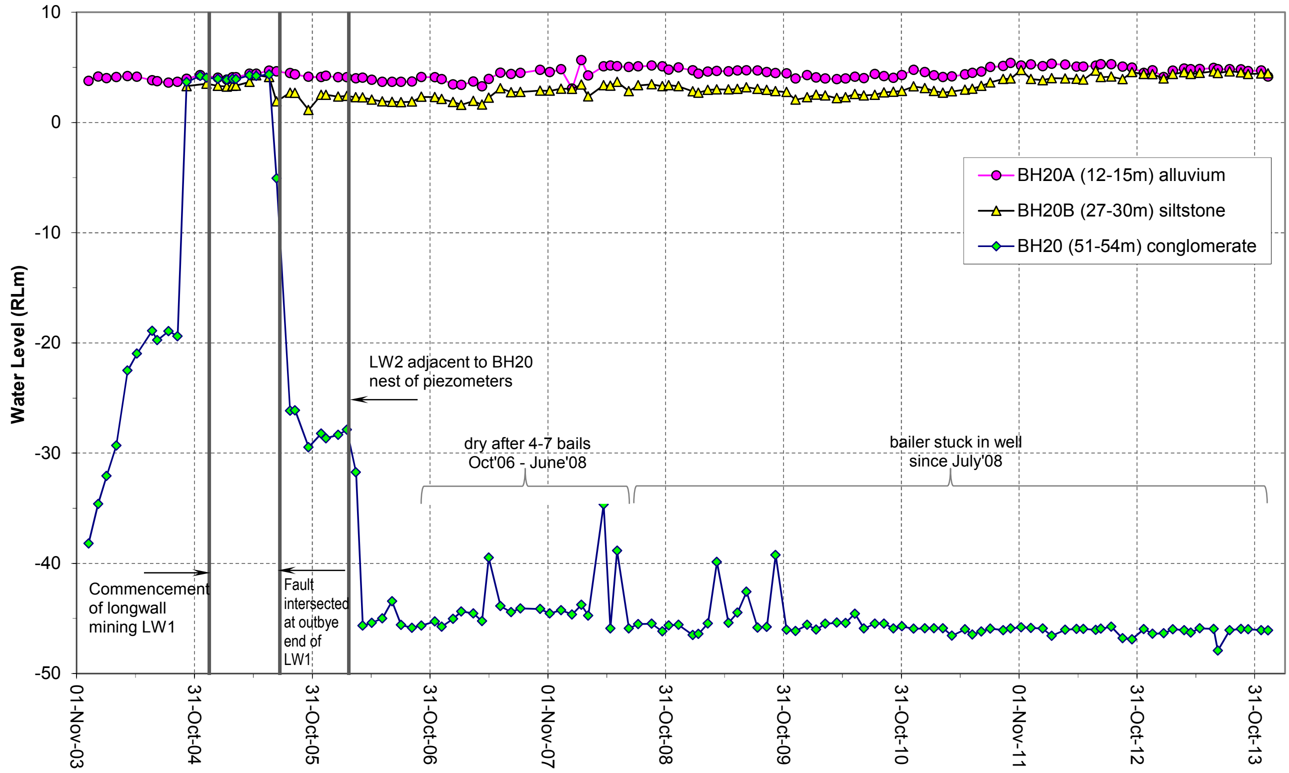


Figure A7: Nested Monitoring – Hydrograph Bores BH 20, 20A, 20B

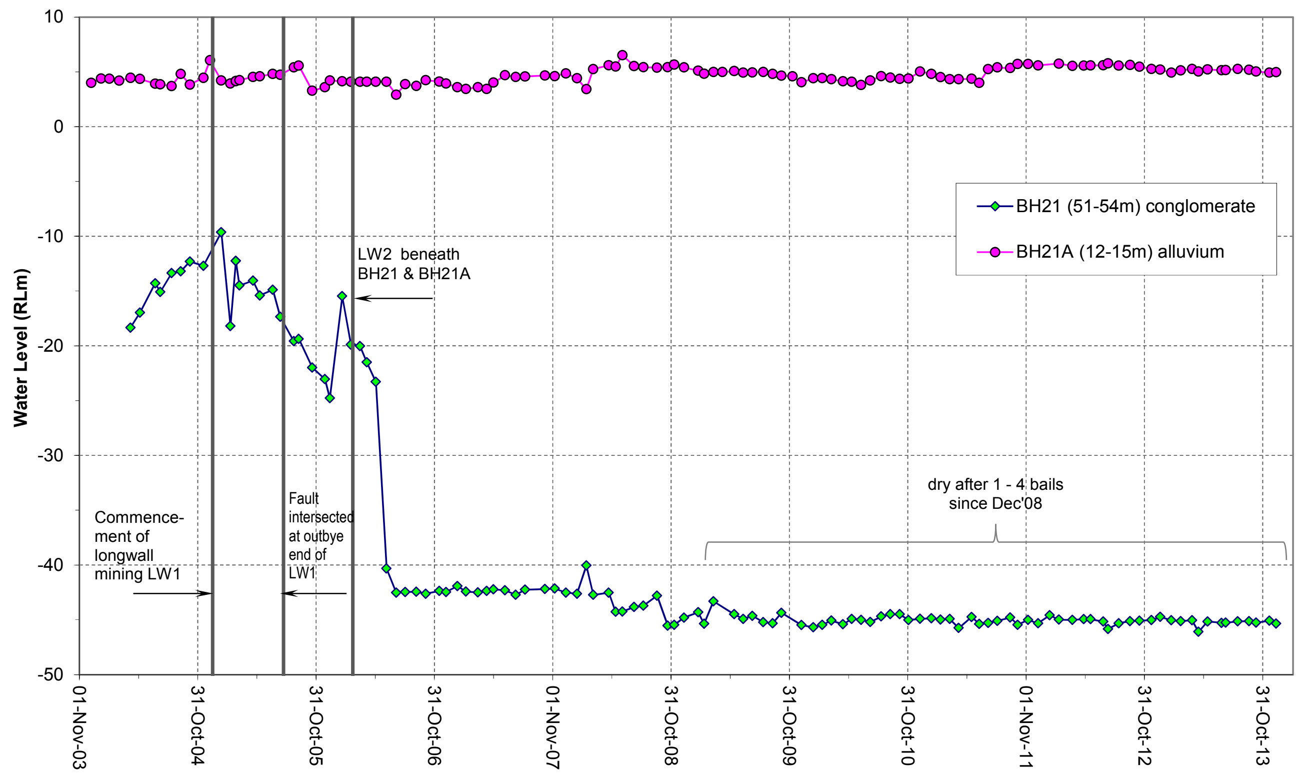


Figure A8: Nested Monitoring – Hydrograph Bores BH21 – 21A

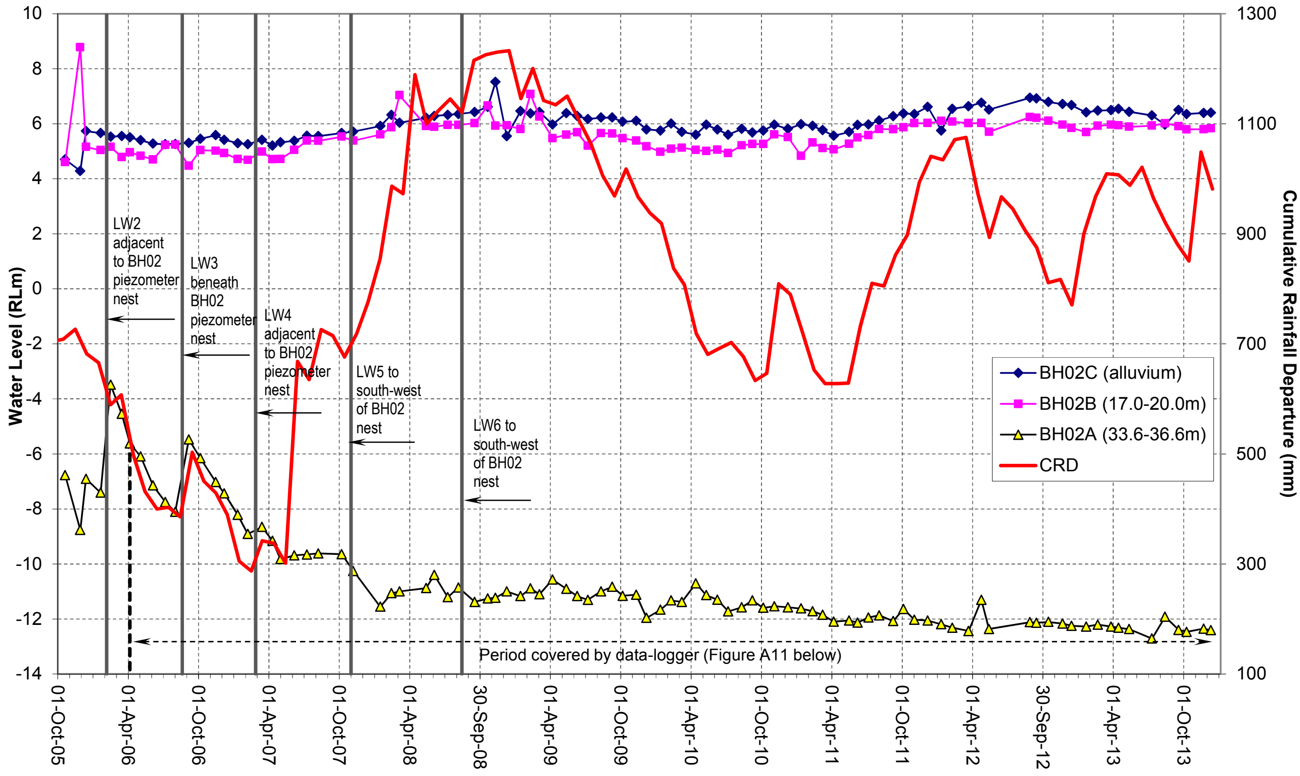


Figure A9: Nested Monitoring – Hydrograph Bores BH02A, 02B, 02C

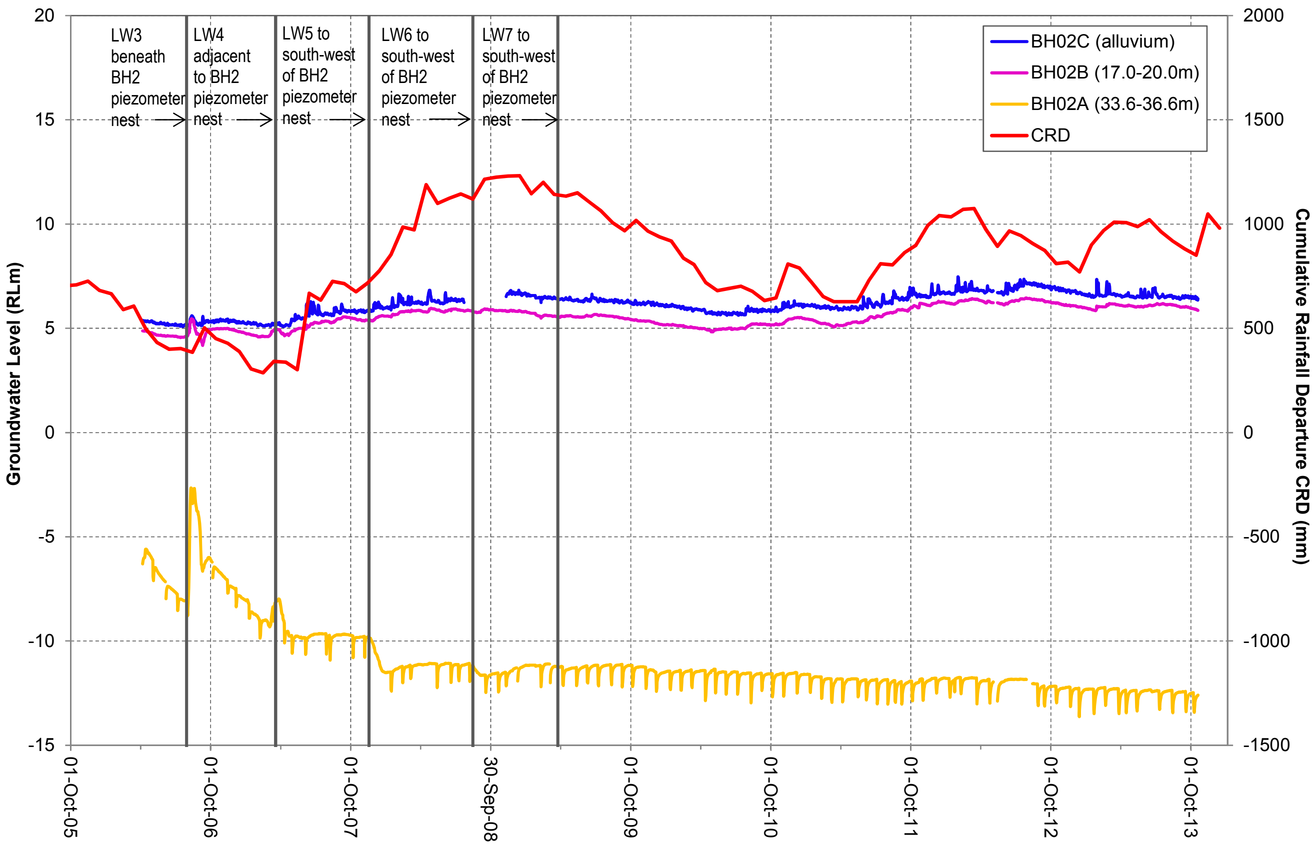


Figure A10: Nested Monitoring – Data-logger Hydrograph of Bores BH02A, 02B, 02C

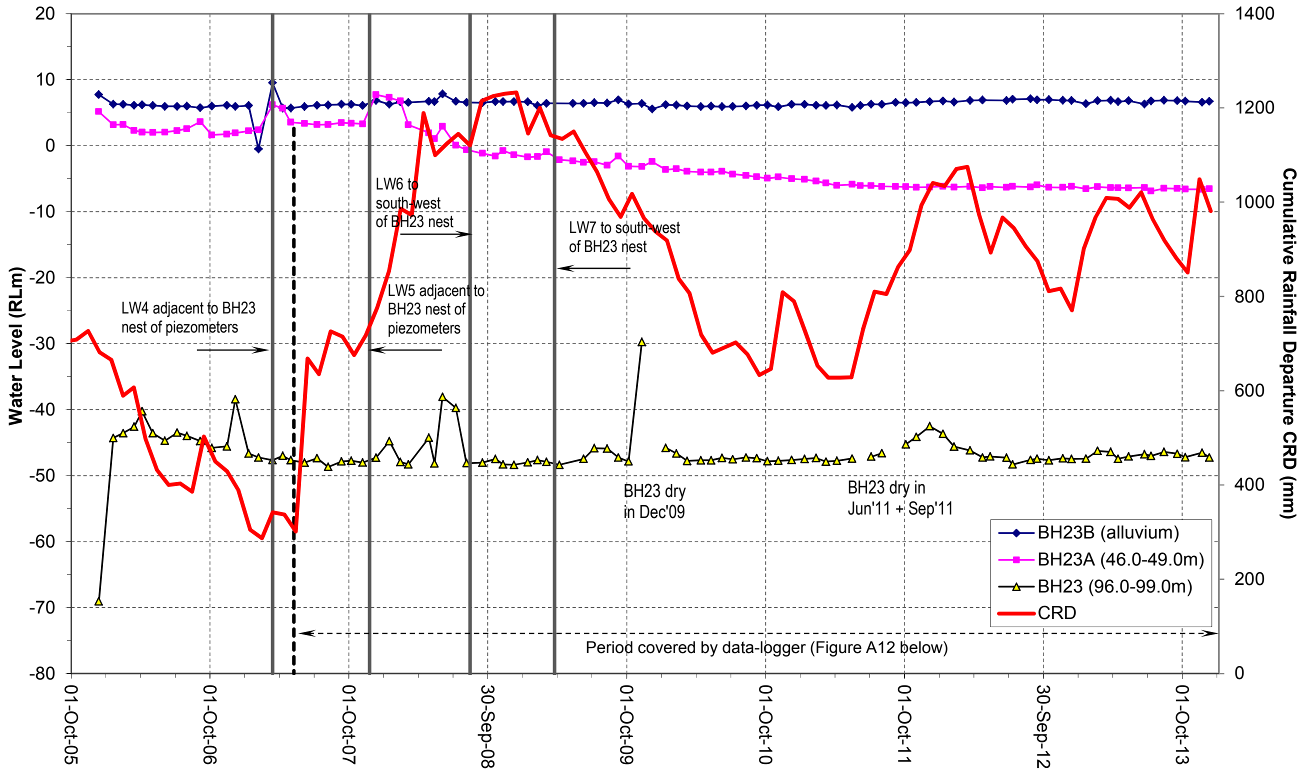


Figure A11: Nested Monitoring – Hydrograph Bores BH23, 23A, 23B

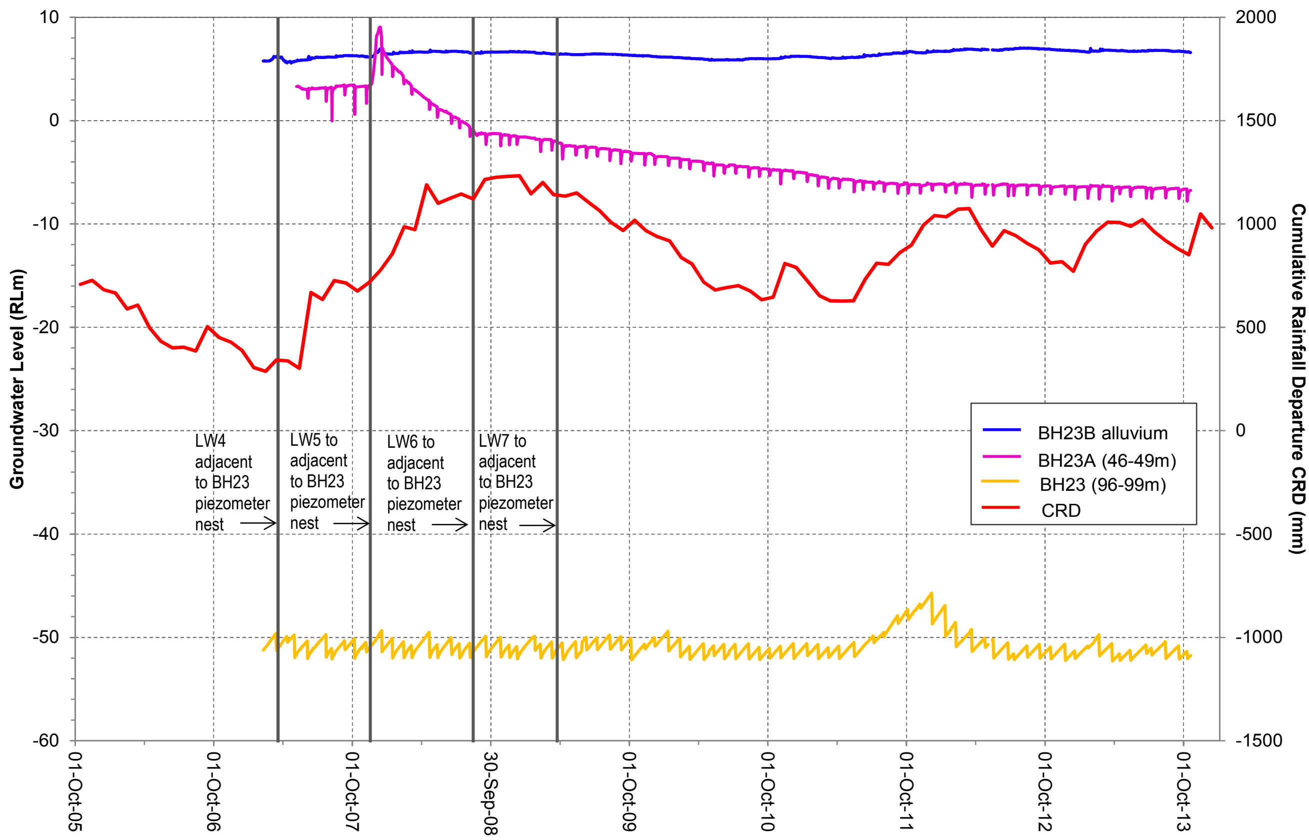


Figure A12: Nested Monitoring – Data-logger Hydrographs of Bores BH23, 23A, 23B

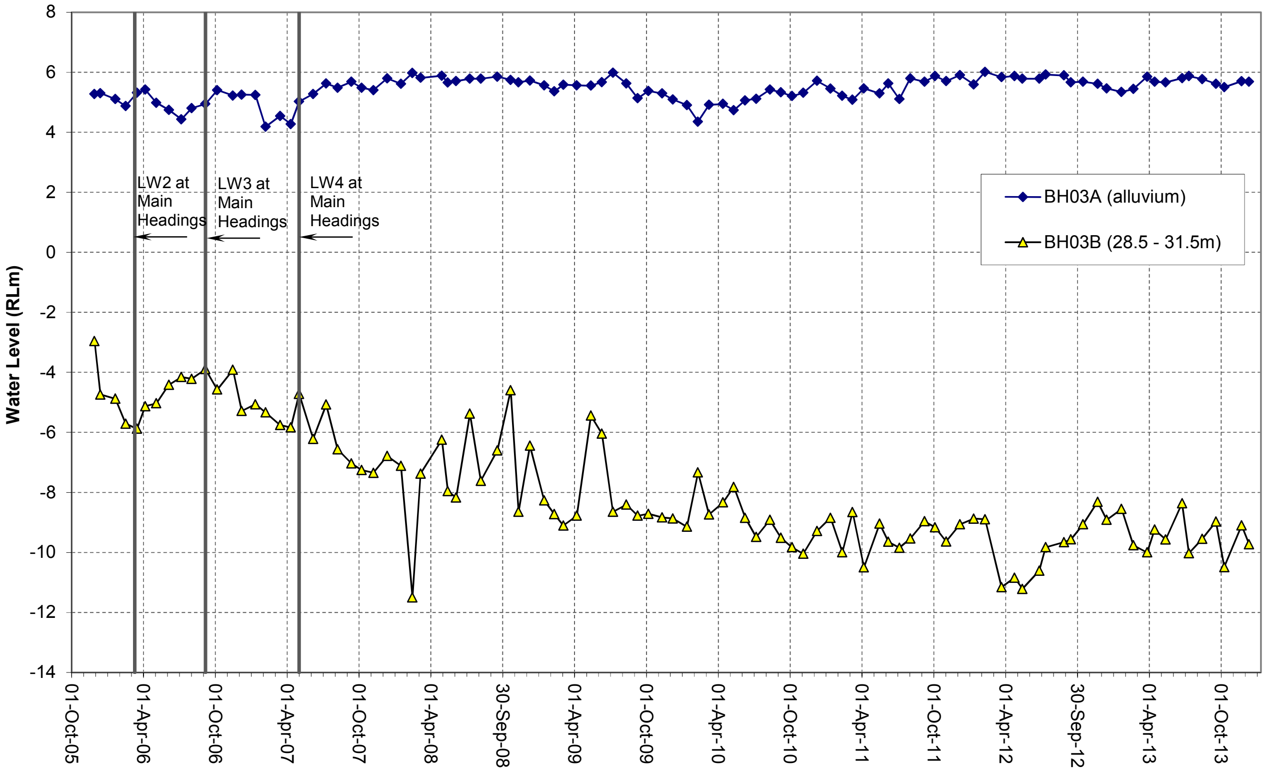


Figure A13: Nested Monitoring – Hydrograph Bores BH03A, 03B

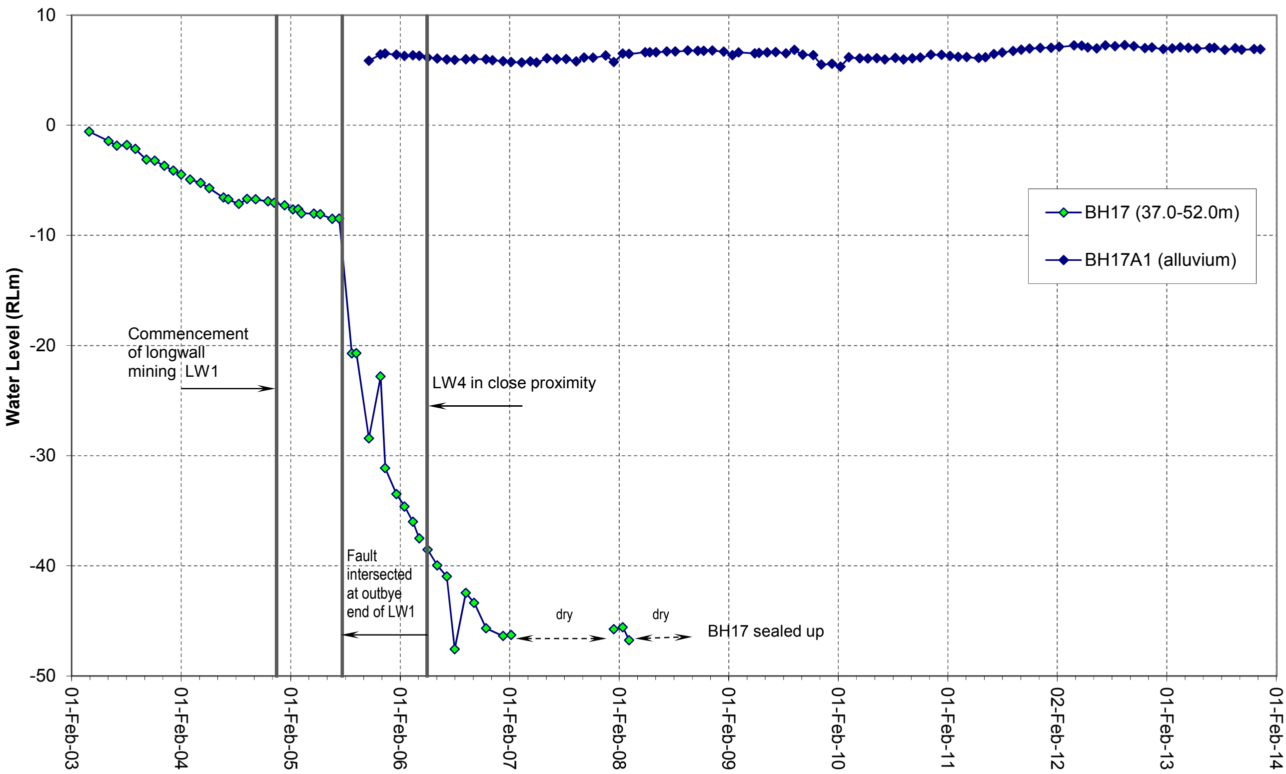


Figure A14: Nested Monitoring – Hydrograph Bores BH17 – 17A1

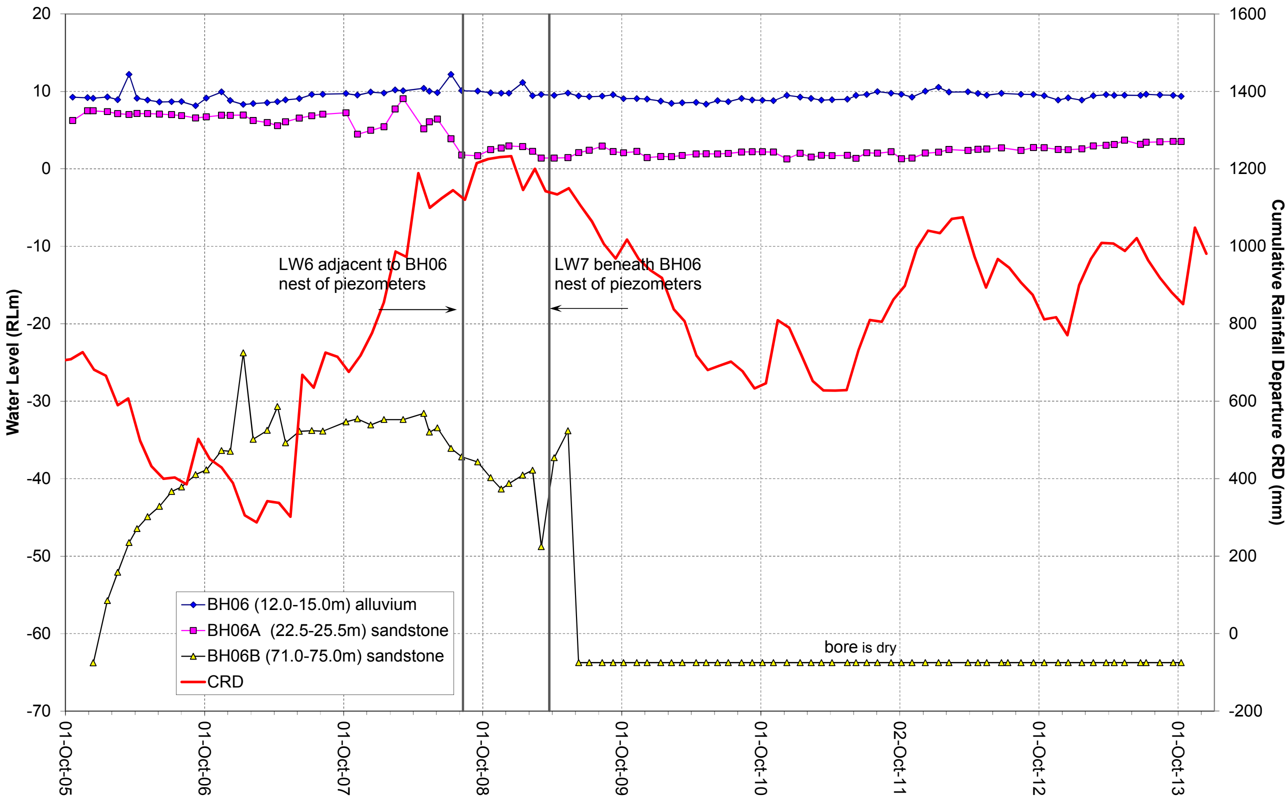


Figure A15: Nested Monitoring – Hydrograph Bores BH6 (A, B, C)

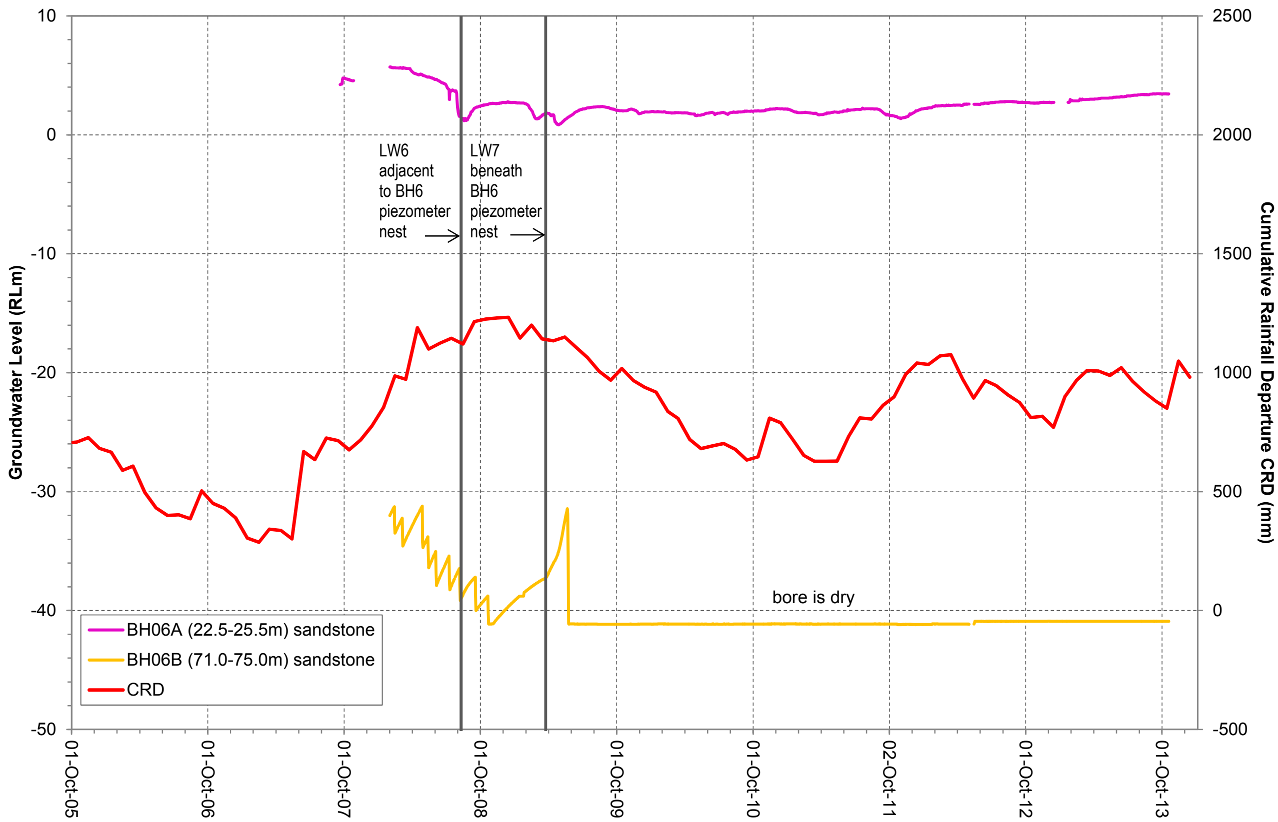


Figure A16: Nested Monitoring – Data-logger Hydrographs of Bores BH6 (A and B)

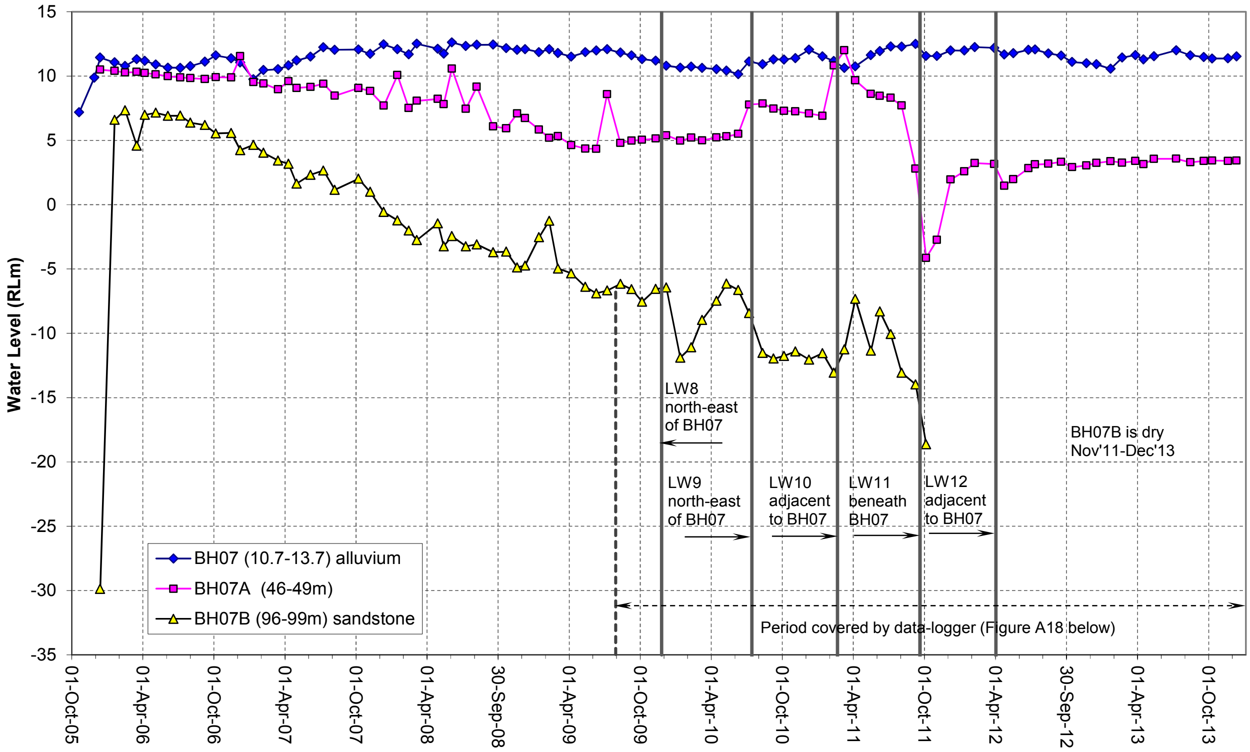


Figure A17: Nested Monitoring – Hydrograph Bores BH7, 7A, 7B

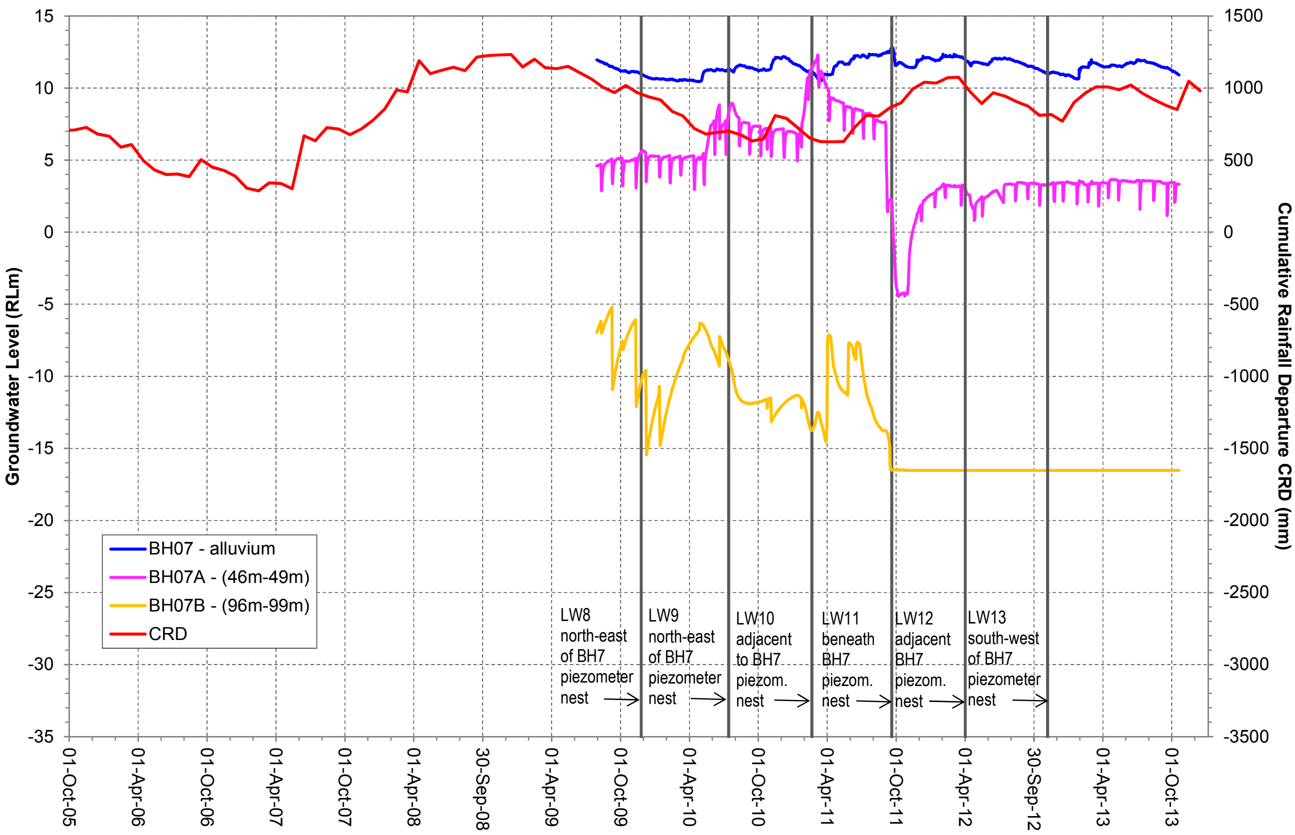


Figure A18: Nested Monitoring – Data-logger Hydrographs of Bores BH7, 7A, 7B

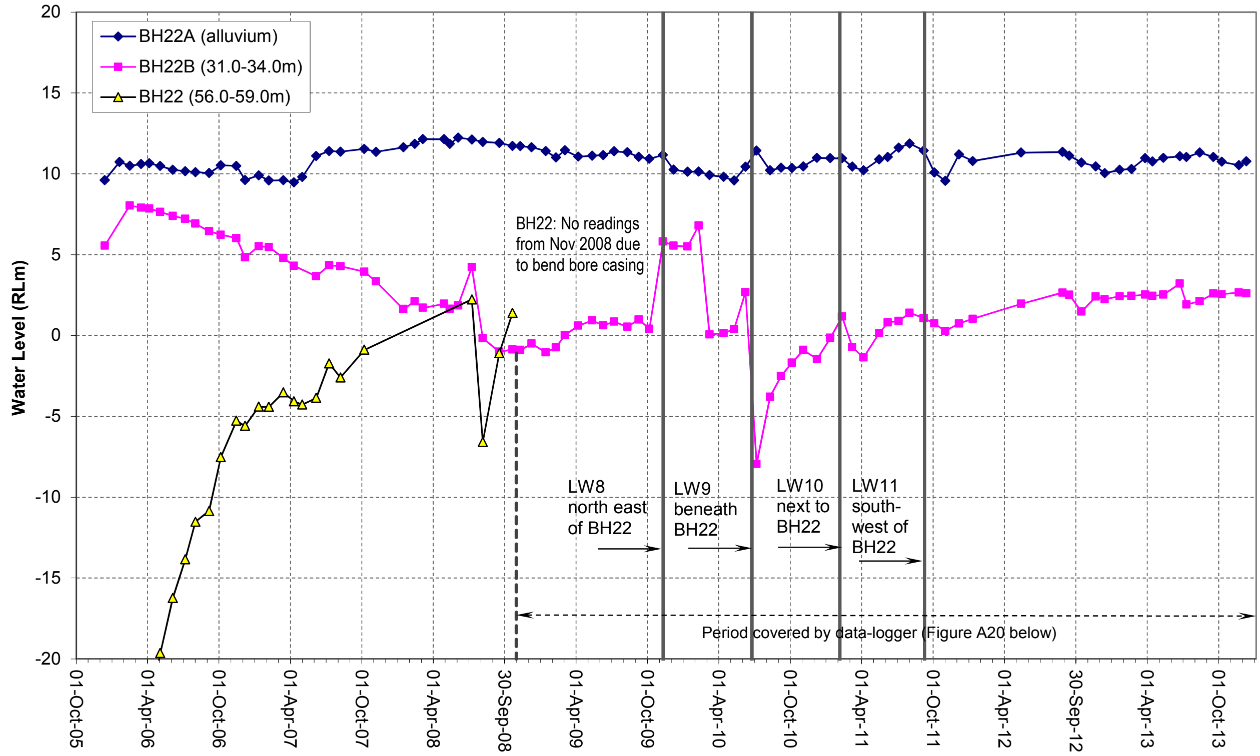


Figure A19: Nested Monitoring – Hydrograph Bores BH22 (A, B, C)

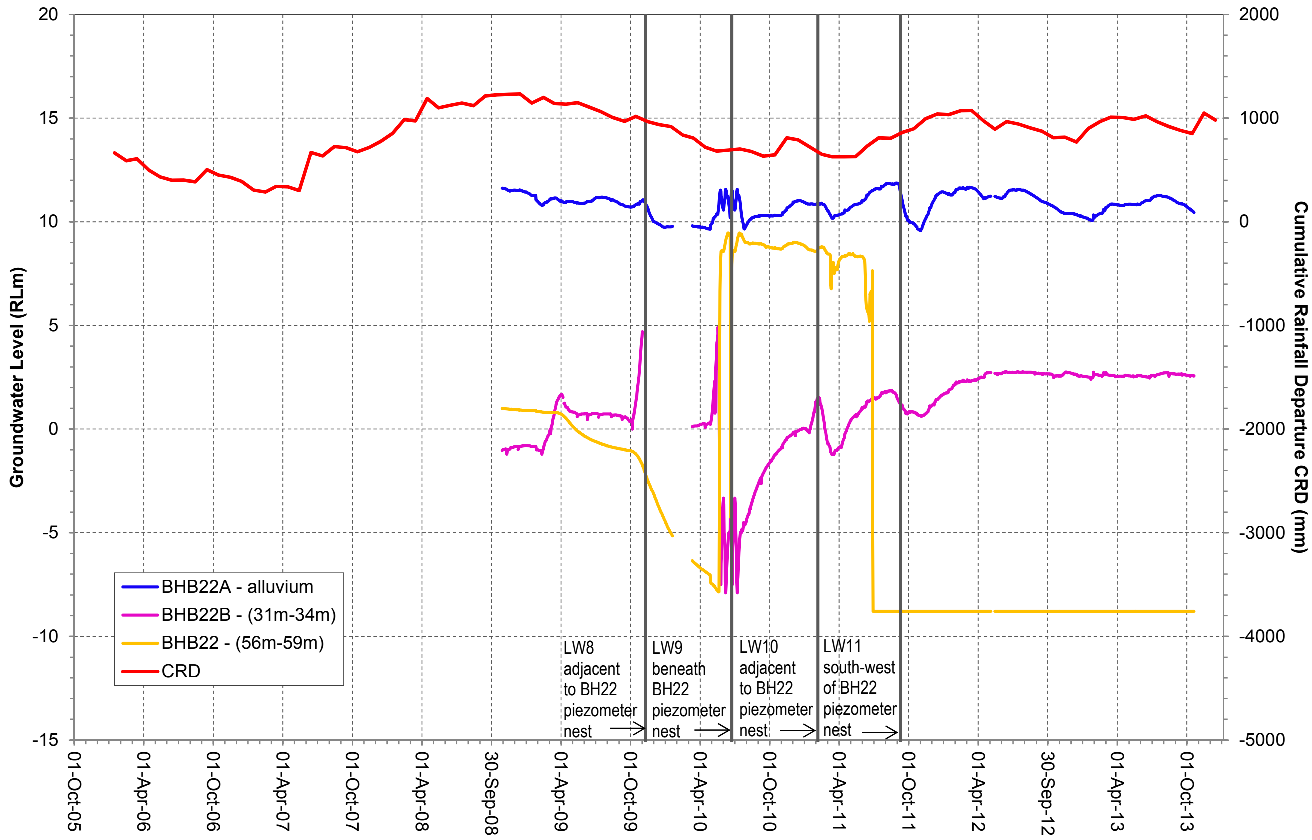


Figure A20: Nested Monitoring – Data-logger Hydrographs of Bores BH22 (A, B, C)

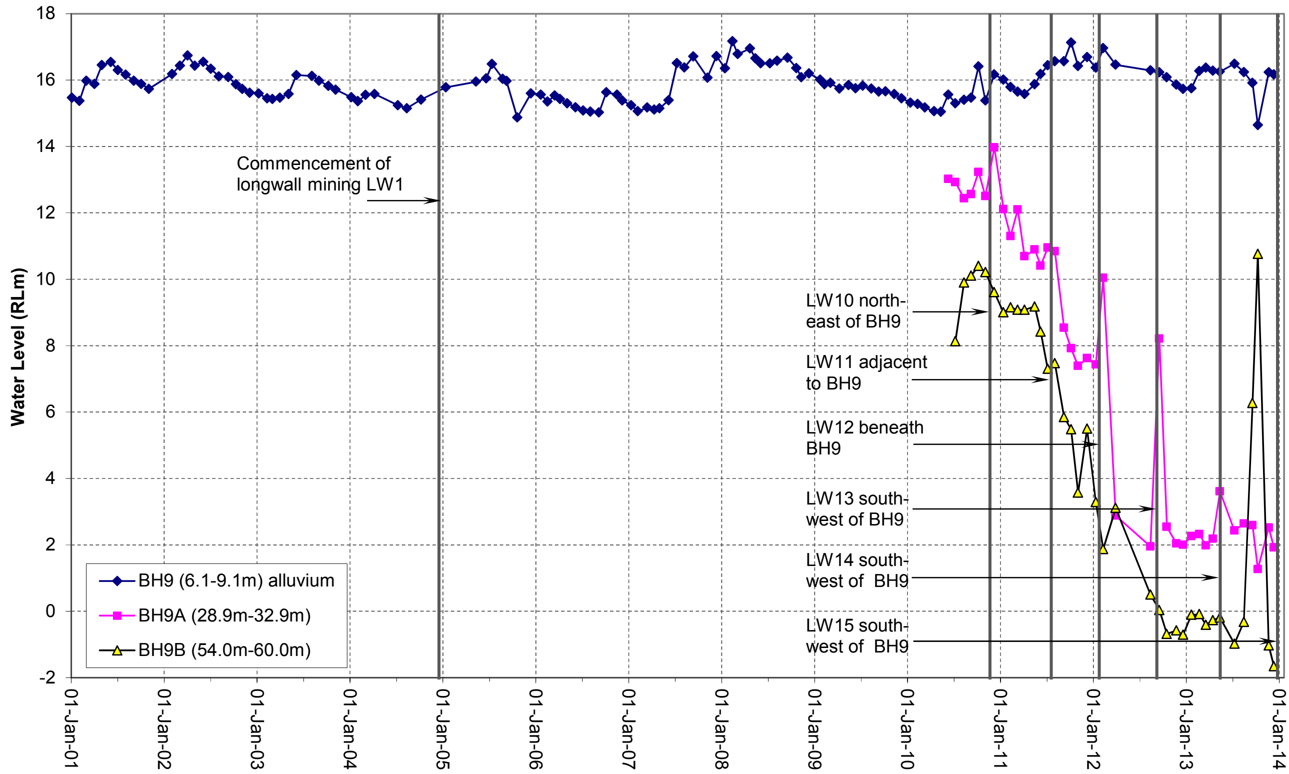


Figure A21: Nested Monitoring – Hydrograph of Bores BH 9, 9A, 9B

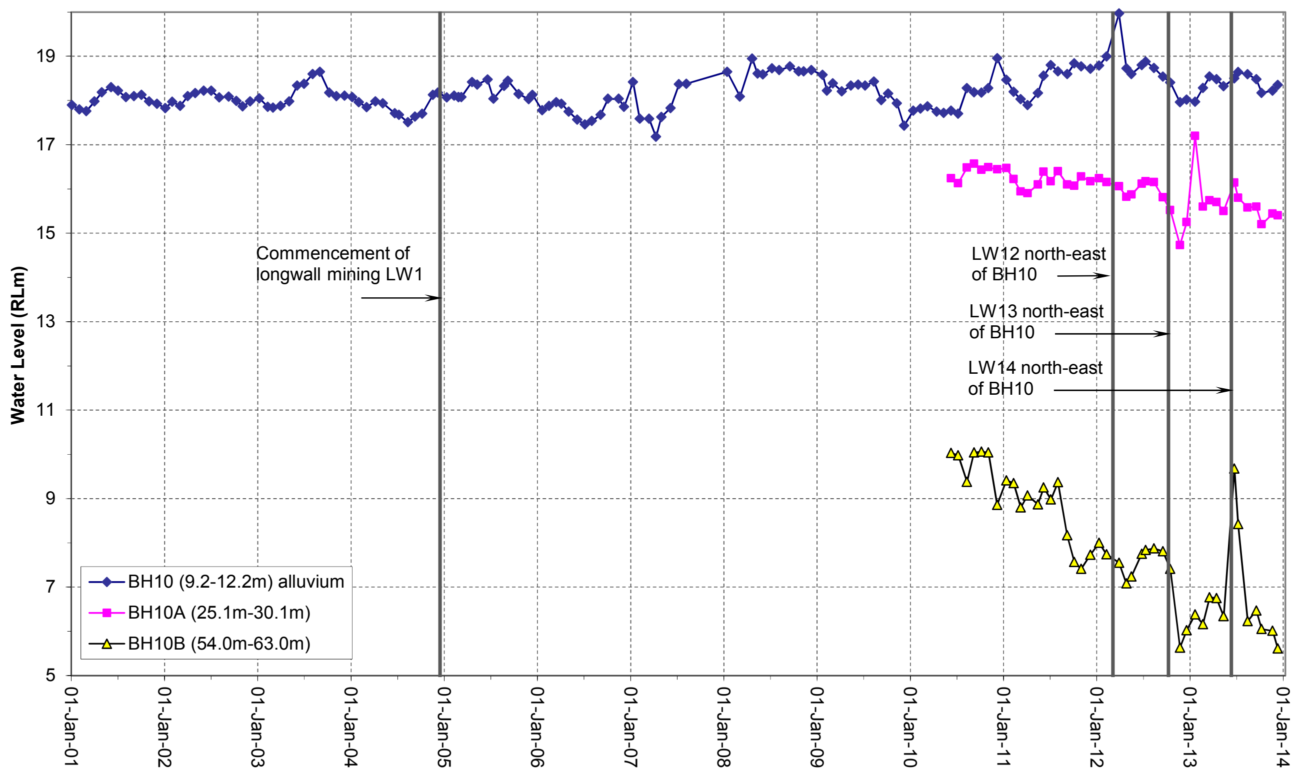


Figure A22: Nested Monitoring – Hydrograph of Bores BH 10, 10A, 10B

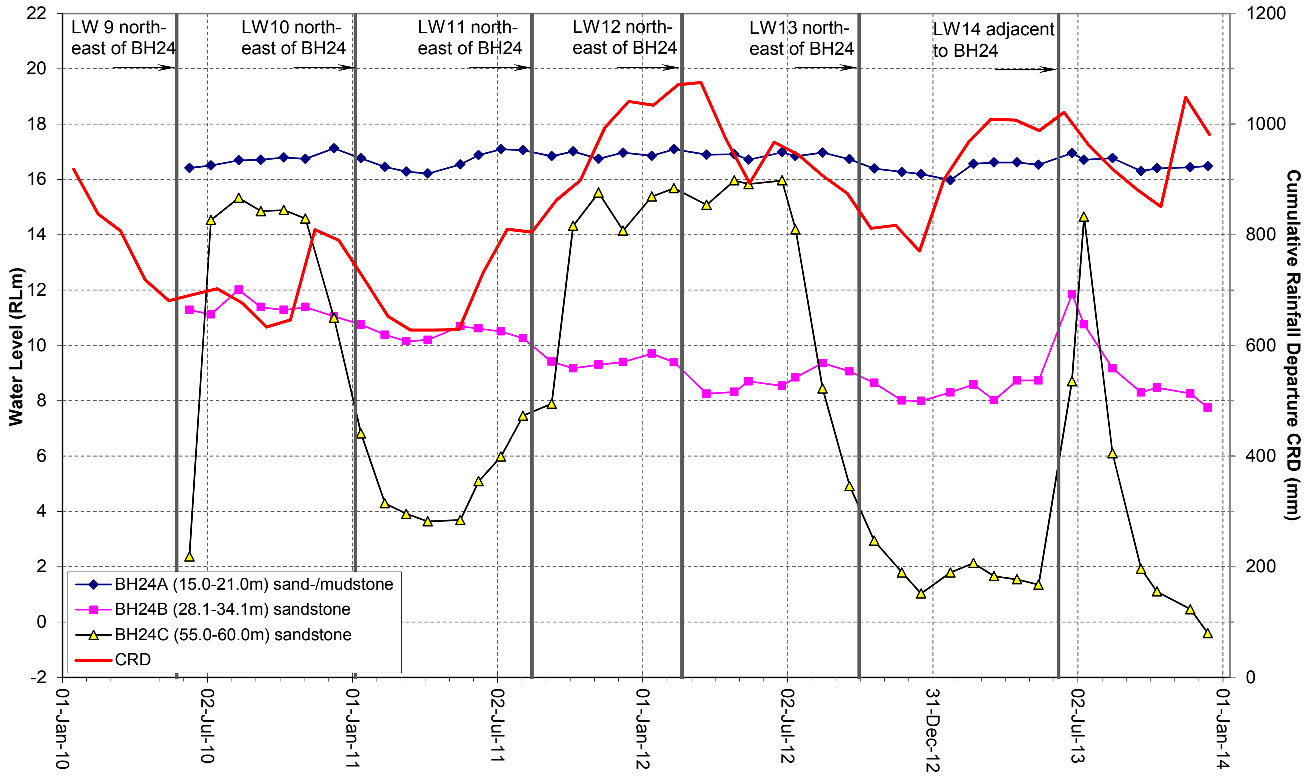


Figure A23: Nested Monitoring – Hydrograph Bores of BH24A, 24B, 24C

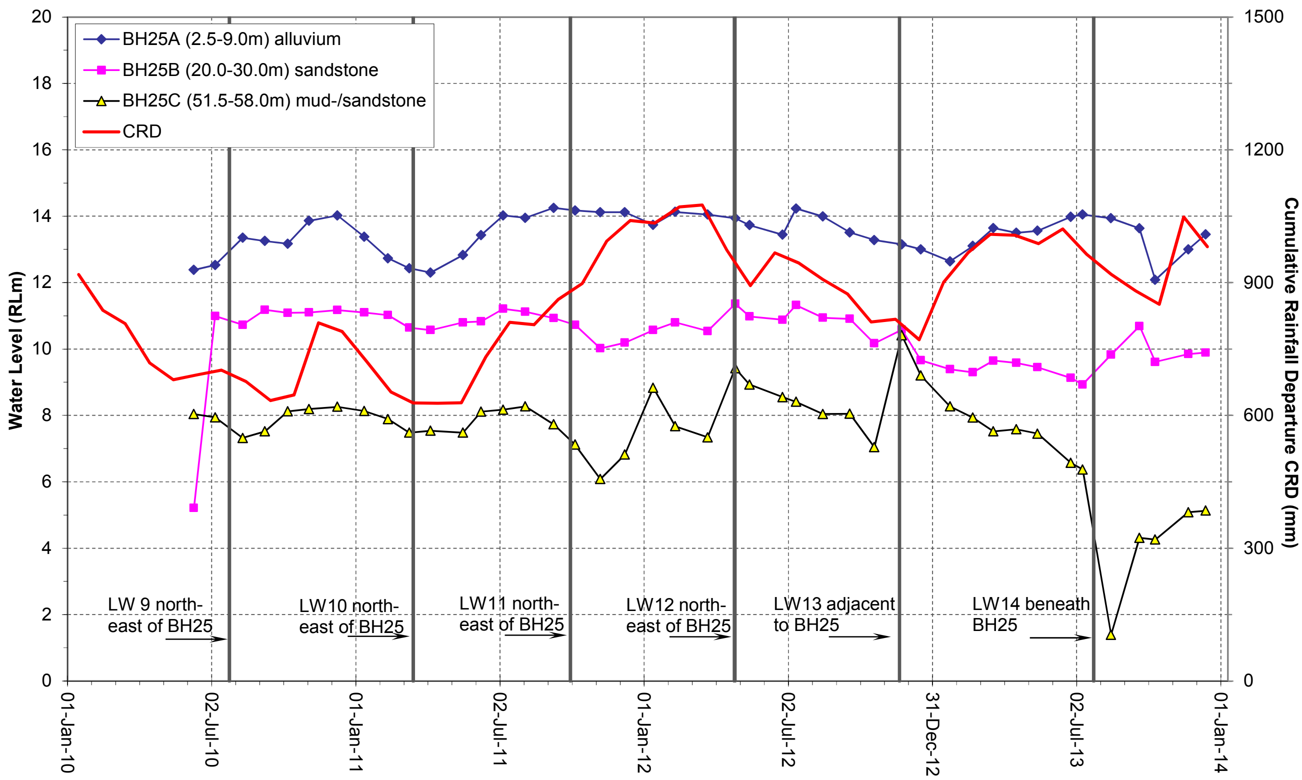


Figure A24: Nested Monitoring –Hydrograph of Bores BH25A, 25B, 25C

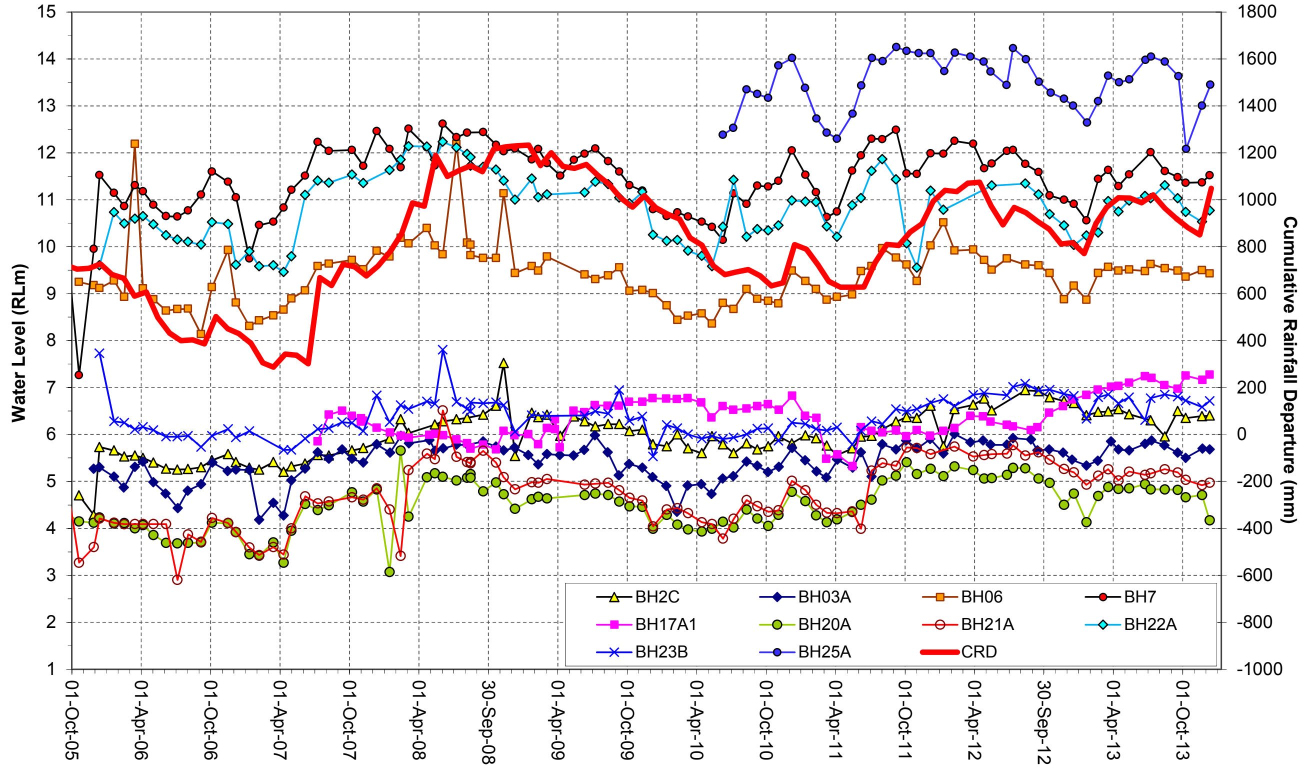


Figure A25: Hydrographs of alluvial monitoring bores at nested sites compared to CRD

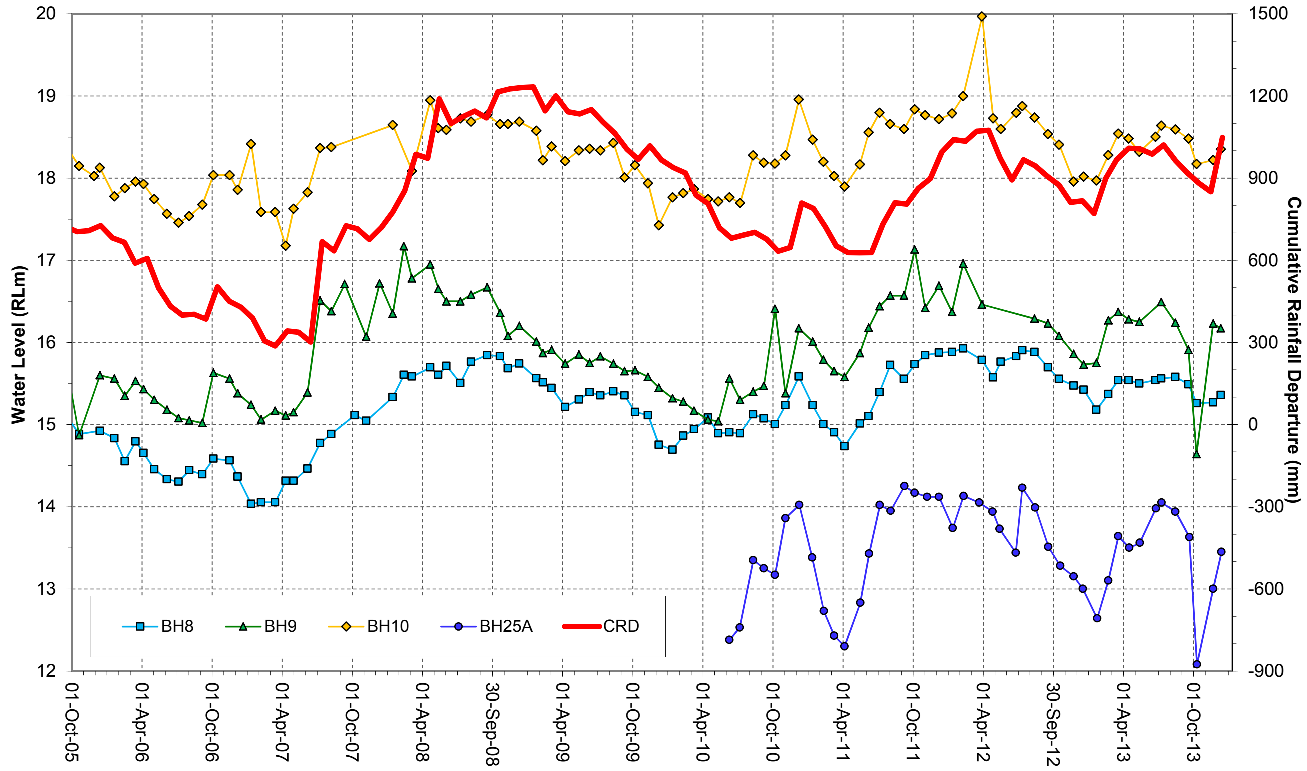


Figure A26: Hydrographs of alluvial monitoring bores at nested sites compared to CRD

Appendix B

MONITORING BORE WATER QUALITY (ELECTRICAL CONDUCTIVITY)

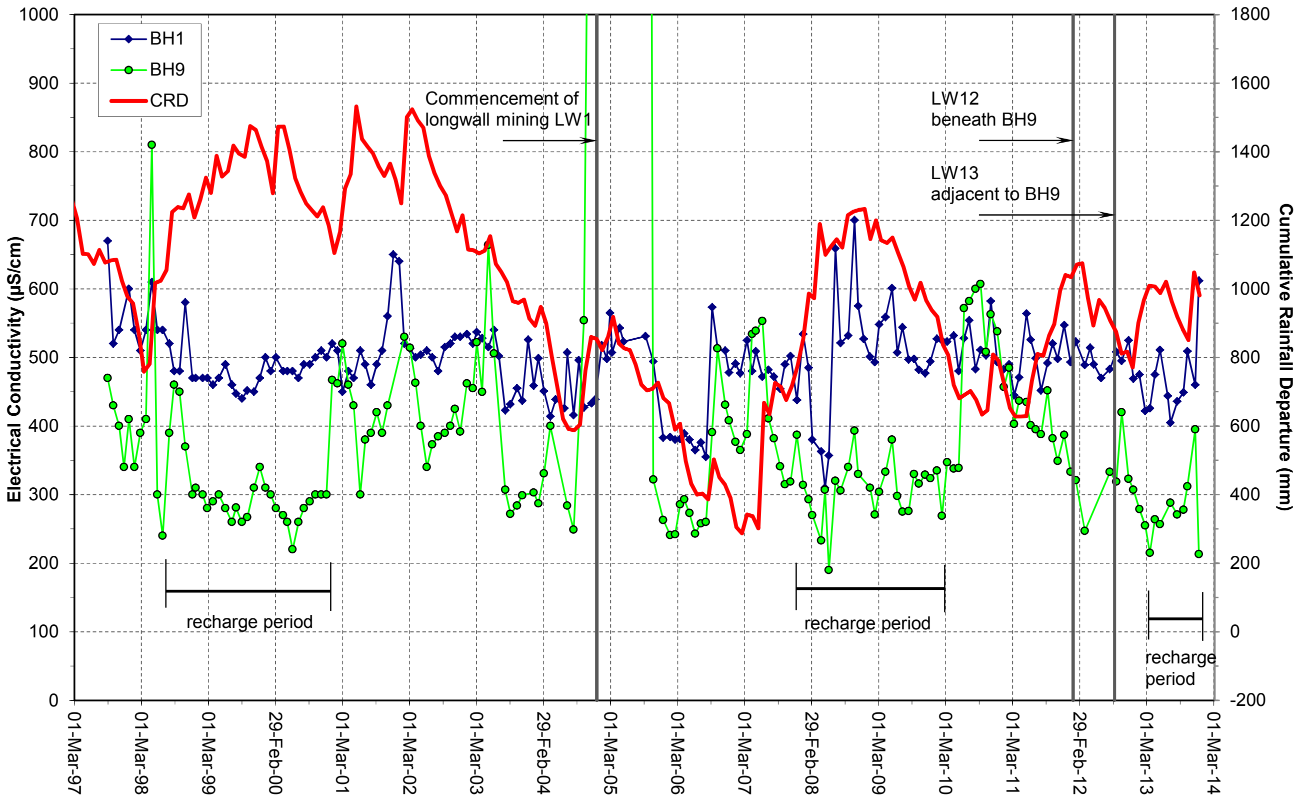


Figure B1: Alluvium – Bores BH1 and BH9

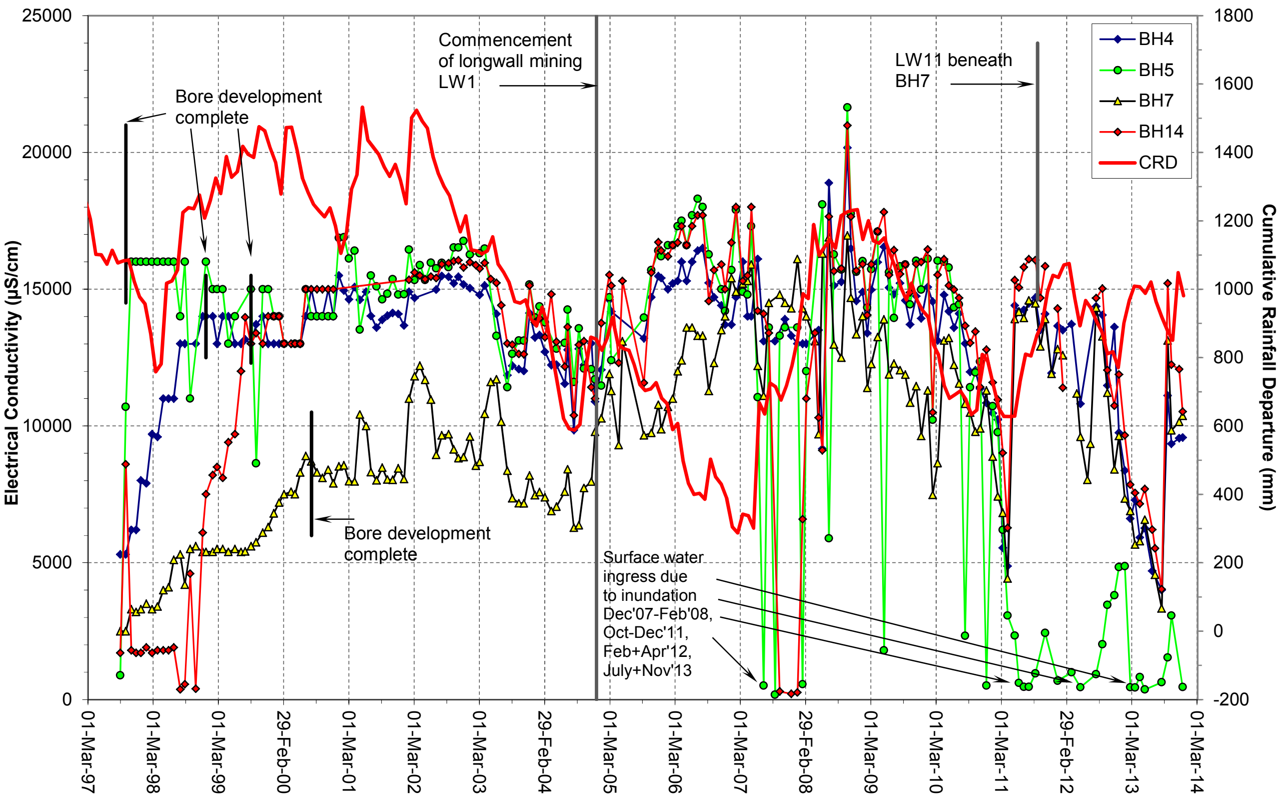


Figure B2: Alluvium – Bores BH4, BH5 BH7, BH14

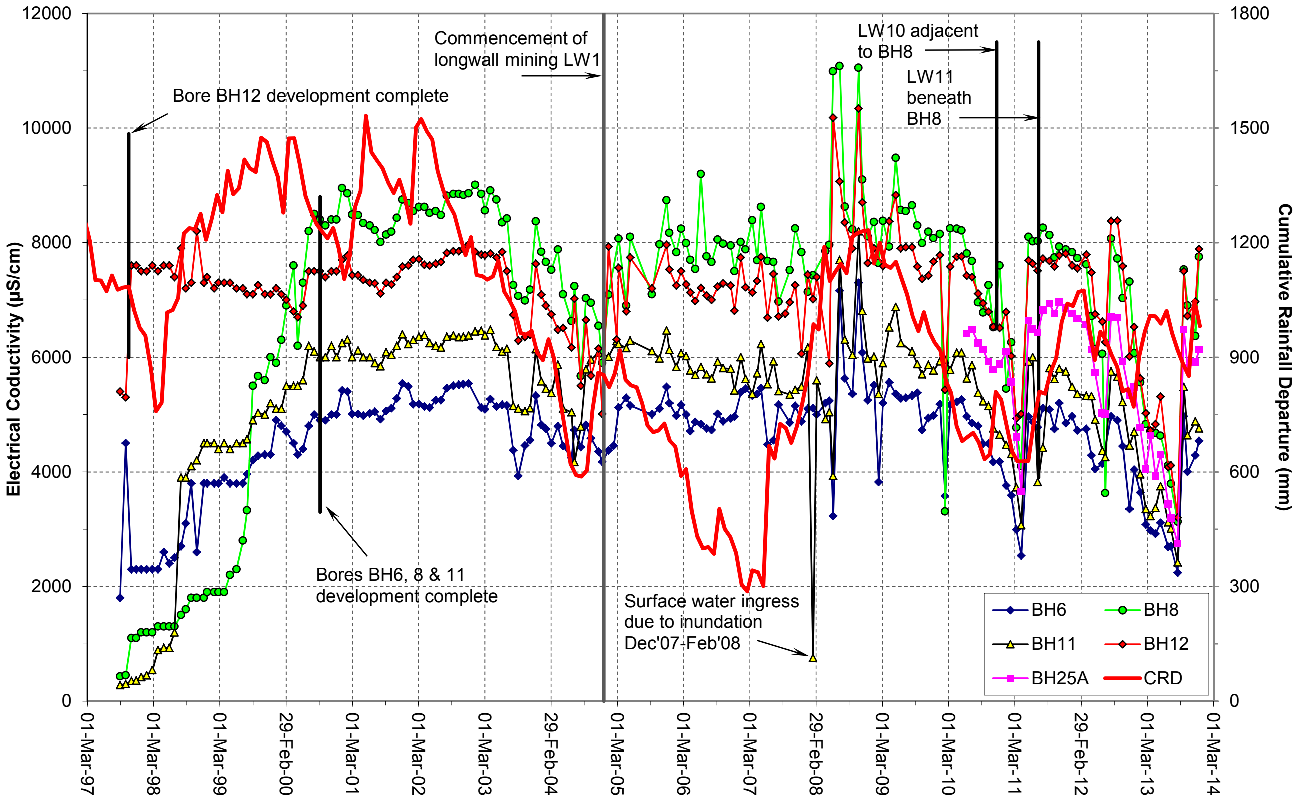


Figure B3: Alluvium – Bores BH6, BH8, BH11, BH12, BH25A

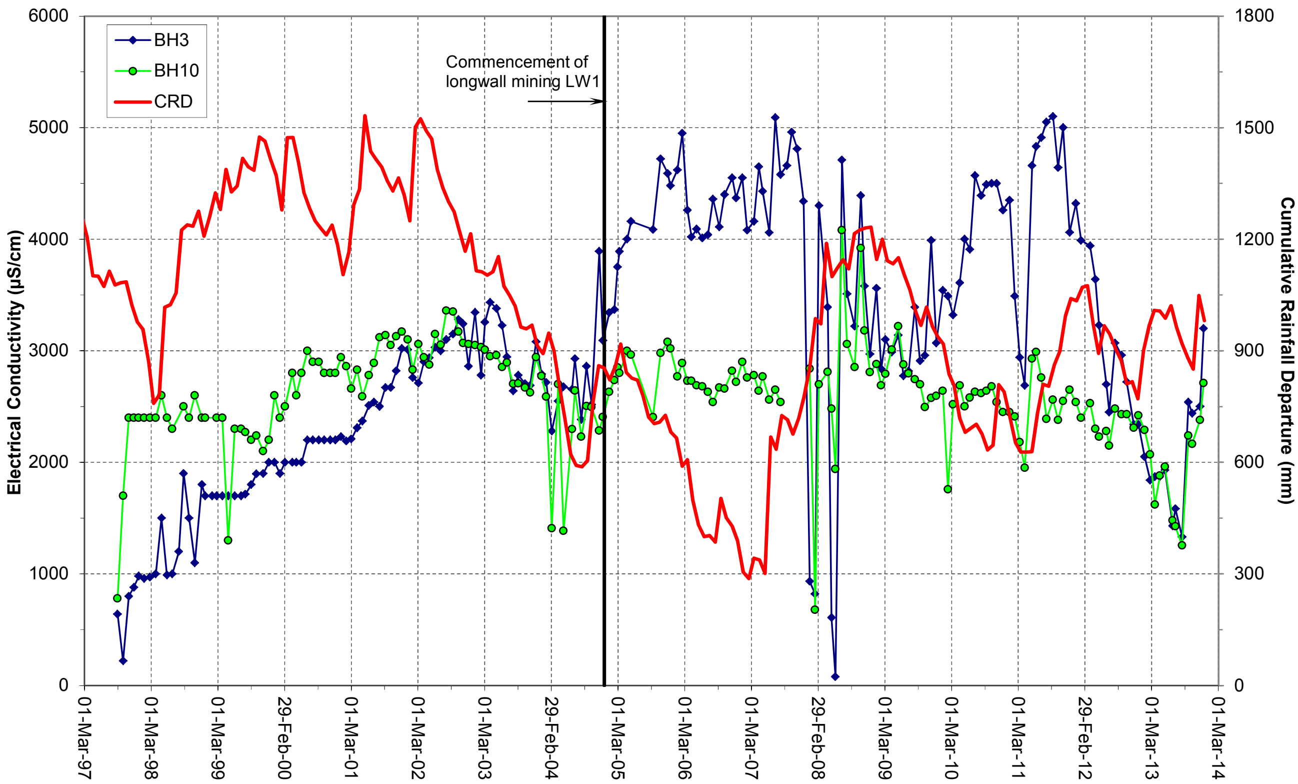


Figure B4: Alluvium – Bores BH3, BH10

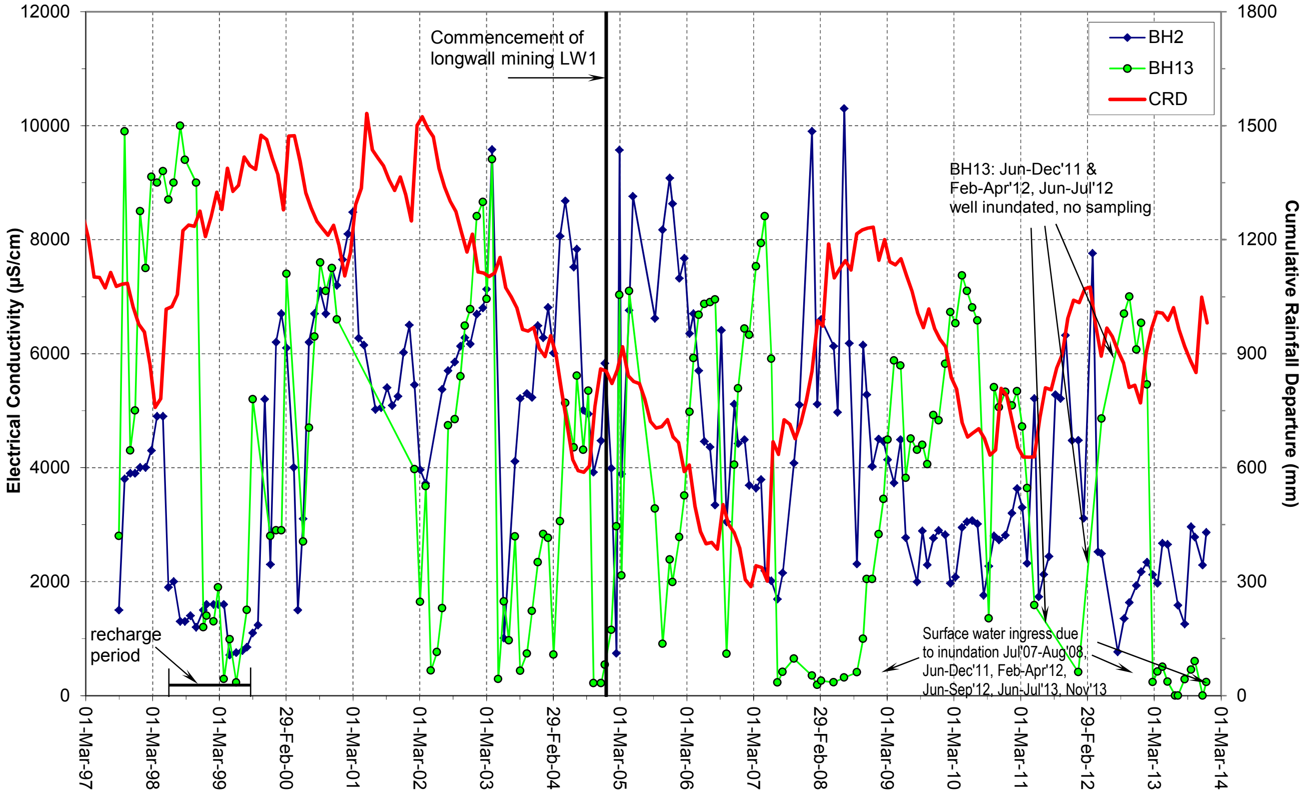


Figure B5: Alluvium – Bores BH2, BH13

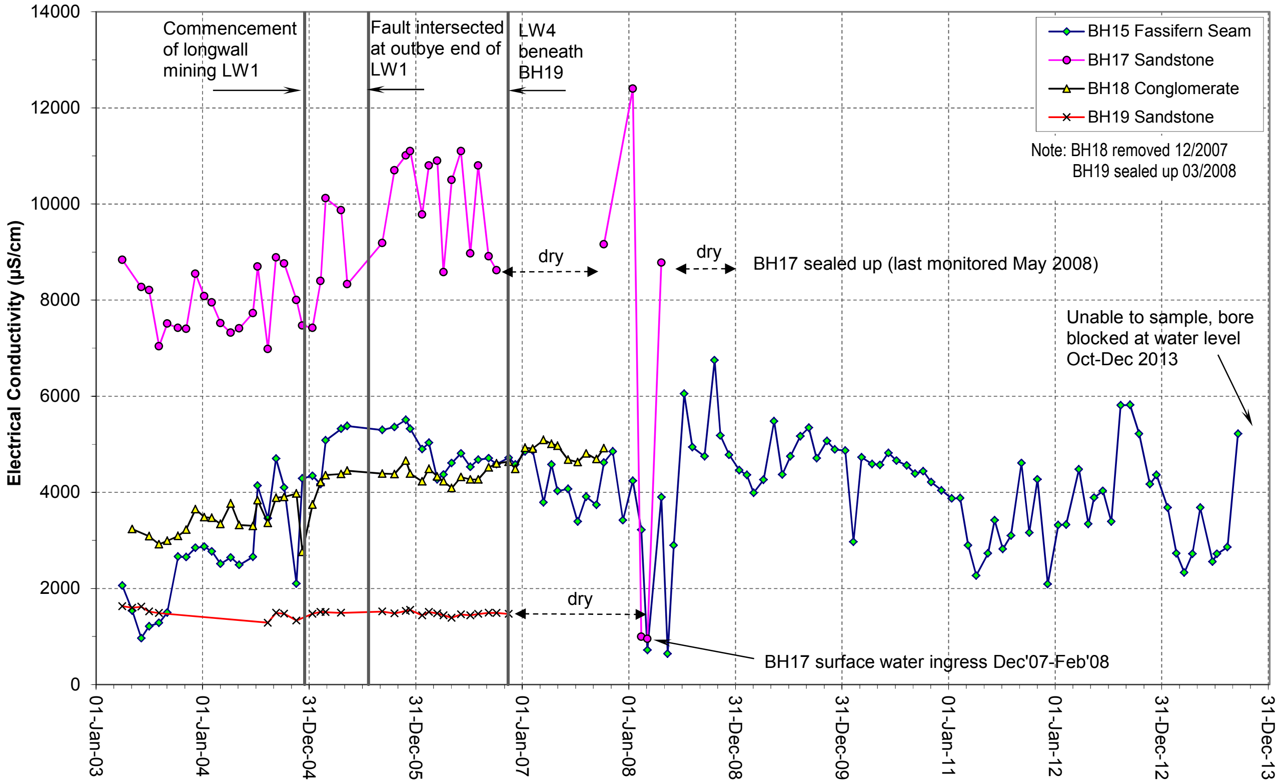


Figure B6: Coal Seam and Overburden Bores BH15, BH17, BH18, BH19

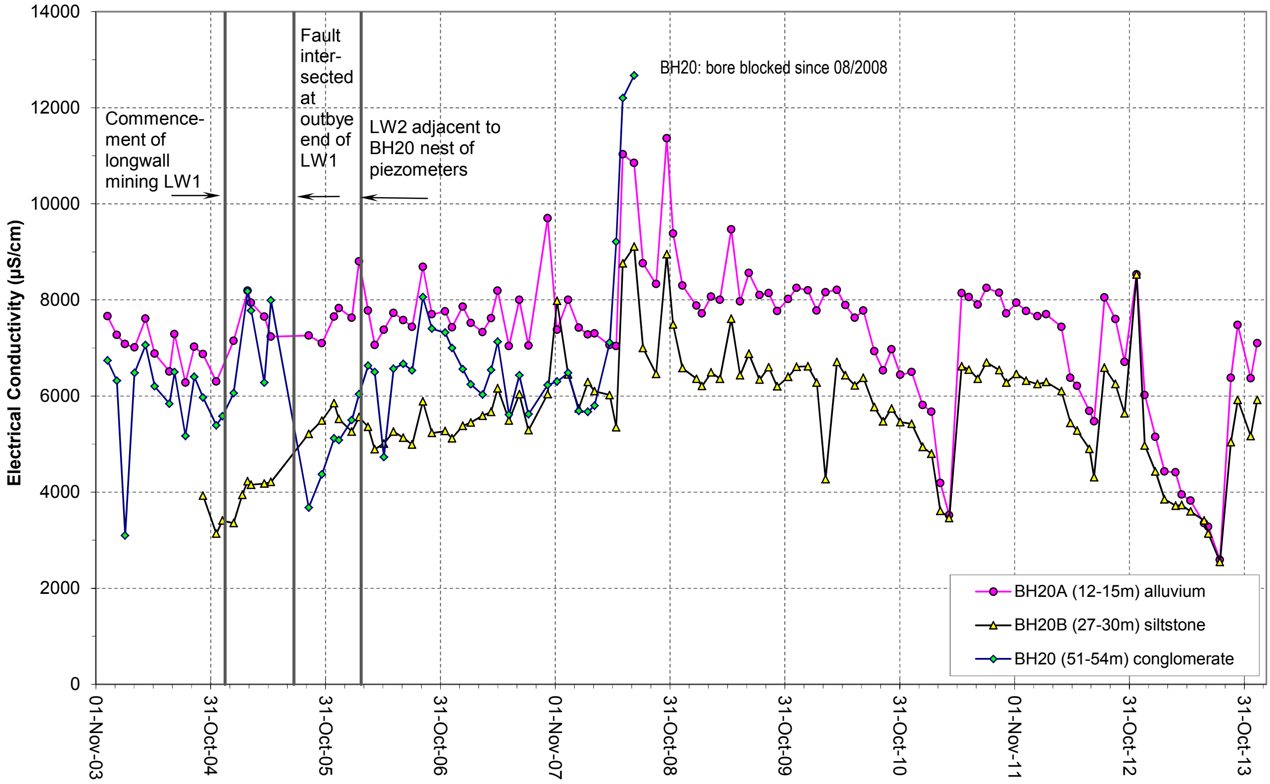


Figure B7: Nested Monitoring Bores BH20, 20A, 20B

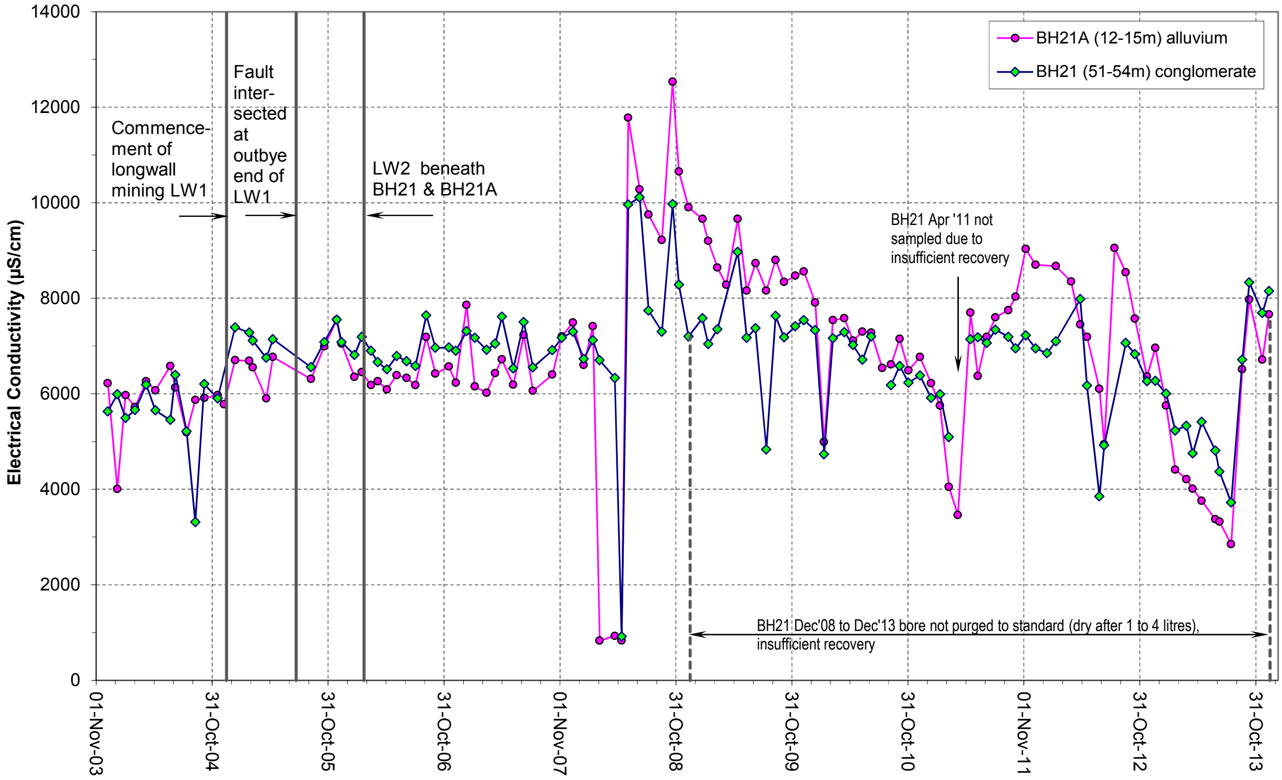


Figure B8: Nested Monitoring Bores BH21, 21A

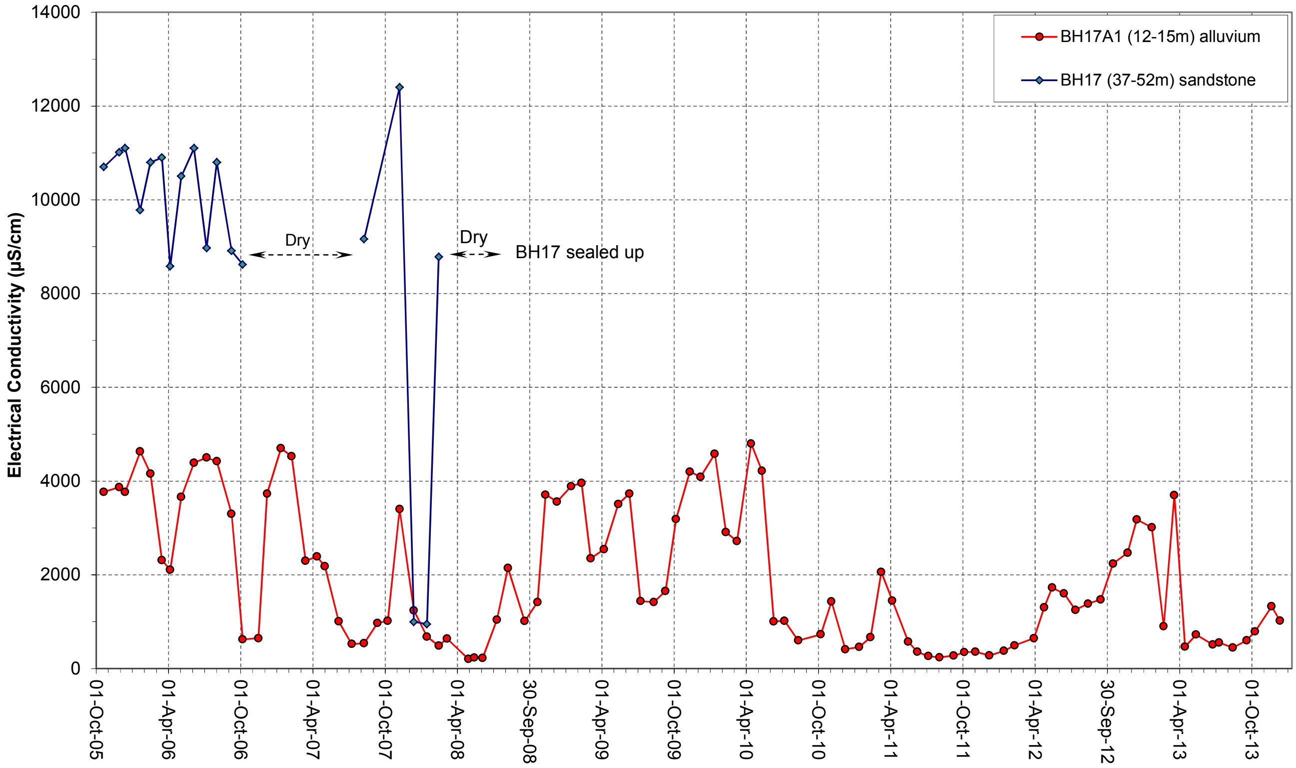


Figure B9: Nested Monitoring Bores BH17, 17A1

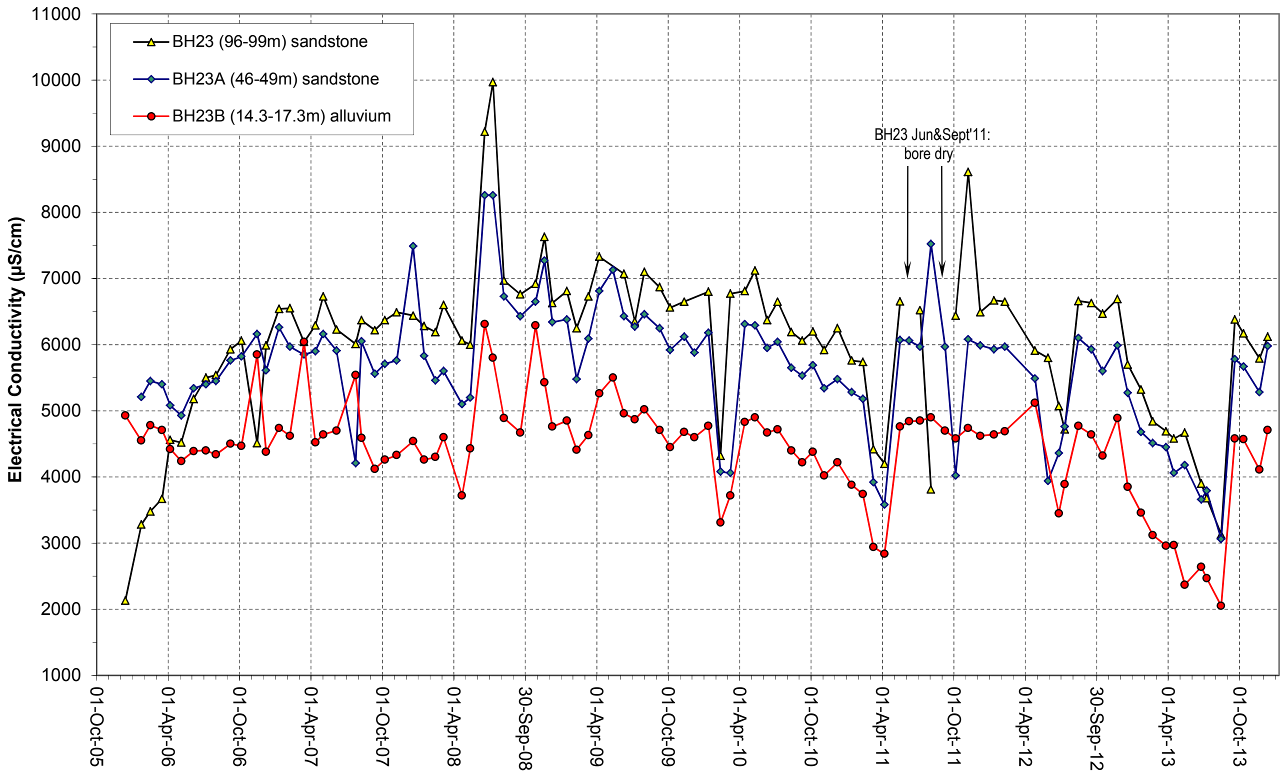


Figure B10: Nested Monitoring Bores BH23, 23A, 23B

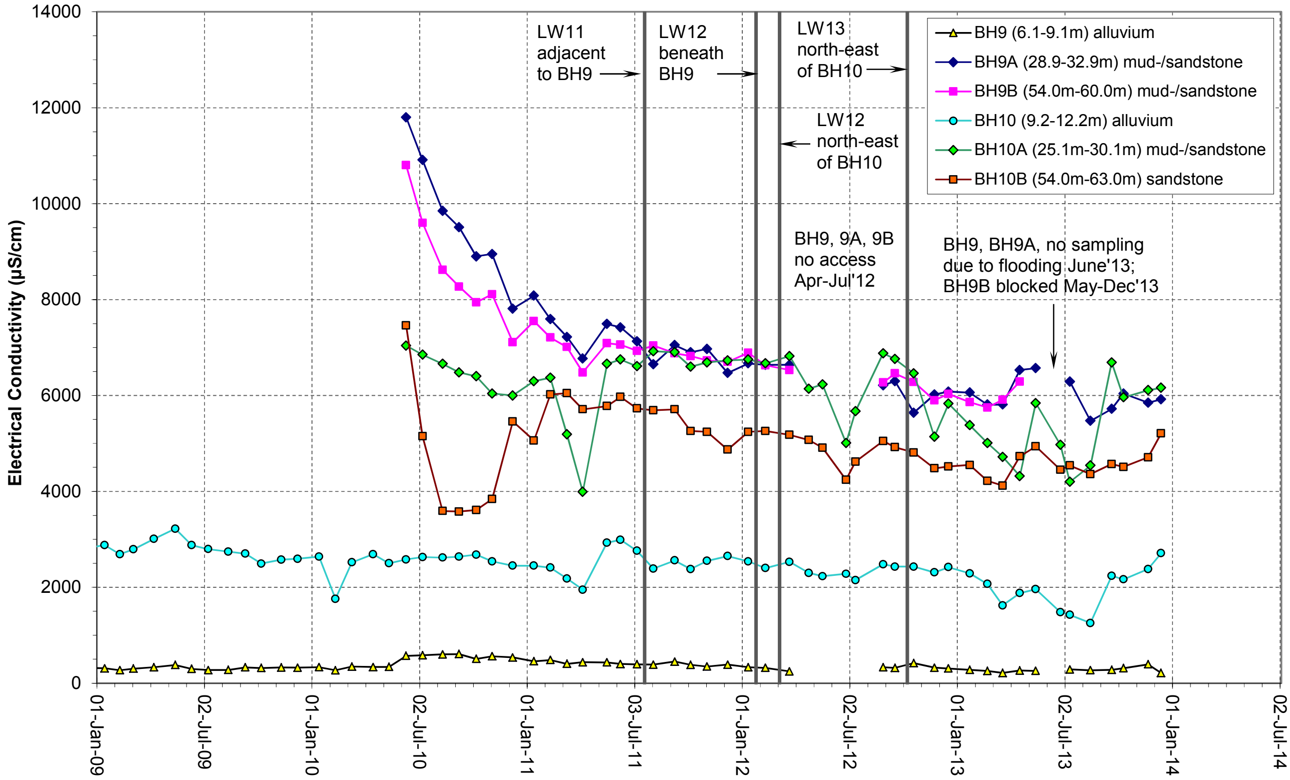


Figure B11: Nested Monitoring Bores BH9 and BH10

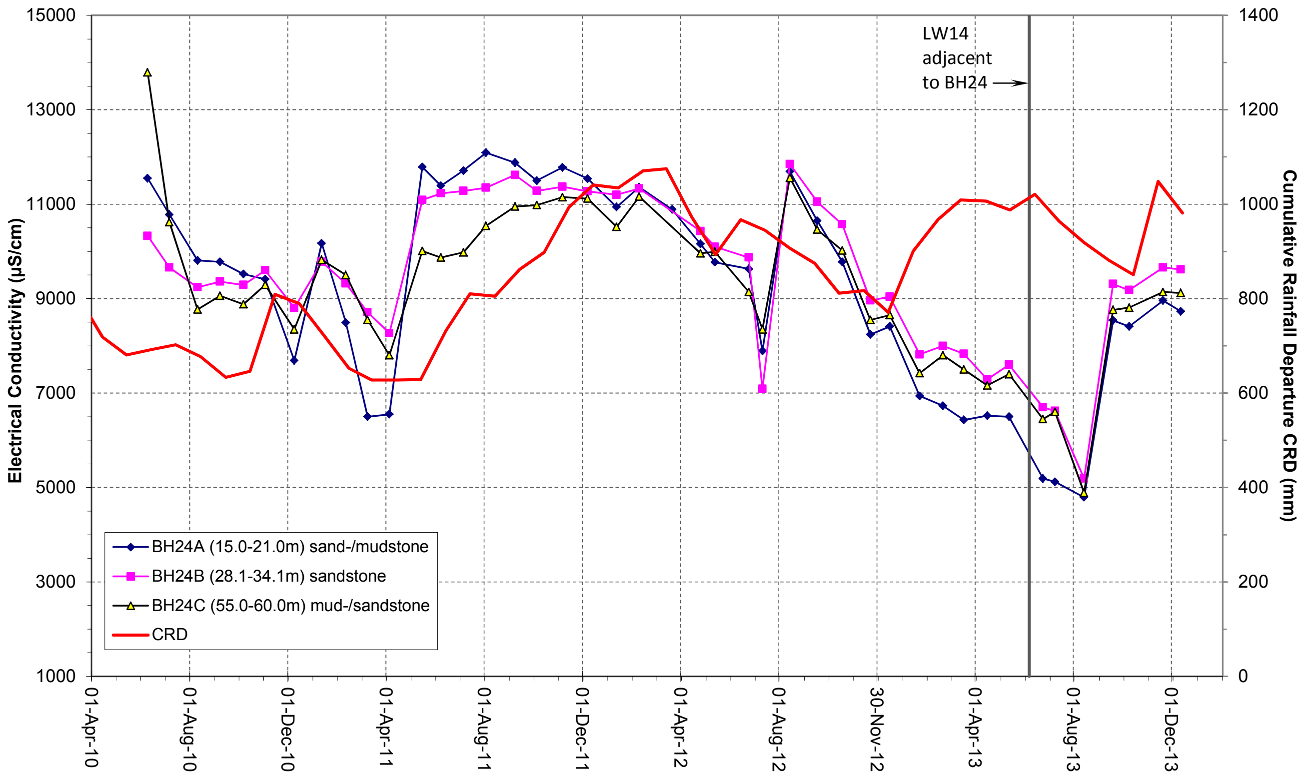


Figure B12: Nested Monitoring Bores BH24A, 24B, 24C

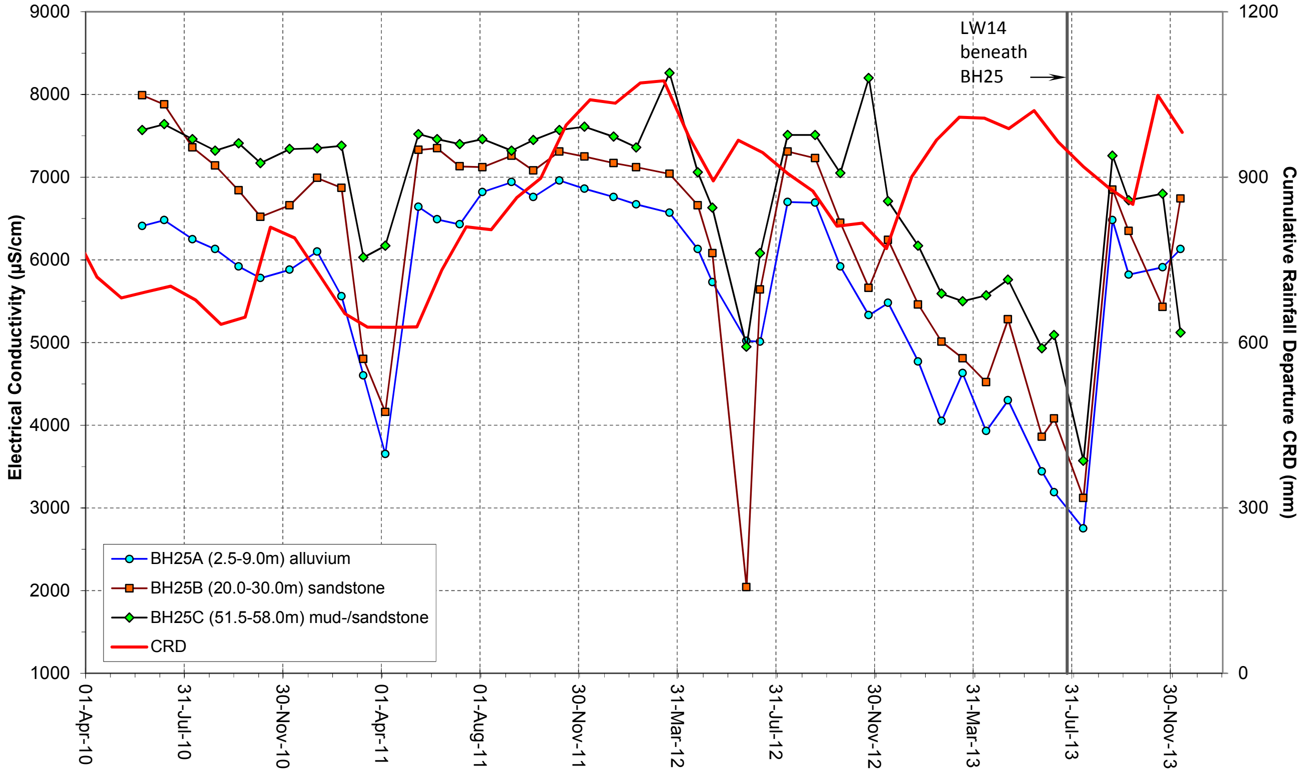


Figure B13: Nested Monitoring Bores BH25A, 25B, 25C

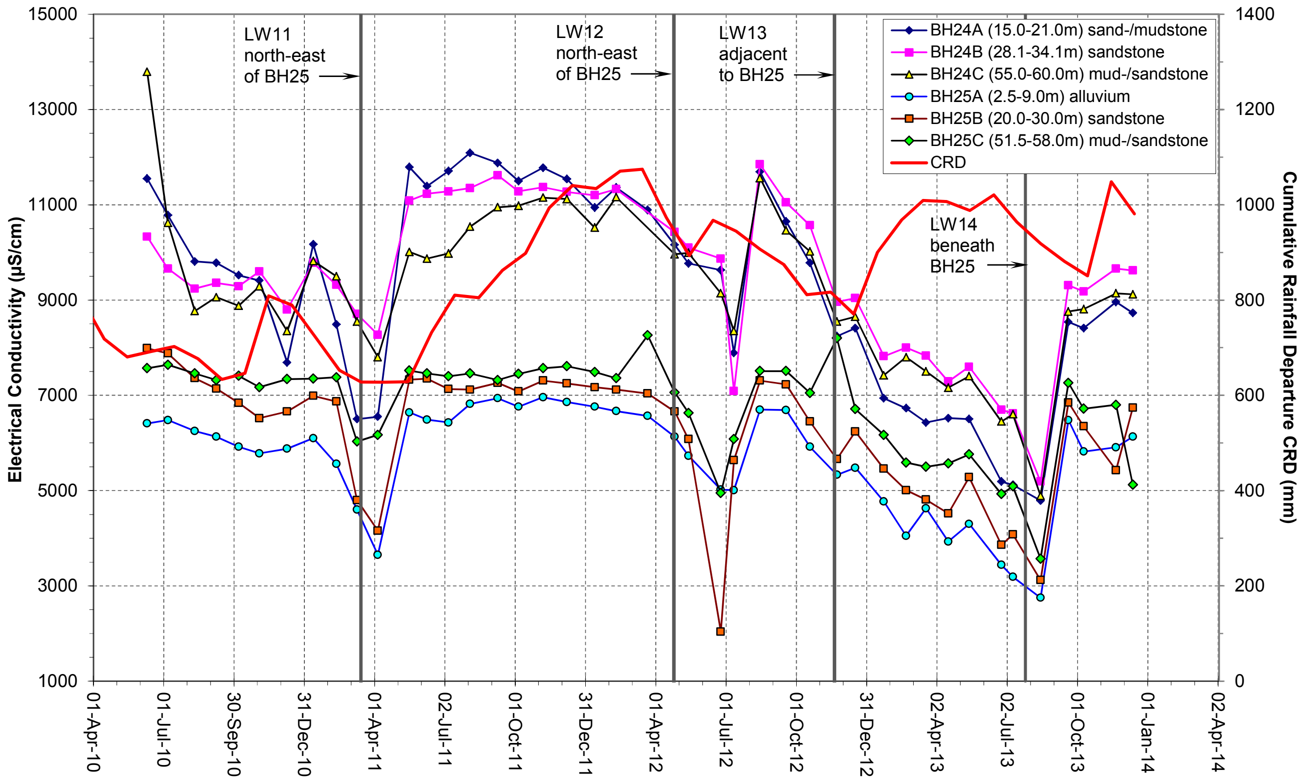
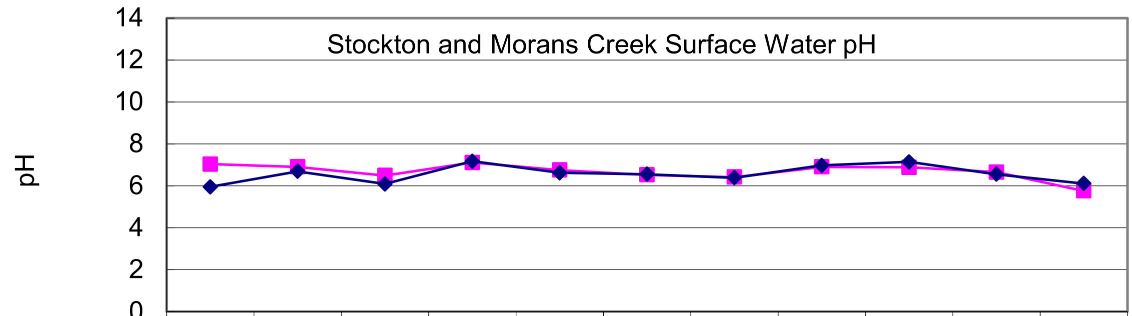


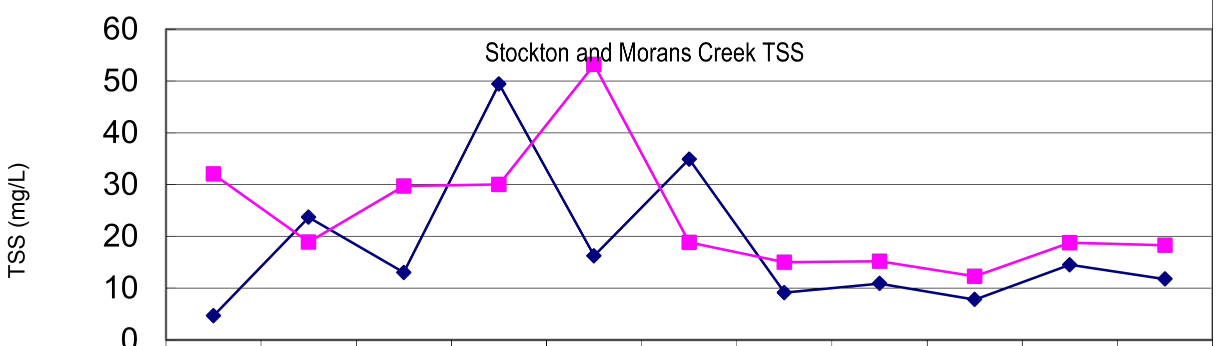
Figure B14: Nested Monitoring Bores BH24A-C and BH25A-C

APPENDIX 6
Surface Water Monitoring



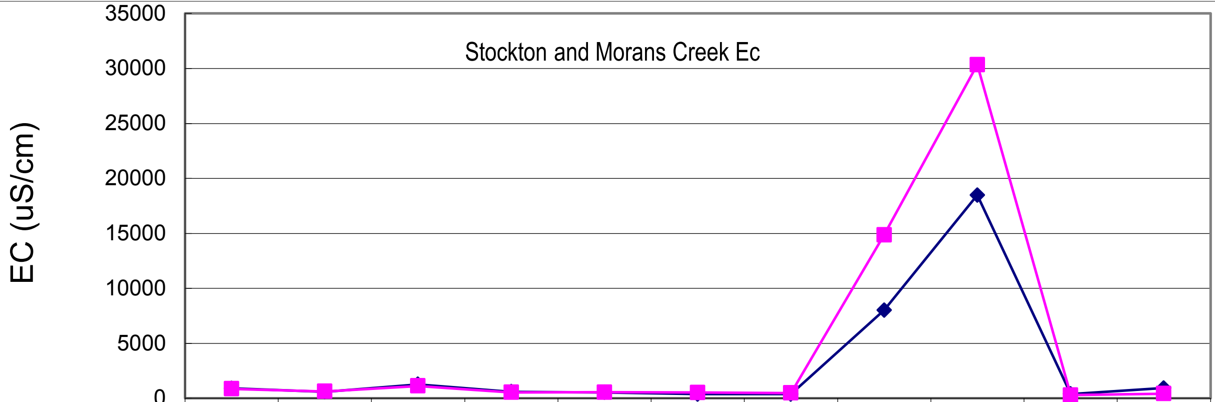
	SW008	SW004	SW012	SW018	SW011	SW006	SW003	SW002	SW001	SW009	SW010
Average	7.0	6.9	6.5	7.1	6.8	6.5	6.4	6.9	6.9	6.7	5.8
LTA	6.0	6.7	6.1	7.2	6.6	6.6	6.4	7.0	7.1	6.6	6.1

Figure 1 pH Monitoring Stockton and Morans Creek



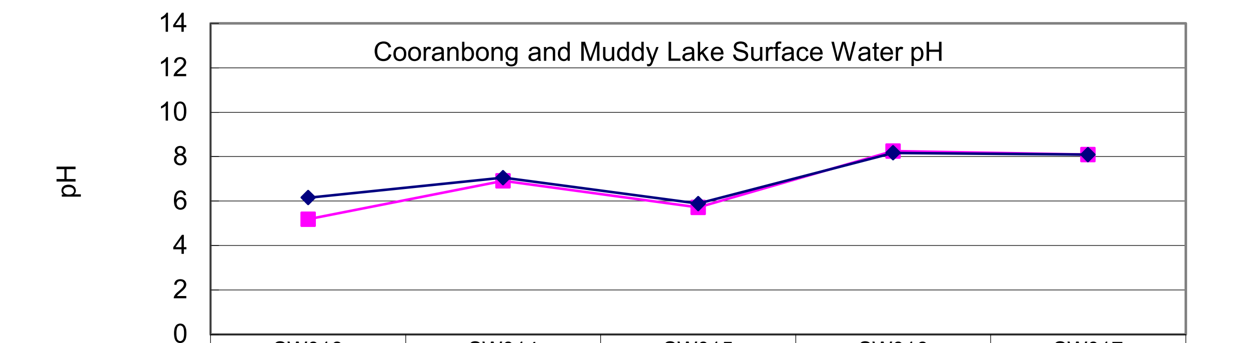
	SW008	SW004	SW012	SW018	SW011	SW006	SW003	SW002	SW001	SW009	SW010
Average	4.6	23.7	13.0	49.4	16.2	34.9	9.1	10.9	7.8	14.5	11.8
LTA	32.0	18.9	29.7	30.0	53.2	18.8	15.0	15.2	12.3	18.8	18.3

Figure 2 TSS Monitoring Stockton and Morans Creek



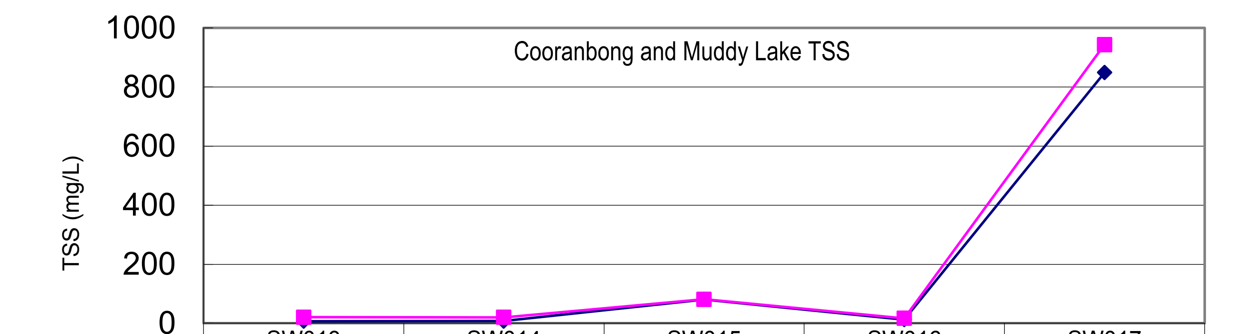
	SW008	SW004	SW012	SW018	SW011	SW006	SW003	SW002	SW001	SW009	SW010
Average	905.3	605.2	1280.4	606.0	547.1	384.9	383.1	8019.4	18488.1	403.5	945.0
LTA	863.5	634.4	1133.6	538.2	561.9	537.0	486.9	14862.5	30336.8	295.5	432.2

Figure 3 Ec Monitoring Stockton and Morans Creek



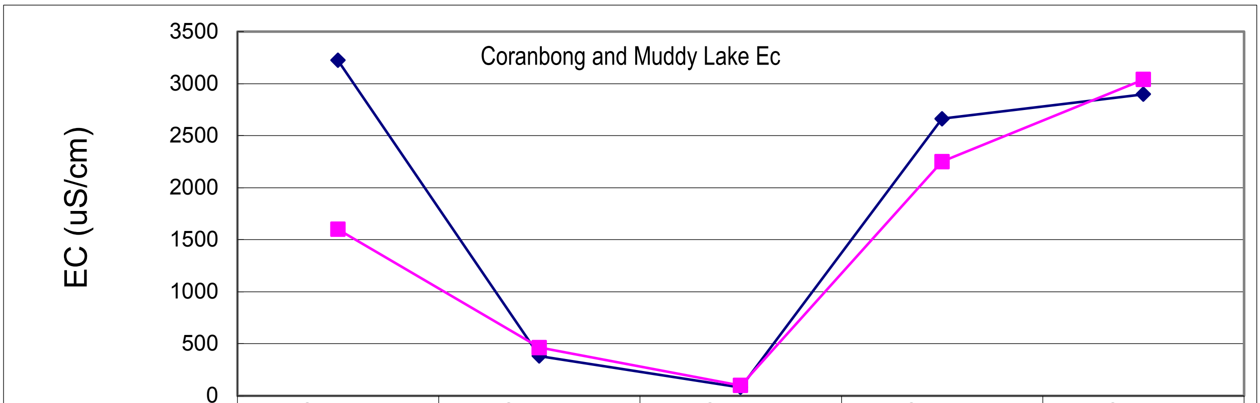
	SW013	SW014	SW015	SW016	SW017
Average	5.2	6.9	5.7	8.3	8.1
LTA	6.2	7.1	5.9	8.2	8.1

Figure 4 Cooranbong pH monitoring



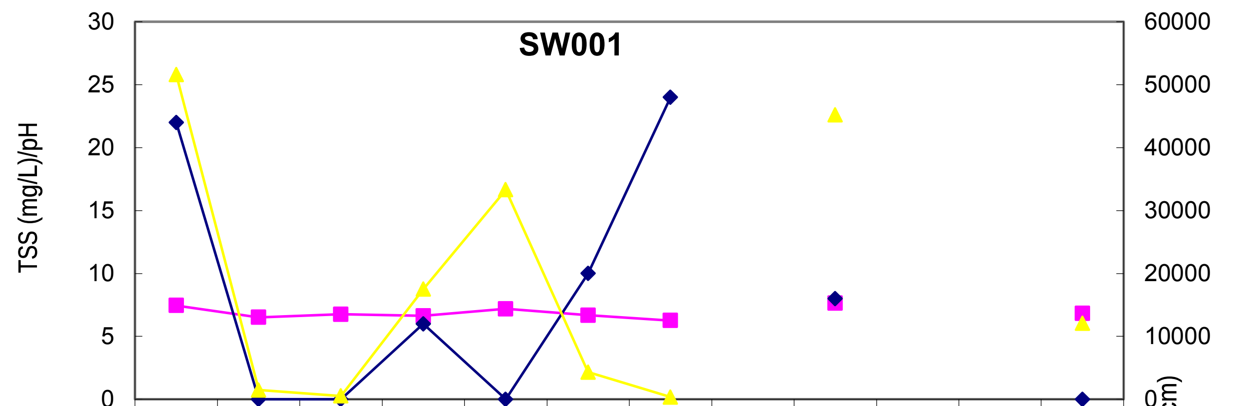
	SW013	SW014	SW015	SW016	SW017
Average	7.0	7.8	80.6	12.6	849.5
LTA	20.9	20.1	81.3	16.7	943.9

Figure 5 Cooranbong TSS monitoring



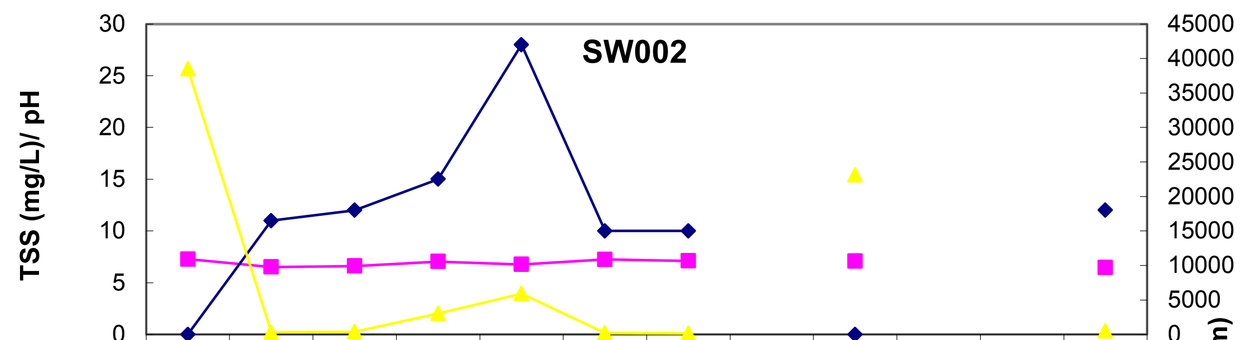
	SW013	SW014	SW015	SW016	SW017
Average	3224.6	380.4	80.2	2663.3	2898.2
LTA	1599.8	463.0	98.1	2249.8	3040.0

Figure 6 Cooranbong Ec monitoring



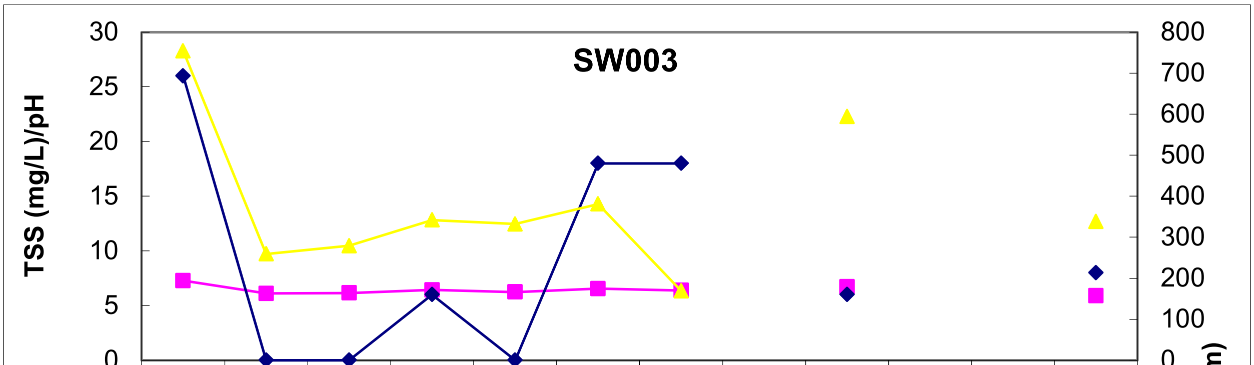
	Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13
pH	7.45	6.51	6.76	6.63	7.19	6.68	6.26		7.64			6.82
TSS	22	0	0	6	0	10	24		8			0
EC	51600	1480	539	17500	33300	4320	354		45200			12100

Figure 7 Surface Water Monitoring SW01



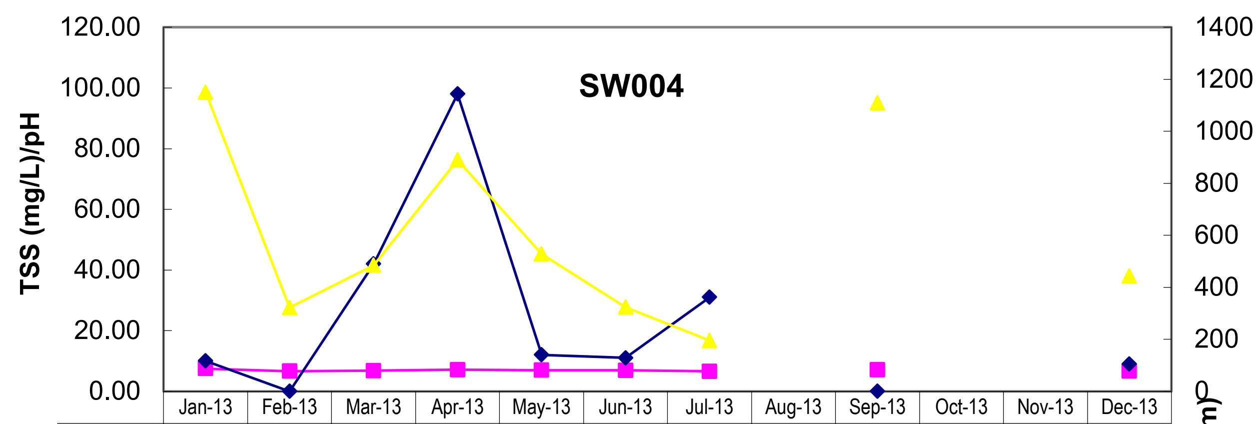
	Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13
pH	7.28	6.51	6.61	7.05	6.77	7.25	7.11		7.08			6.46
TSS	0	11	12	15	28	10	10		0			12
EC	38500	332	398	3040	5930	200	159		23100			516

Figure 8 Surface water Monitoring SW02



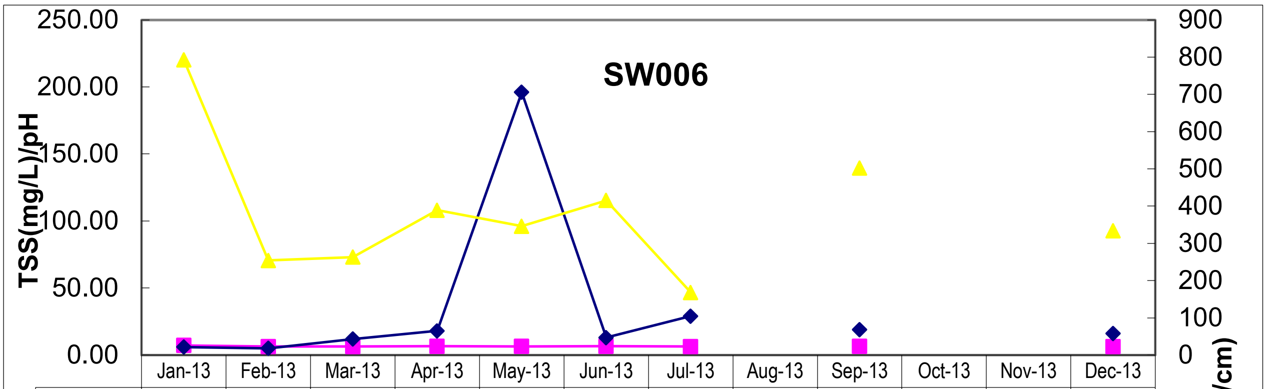
	Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13
pH	7.27	6.11	6.15	6.43	6.24	6.54	6.39		6.70			5.89
TSS	26	0	0	6	0	18	18		6			8
EC	754	259	279	342	332	381	169		594			338

Figure 9 Surface Water Monitoring SW03



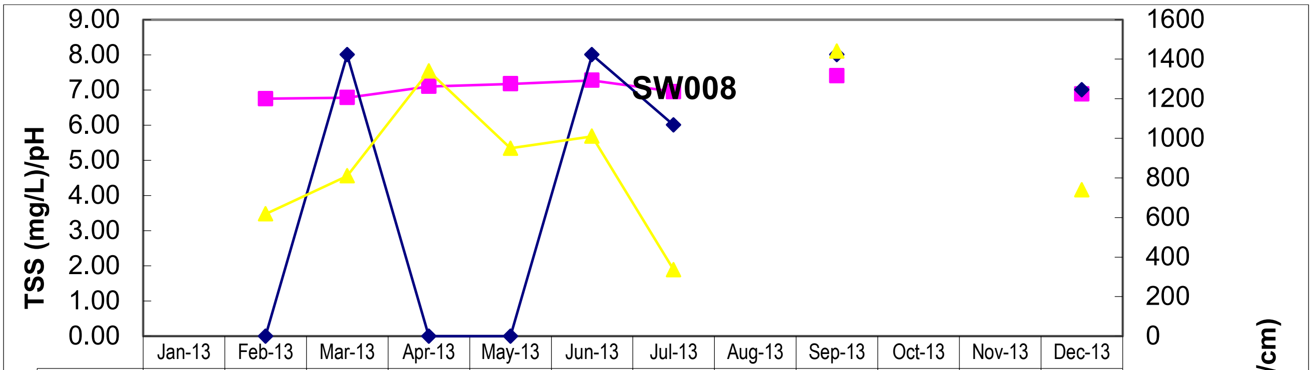
	Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13
pH	7.49	6.63	6.79	7.11	6.97	6.88	6.60		7.04			6.65
TSS	10	0	42	98	12	11	31		0			9
EC	1150	322	485	890	528	324	195		1110			443

Figure 10 Surface Water Monitoring SW04



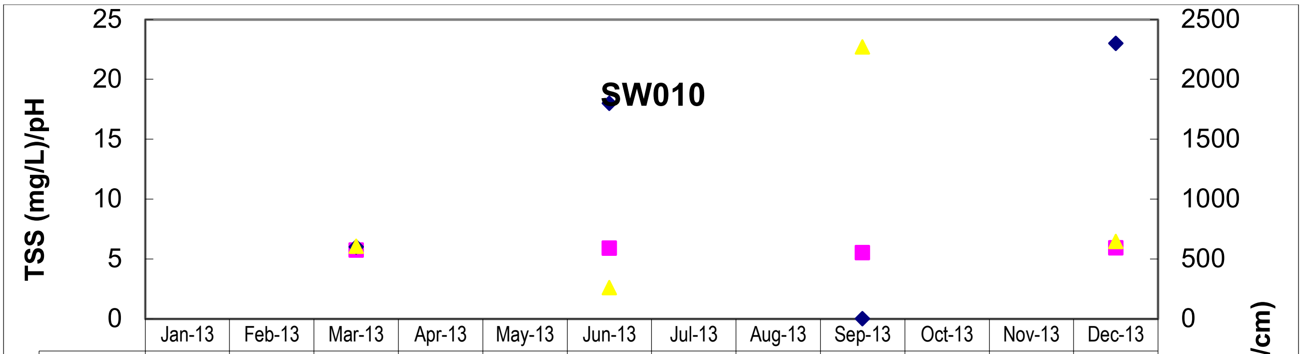
	Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13
pH	7.17	6.31	6.37	6.57	6.46	6.65	6.39		6.59			6.21
TSS	6	5	12	18	196	13	29		19			16
EC	793	254	263	389	346	415	168		502			334

Figure 11 surface Water Monitoring SW06



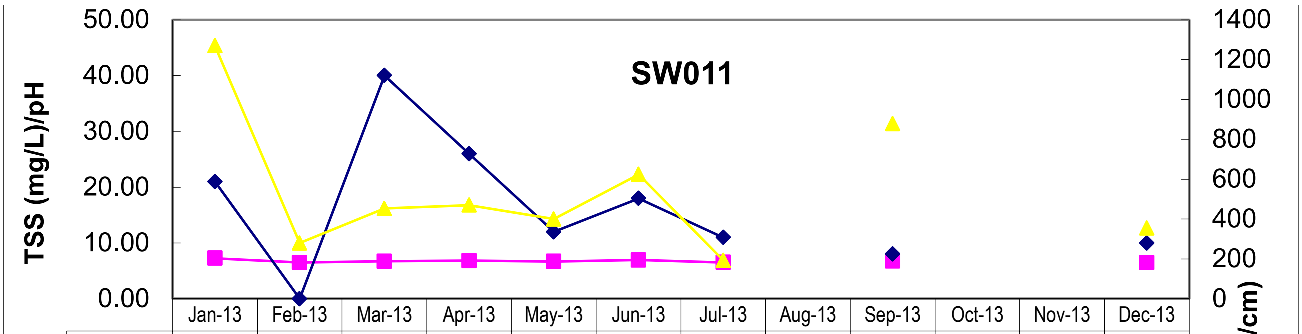
	Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13
pH		6.75	6.78	7.10	7.17	7.27	6.95		7.40			6.88
TSS		0	8	0	0	8	6		8			7
EC		618	810	1340	950	1010	335		1440			739

Figure 12 Surface Water Monitoring SW08



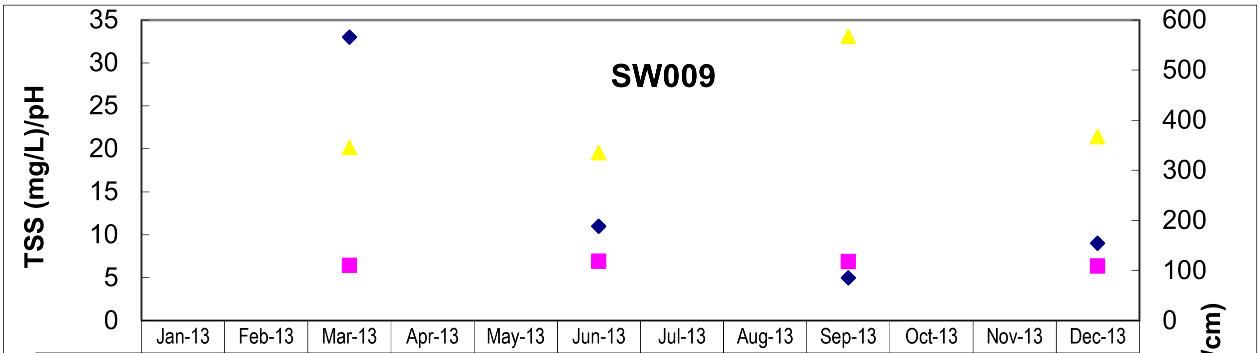
	Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13
pH			5.72			5.89			5.52			5.91
TSS			6			18			0			23
EC			604			260			2270			646

Figure 13 Surface Water Monitoring SW010



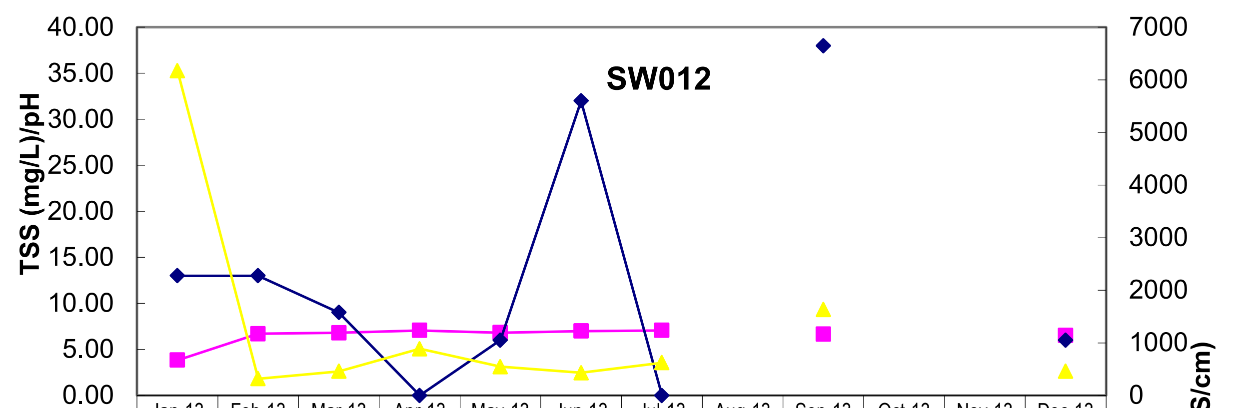
	Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13
pH	7.26	6.49	6.73	6.83	6.68	6.95	6.52		6.79			6.50
TSS	21	0	40	26	12	18	11		8			10
EC	1270	280	453	470	400	624	193		879			355

Figure 14 Surface Water Monitoring SW011



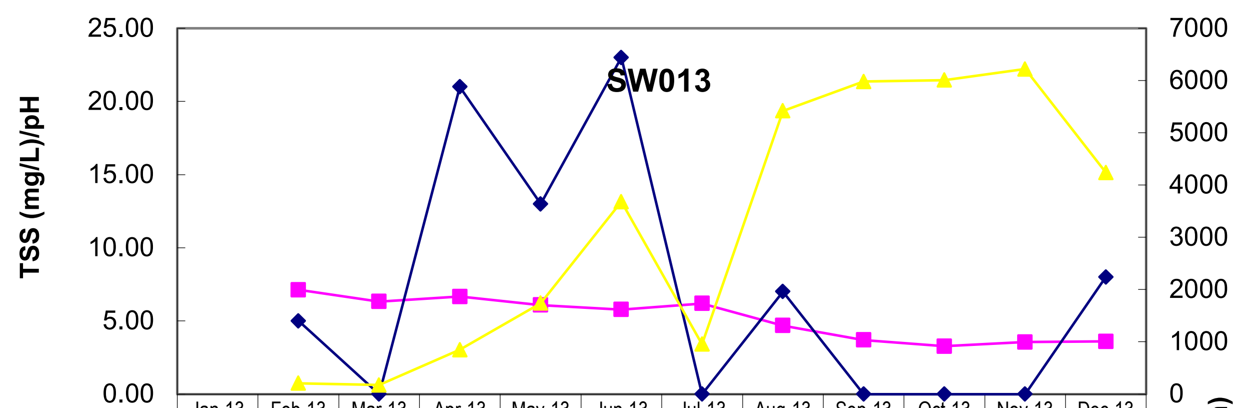
	Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13
pH			6.44			6.94			6.87			6.35
TSS			33			11			5			9
EC			345			335			567			367

Figure 15 Surface Water Monitoring SW09



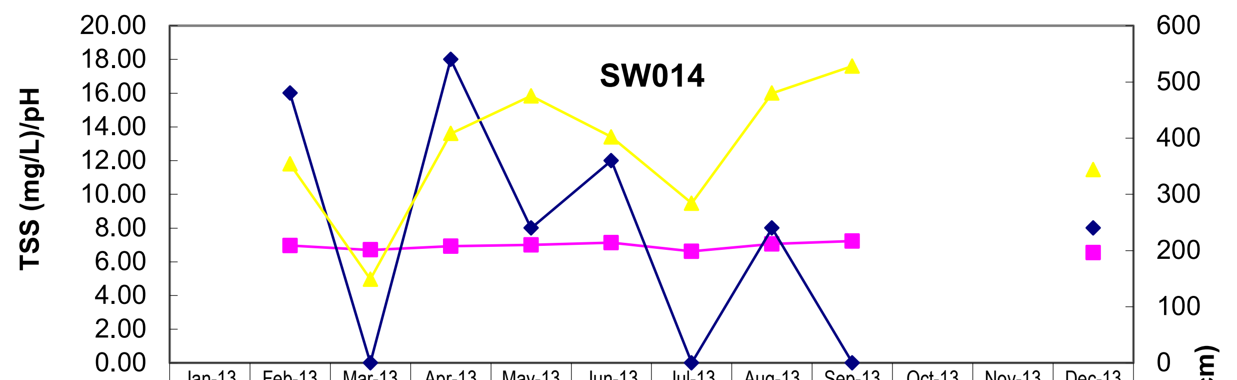
	Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13
pH	3.84	6.69	6.81	7.07	6.82	7.00	7.07		6.64			6.53
TSS	13	13	9	0	6	32	0		38			6
EC	6170	318	458	887	546	431	623		1630			461

Figure 16 Surface Water Monitoring SW012



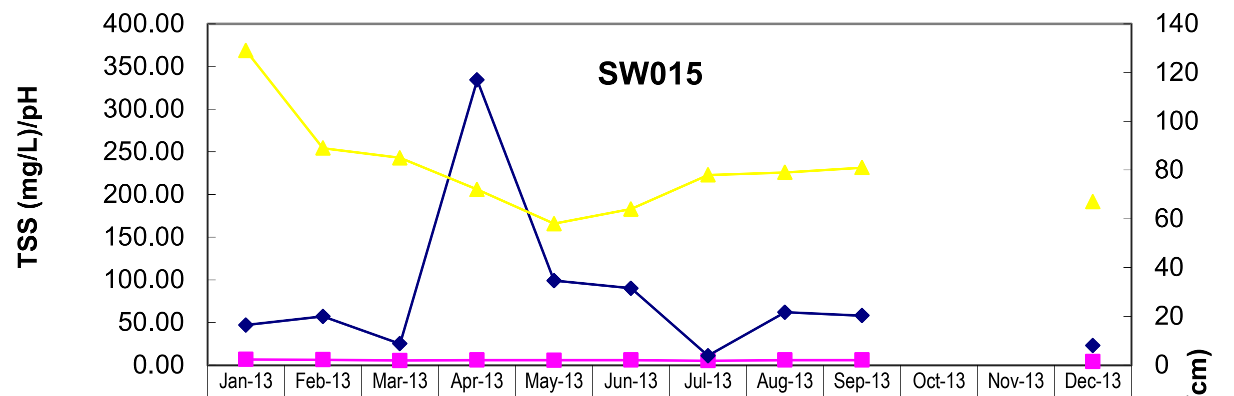
	Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13
pH		7.12	6.32	6.66	6.08	5.78	6.19	4.68	3.70	3.27	3.55	3.60
TSS		5	0	21	13	23	0	7	0	0	0	8
Ec		206	173	847	1740	3680	955	5420	5980	6010	6220	4240

Figure 17 Surface Water Monitoring SW013



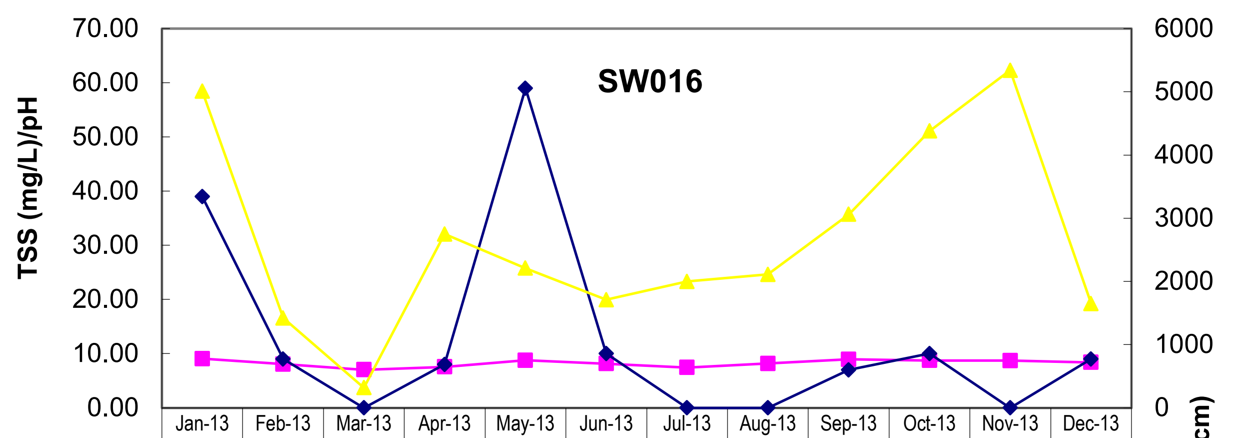
	Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13
pH		6.96	6.70	6.92	7.00	7.13	6.62	7.06	7.23			6.53
TSS		16	0	18	8	12	0	8	0			8
Ec		354	149	408	475	402	284	480	528			344

Figure 18 Surface Water Monitoring SW014



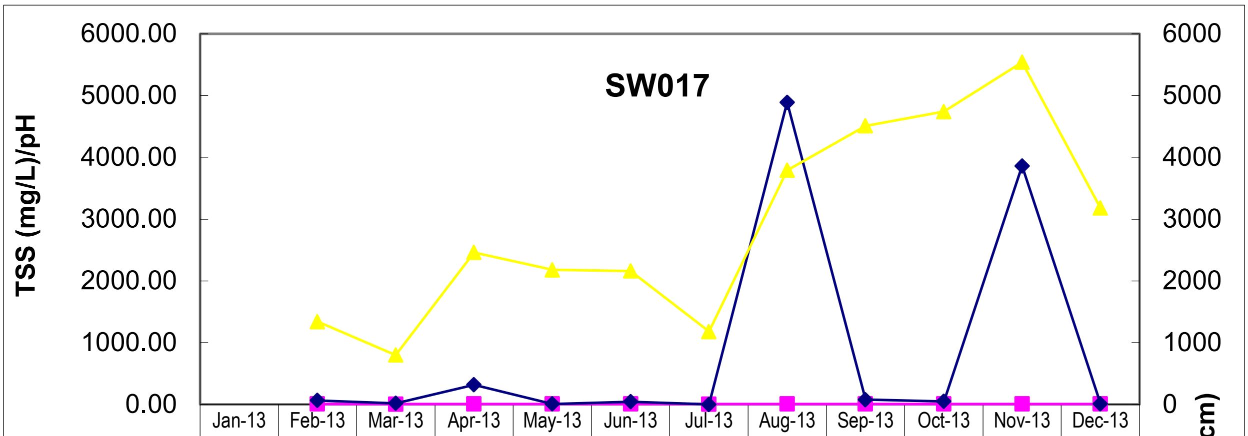
	Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13
pH	6.63	6.28	5.43	5.84	5.82	5.89	5.16	5.90	5.96			4.19
TSS	47	57	25	334	99	90	11	62	58			23
Ec	129	89	85	72	58	64	78	79	81			67

Figure 19 Surface Water Monitoring SW015



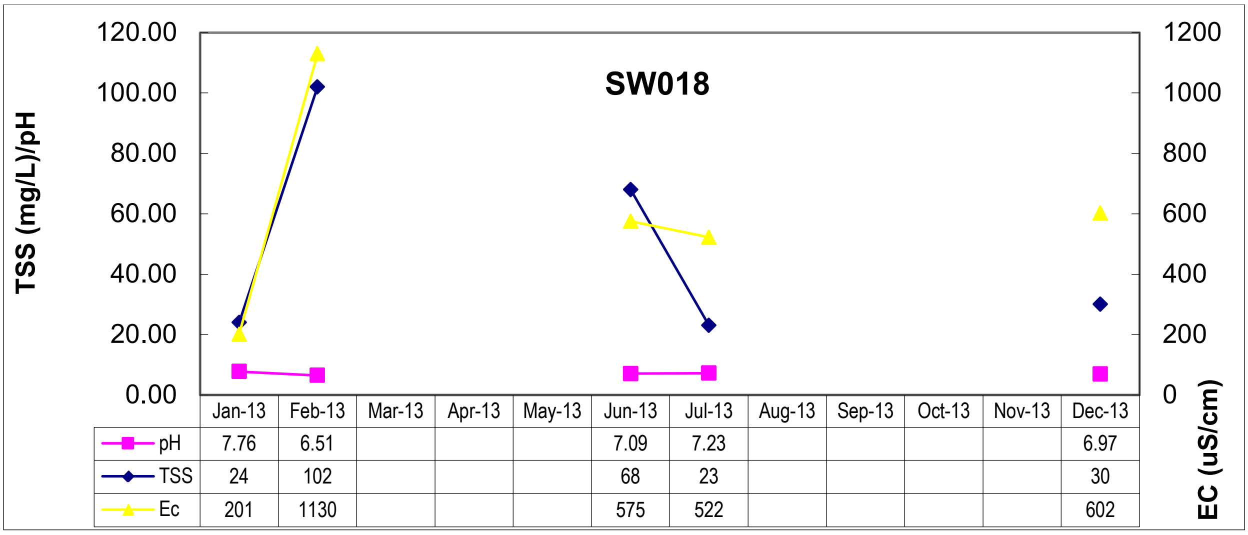
	Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13
pH	9.06	8.06	7.03	7.56	8.77	8.15	7.43	8.18	8.95	8.73	8.71	8.38
TSS	39	9	0	8	59	10	0	0	7	10	0	9
Ec	5010	1420	319	2750	2210	1710	2000	2110	3060	4380	5340	1650

Figure 20 Surfacw Water Monitoring SW016



	Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13
pH		8.24	6.23	8.99	9.14	7.51	7.23	8.04	8.24	8.48	8.66	8.24
TSS		65	19	319	8	44	0	4890	78	51	3860	10
Ec		1340	800	2460	2180	2160	1180	3790	4510	4740	5540	3180

Figure 21 Surface Water Monitoring SW017



	Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13
pH	7.76	6.51				7.09	7.23					6.97
TSS	24	102				68	23					30
Ec	201	1130				575	522					602

Figure 22 Surface Water Monitoring SW018

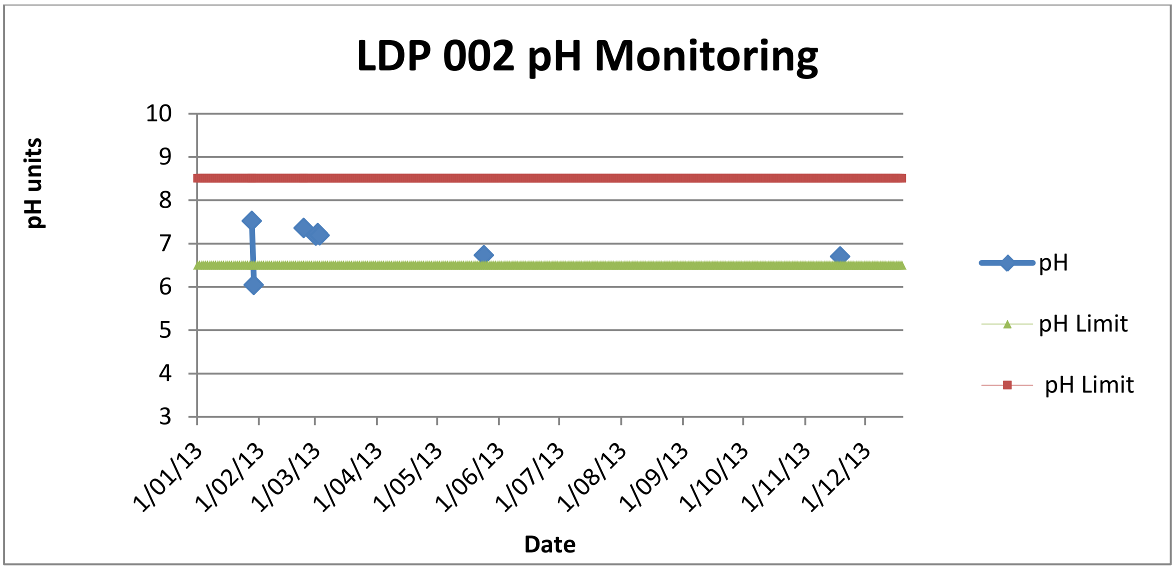


Figure 23 LDP002 pH monitoring

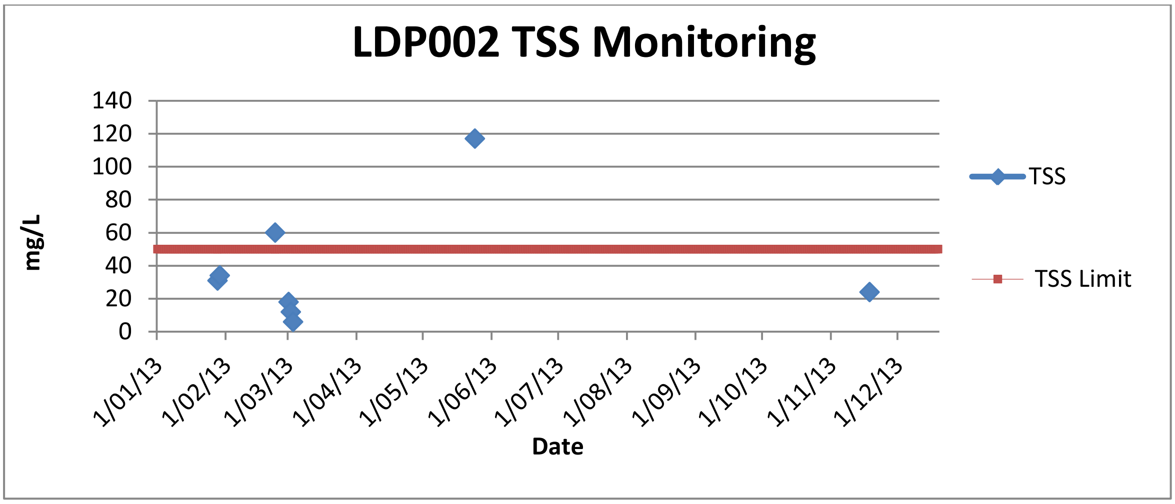


Figure 24 LDP002 TSS monitoring

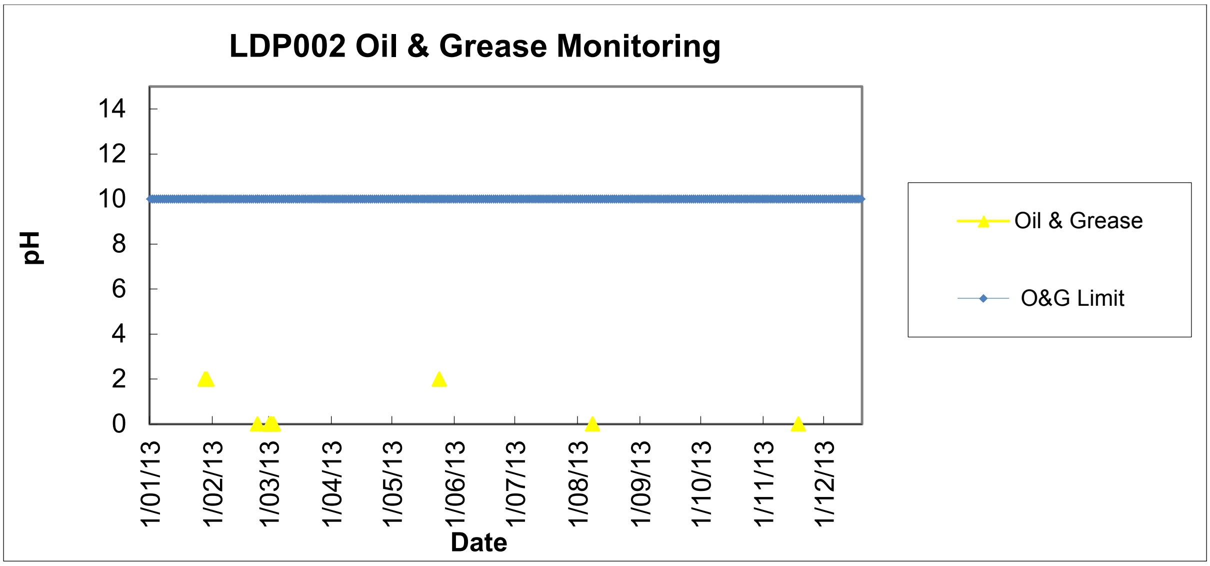


Figure 25 LDP002 Oil & Grease Monitoring

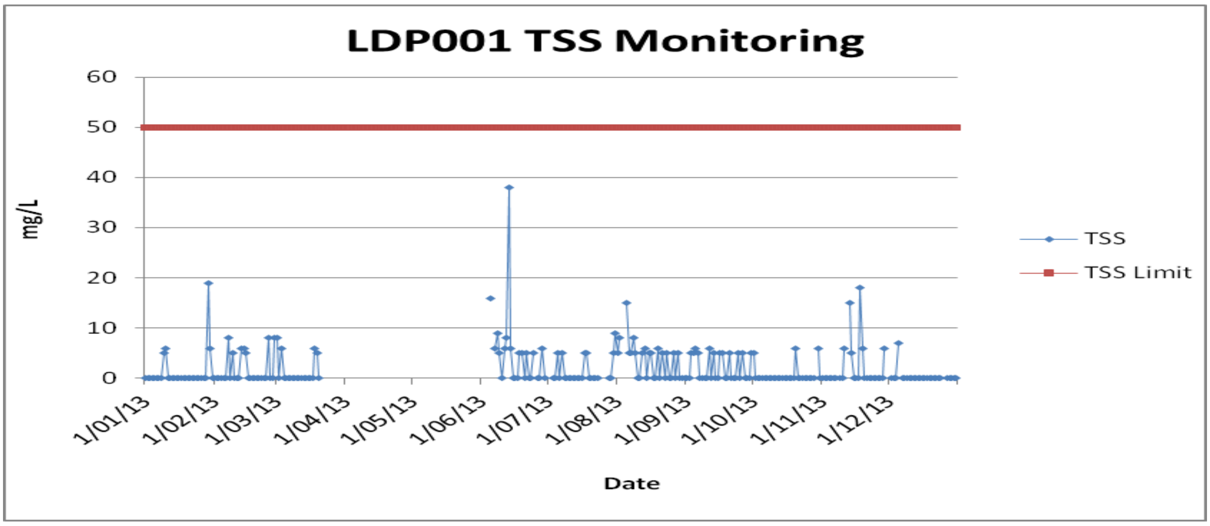


Figure 26 LDP001 TSS monitoring

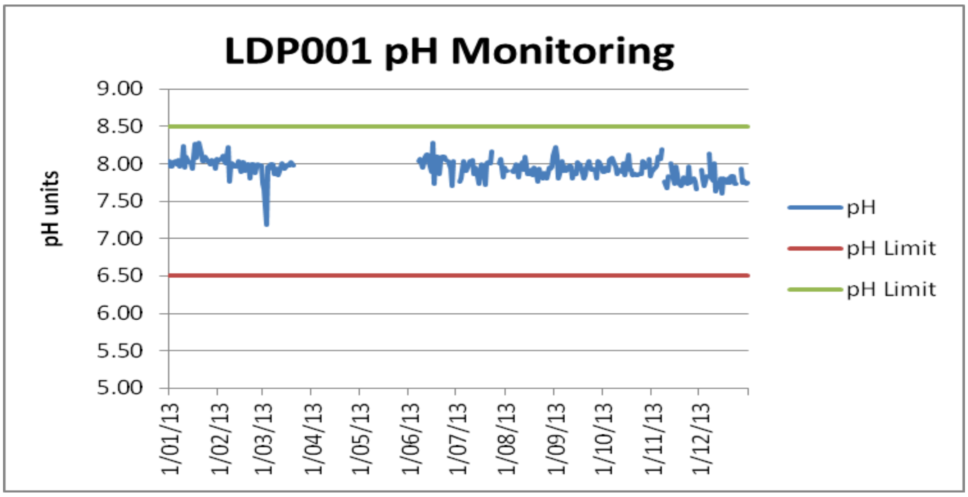


Figure 27 LDP001 pH Monitoring

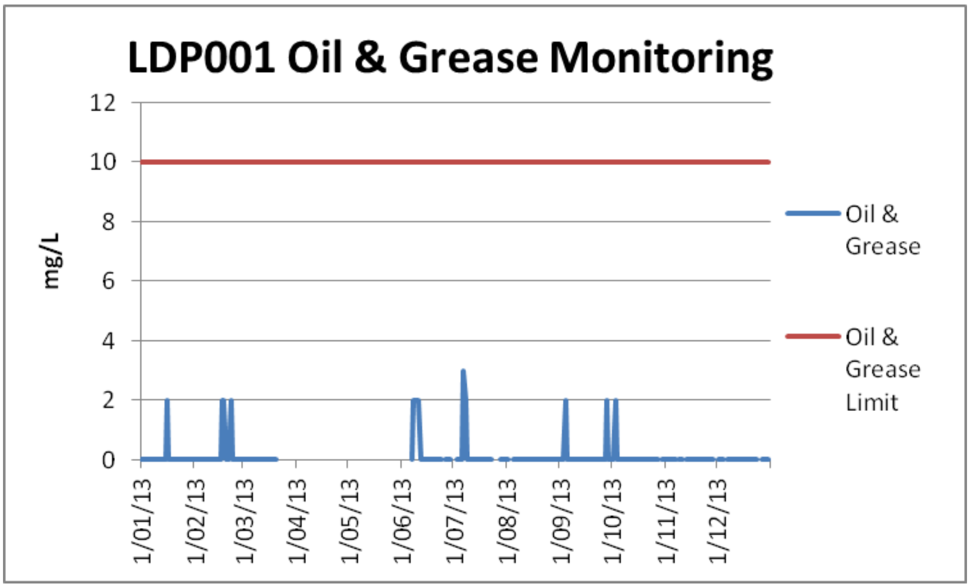
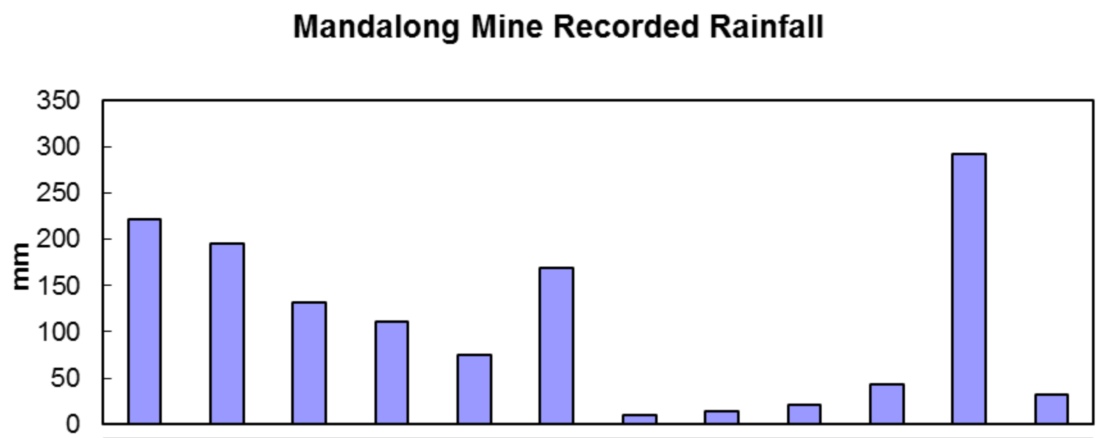


Figure 28 LDP001 Oil & Grease Monitoring

APPENDIX 7
Rainfall Data



	Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13
Total mm	222	195	132	112	76	170	11	14	21	43	292	32

APPENDIX 8
Noise and Blast Monitoring Reports

Mandalong Mine

Annual Compliance Noise Monitoring

August 2013

Report Number 630.02130.00000

16 October 2013

Centennial Coal Company Limited
PO Box 1000
Toronto NSW 2283

Version: Revision 0

Mandalong Mine

Annual Compliance Noise Monitoring

August 2013

PREPARED BY:

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630.02130.00000	Draft 1	15 October 2013	Tristan Robertson	Katie Teyhan	Katie Teyhan

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APPENDICES

1 INTRODUCTION

Centennial Coal Company Limited (Centennial) has commissioned SLR Consulting Australia Pty Ltd (SLR) to conduct noise monitoring surveys for the Mandalong Coal Project Site (Mandalong) and Cooranbong Colliery Site (Cooranbong) in accordance with the Mandalong Mine Noise Monitoring and Management Program July 2013.

The objectives of the noise monitoring survey for this operating period were as follows:

- Measure the ambient noise levels at the focus receptor locations (potentially worst affected) surrounding the mine and coal handling facilities. Noise surveys comprised of operator attended monitoring, for a minimum of 1.5 hours during the day; 30 minutes during the evening; and 1 hour during the night. Statistical indices recorded include L_{Amax}, L_{A1}, L_{A10}, L_{A90} and L_{Aeq}.
- Qualify all sources of noise within each of the attended surveys, including estimated contribution or maximum level of individual noise sources.
- Assess the noise emissions from Mandalong and Cooranbong Entry Site with respect to the limits contained in the Development Consent.

1.1 Acoustic Terminology

The following report uses specialist acoustic terminology. An explanation of common terms is provided in **Appendix A**.

1.2 Site Description

Mandalong Mine is an existing underground coal mine operation located in the Lake Macquarie Local Government Area (LGA) approximately 130 kilometres (km) north of Sydney near Morisset within the Newcastle Coalfield of NSW. It is part of the northern operations of Centennial Coal, which consists of Newstan, Awaba and Myuna.

The local setting of the Mandalong Mine is shown in **Figure 2**.

Figure 1 Site Location

2 NOISE CRITERIA

2.1 Development Consent DA 97/800 (MOD 9)

Condition 44 of the development consent provides relevant noise criteria and is reproduced as follows:

*The Applicant shall ensure that the noise generated by the development does not exceed the criteria in **Table 1** at any residence on privately-owned land or on more than 25% of any privately owned land.*

Table 1 ***Development Consent Noise Impact Assessment Criteria (dB(A))***

Noise Receiver locations	*Day* $L_{Aeq\ (15\ minute)}$	*Evening* $L_{Aeq\ (15\ minute)}$	*Night* $L_{Aeq\ (15\ minute)}$	*Night* $L_{A(1\ minute)}$
Receivers Near Mandalong Mine Service Site				
(23)	*38*	*38*	*38*	*45*
(26)	*37*	*37*	*37*	*45*
All other privately-owned land	*35*	*35*	*35*	*45*
Receivers Near Mandalong Mine Access Site				
R1 (64) *R2 (82)* *R4 (109)*	*35*	*35*	*35*	*45*
R3 (97)	*37*	*37*	*37*	*45*
R5 (110)	*36*	*36*	*36*	*45*
R6 (86)(87)	*40*	*40*	*40*	*45*
R7 (85)(89)	*43*	*43*	*43*	*45*
R8 (72)	*43*	*43*	*43*	*45*
R9 (73)	*40*	*40*	*40*	*45*
R10 (66)	*41*	*41*	*42*	*45*
All other privately-owned land	*35*	*35*	*35*	*45*

Notes:

1. Day is defined as the period from 7am to 6pm Monday to Saturday and 8am to 6pm Sunday and public holidays; evening is defined as the period from 6pm to 10pm; and night is defined as the period from 10pm to 7am Monday to Saturday and 10pm to 8am Sunday and public holidays
2. The noise receiver locations R1-R10 are described in the EA for Mod 6. The locations of corresponding receiver locations for the EA for Mod 4 (numerals in parentheses) are shown in Schedule 6.
3. Noise generated by the project is to be measured in accordance with the relevant procedures and exemptions (including meteorological conditions) in the NSW Industrial Noise Policy.
4. The Mandalong mine meteorological monitoring station data used for determining meteorological conditions shall be compared against data recorded at the Eraring power station meteorological weather station to ensure it is representative.

2.2 Environmental Protection Licence 365

Conditions of the Environmental Protection Licence (EPL) 365 provides noise criteria for Mandalong Mine and is reproduced as follows:

L5 Noise limits

L5.1 *The licensee must ensure that noise generated by the activities within the premises do not exceed the following criteria measured by dB(A) at any of the following locations or on more than 25% of any privately-owned land.*

Location	*Day LAeq(15min)*	*Evening LAeq(15min)*	*Night LAeq(15min)*	*Night A(1min)*
23 Gradwells Rd	*38*	*38*	*38*	*45*
26 Gradwells Rd	*37*	*37*	*37*	*45*
R1 (64) *R2 (82)* *R4 (109)*	*35*	*35*	*35*	*45*
R3 (97)	*37*	*37*	*37*	*45*
R5 (110)	*36*	*36*	*36*	*45*
R6 (86) (87)	*40*	*40*	*40*	*45*
R7 (85) (89)	*43*	*43*	*43*	*45*
R8 (72)	*43*	*43*	*43*	*45*
R9 (73)	*40*	*40*	*40*	*45*
R10 (66)	*41*	*41*	*42*	*45*
All other privately owned land	*35*	*35*	*35*	*45*

Note: *Locations '23 and 26 Gradwells Road' are defined in Figure 2 of the Noise Impact Assessment contained within the Mandalong Mine - Cooranbong Entry Site Environmental Assessment dated May 2012. Locations 'R1 to R10' are defined in the Mandalong Mine - Modification 4 to Development Consent Environment Assessment dated September 2008.*

The licensee may provide to the EPA written evidence of any agreement with a landholder which is subject to the above noise limits. The written evidence may be submitted with a licence variation to remove the landholder from the above table.

L5.2 *For the purpose of condition L5.1:*

(a) Day is defined as the period from 7am to 6pm Monday to Saturday and 8am to 6pm Sunday and public holidays;

(b) Evening is defined as the period 6pm to 10pm, and

(c) Night is defined as the period from 10pm to 7am Monday to Saturday and 10pm to 8am Sunday and public holidays.

It is relevant to note that the noise limits presented in condition 44 of the development consent are consistent with the noise limits in EPL 365.

L5.3 *The noise limits set out in conditions L5.1 apply under all meterorological conditions except for any one of the following:*

(a) Wind speeds greater than 3 metres/second at 10 metres above ground level; or

(b) Stability category F temperature inversion conditions and wind speeds greater the 2 metres/second at 10 metres above ground level; or

(c) Stability category G temperature inversion conditions.

L5.4 *For the purpose of condition L5.3:*

(a) the meteorological data to be used for determining meteorological conditions is the data recorded at the meteorological station identified in this licence as EPA Identification Point W1.

(b) Stability category temperature inversion conditions are to be determined by the sigma-theta method referred to in Part E4 of Appendix E to the NSW industrial Noise Policy (EPA 2000)

Note: The weather station must be designed, commissioned and operated in a manner to obtain the necessary parameters required under the above condition.

L5.5 *For the purpose of determining the noise generated at the premises the licensee must use a Class 1 or Class 2 noise monitoring device as defined by AS IEC61672.1 and AS IEC61672.2-2004, or other noise monitoring equipment accepted by the EPA in writing.*

L5.6 *To determine compliance:*

1. With the $L_{Aeq(15\ min)}$ noise limits in condition L5.1, the licensee must locate noise monitoring equipment;

(a) within 30 metres of a dwelling facade (but not closer than 3 metres) where any dwelling on the property is situated more then 30 metres from the property boundary that is closest to the premises;

(b) approximately on the boundary where any dwelling is situated 30 metres or less from the property boundary that is closest to the premises, or, where applicable,

(c) within approximately 50 metres if the boundary of a national park or nature reserve.

2. With the LA1(1 minute) noise limits in condition L5.1, the noise monitoring equipment must be located within 1 metre of a dwelling facade.

3. With the noise limits in condition L5.1, the noise monitoring equipment must be located;

(a) at the most affected point at a location where there is no dwelling at the location, or

(b) at the most affected point within an area at a location prescribed by conditions L5.6 1(a) or L5.6 1(b).

L5.7 *A non-compliance of condition L5.1 will still occur where noise generated from the premises in excess of the appropriate limit is measure;*

- at a location other than an area presribed by conditions L5.6 1(a) and L5.6 1(b), and /or

- at a point other than the most affected point at a location.

L5.8 *For the purposes of determining the noise generated at the premises the modification factors in Section 4 of the NSW Iductrial Noise Policy must be applied, as appropriate, to the noise levels measured by the noise monitoring equipment.*

M4.1 *To determine compliance with condition L5.1, attended noise monitoring must be undertaken in accordance with conditions L5.5 and L5.6, and*

(a) at each one of the locations listed in condition L5.1;

(b) occur annually within the reporting period of the Environment Protection Licence;

(c) occur during each day, evening and night period as defined in the NSW Industrial Noise Policy (EPA2000) for a minimum of 1.5 hours during the day; 30 minutes during the evening; and 1 hours during the night, and

(d) occur for three (3) consecutive days.

3 ANNUAL MONITORING LOCATIONS

In accordance with EPL 365 condition M4.1, operator-attended noise surveys at each of the locations listed in EPL 365 condition L5.1 (refer to **Section 2.2**) and shown in **Figure 2** and **Figure 3,** will occur annually within the reporting period of the Environment Protection Licence.

Figure 2 Noise Receiver Locations – Mandalong Mine Access Site

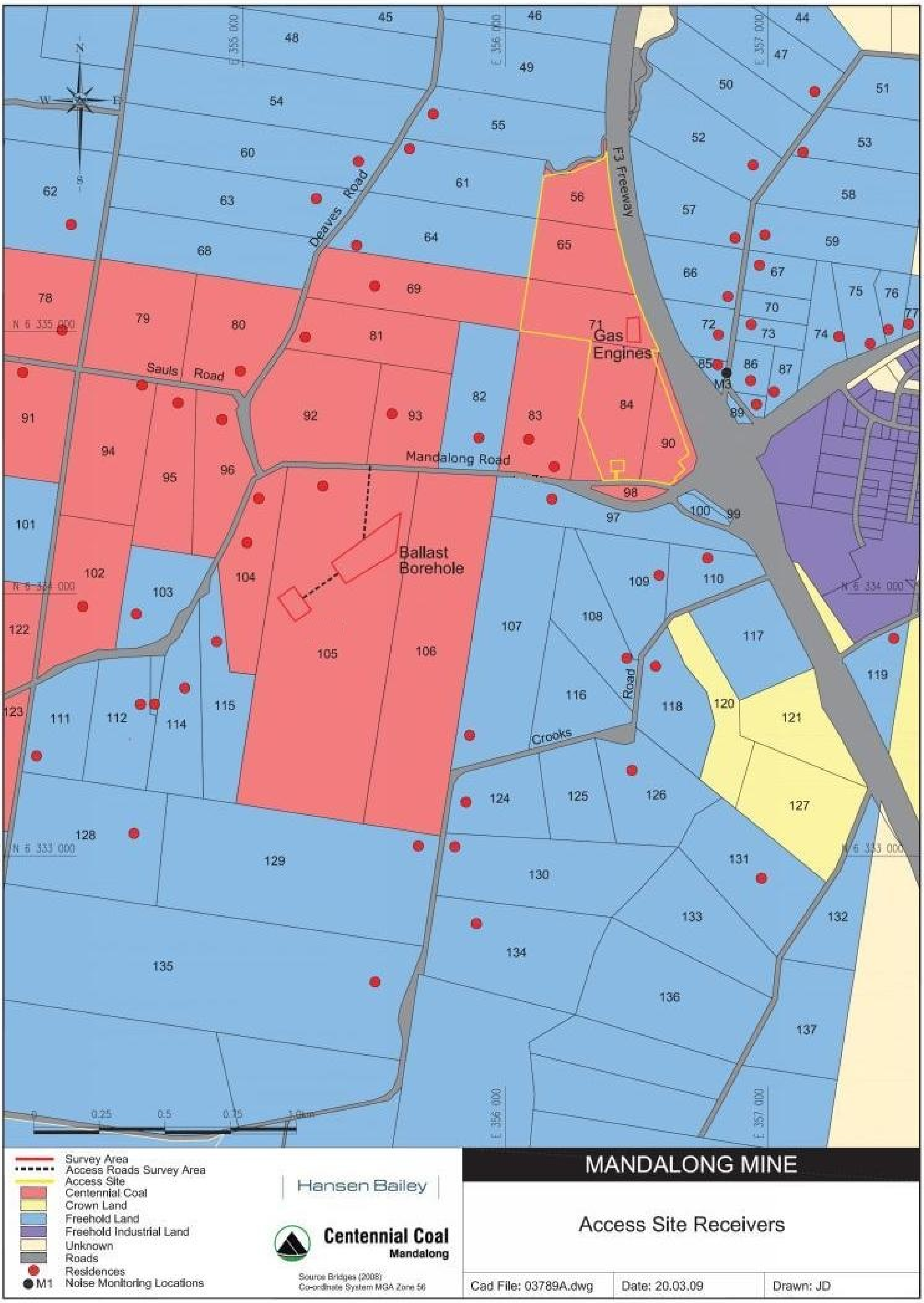
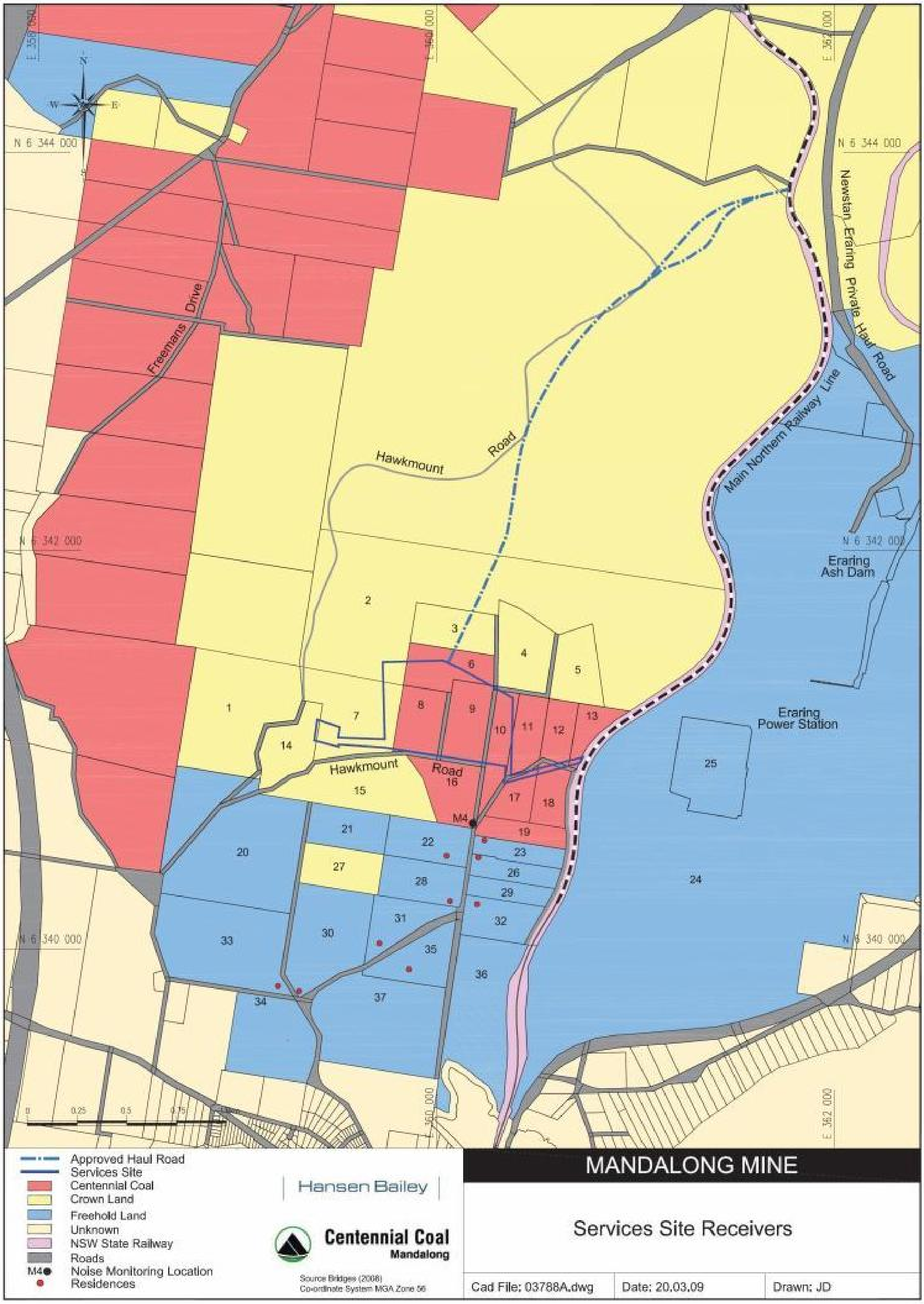


Figure 3 Noise Receiver Locations – Mandalong Mine – Cooranbong Entry Site



4 PROCEDURES AND METHODOLOGY

4.1 General Requirements

The operational noise monitoring programme was conducted with reference to the Mandalong Mine Noise Monitoring Program July 2013 and AS 1055-1997 "*Acoustics –Description and Measurement of Environmental Noise*". All instrumentation used during noise measurements comply with the requirements of AS IEC 61672.1-2004 and carry current NATA or manufacturer calibration certificates.

4.2 Monitoring Locations

The details of the monitoring locations are contained within **Table 2**.

Table 2 Monitoring Locations

Monitoring Location	Receivers ID	Monitoring Location <UTM Zone 56	
		Easting (m)	Northing (m)
M1	23 Gradwells Rd 26 Gradwells Rd	360188	6340617
M2	R1 (64)	355337	6335349
M3	R2 (82)	355864	6334468
M4	R3 (97)	356216	6334412
M5	R4 (109)	356539	6334319
M6	R5 (110)	356727	6334290
M7	R7 (85) (89) R6 (86) (87)	356855	6334788
M8	R8 (72)	356867	6334974
M9	R9 (73)	356882	6335042
M10	R10 (66)	356887	6335120

It is relevant to note that access to each of the residential properties was not obtained and as such all noise monitoring was conducted on the road side/boundary fence of each assessment location. Furthermore, monitoring location M1 was representative of receiver location 23 and 26, and monitoring location M7 was representative of location R6 and R7.

A map giving the approximate location of the noise monitoring sites is contained within **Appendix B**.

4.3 Operator Attended Monitoring

Operator attended noise surveys were conducted at each of the ten (10) locations (refer to **Table 2**) for a minimum of 1.5 hour during the day; 30 minutes during the evening; and 1 hours during the night, to determine the character and relative contribution of ambient noise sources and mine contributions.

Measurements were conducted during worst case operational scenarios for both Mandalong and Cooranbong sites in order to capture associated worst case noise levels.

5 OPERATOR ATTENDED NOISE MONITORING

5.1 Results of Operator Attended Monitoring

Operator attended noise measurements were conducted during the day on Monday 19 August 2013, evening on Tuesday 20 August 2013 and night-time periods on Wednesday 21 August 2013 at the locations identified in **Table 2.**

The results of the operator attended noise measurements are given in **Table 3** to **Table 5**. Ambient noise levels given in the tables include all noise sources such as traffic, insects, birds, and mine operations as well as any other industrial operations.

The tables provide the following information:

- Monitoring location.
- Date & start time.
- Wind velocity (m/s) and Temperature (ºC) at the measurement location.
- Typical maximum (LAmax) and contributed noise levels.

Table 3 Day Time Operator Attended Noise Monitoring Results

Date/Start Time Weather (operator) SLM Details	Measurement Location (Relevant criteria LAeq(15mintue)	Primary Noise Descriptor (dBA re 20 µPa) LAmax	LA1	LA10	LA90	LAeq	Description of Noise Emission and Typical Maximum Levels LAmax – dBA
19/08/2013 2:09 pm W = 4.7m/s W Temp = 21.7ºC (Tristan Robertson) Svan 957 S/N23293	M1 23 Gradwells Rd (38 dBA) 26 Gradwells Rd (37 dBA)	91	67	51	39	57	Intermittent Traffic Noise (Gradwells Road) 62 - 91 Tress in wind 48 - 50 Birds 41 - 63. Plane flyover 46-53 Train passby 44-53 Dog barking 43 Horse 41-42 Mandalong mine audible 40.
		Mandalong Colliery Audible LAeq (15 minute) 37dBA					
19/08/2013 14:48 pm W = 4.7m/s W Temp = 21.7ºC (Nicholas Vandenberg) B&K 2270 S/N 2679354	M2 R1 (64) (35 dBA)	91	78	67	43	66	Traffic ~ 71 to 90 dBA Animal ~ 45 to 53 dBA Birds ~ 39 to 69 dBA Wind ~ 49 dBA Resident ~ 51 dBA Plane ~ 44 to 46 dBA
		Mandalong Colliery Inaudible					
19/08/2013 13:04 pm W = 4.7m/s W Temp = 21.7ºC (Nicholas Vandenberg) B&K 2270 S/N 2679354	M3 R2 (82) (35 dBA)	81	73	64	46	61	Mandalong Rd Traffic ~ 62 to 81 dBA Wind ~ 58 to 66 dBA Birds ~ 58 to 61 dBA Helicopter ~ 50 dBA Resident ~ 48 dBA Plane ~ 45 dBA
		Mandalong Colliery Inaudible					
19/08/2013 11:06 am W = 4.2m/s N Temp = 19.6ºC (Nicholas Vandenberg) B&K 2270 S/N 2679354	M4 R3 (97) (37 dBA)	89	73	63	49	61	Operator ~ 63 to 89 dBA Mandalong Rd Traffic ~ 67 to 83 dBA M1 Traffic ~ 46 to 53 dBA Plane ~ 46 dBA Wind ~ 54 to 70 dBA Helicopter ~ 57 dBA Birds ~ 58 dBA Resident ~ 49 dBA Mandalong Bang ~53 dBA Mandalong Vehicles ~ 45 to 42 dBA
		Mandalong Colliery Audible Estimated LAeq (15 minute) 33dBA					

Date/Start Time Weather (operator) SLM Details	Measurement Location (Relevant criteria LAeq(15mintue)	Primary Noise Descriptor (dBA re 20 µPa)					Description of Noise Emission and Typical Maximum Levels LAmax – dBA
		LAmax	LA1	LA10	LA90	LAeq	
19/08/2013 09:22 am W = 1.9m/s N Temp = 17.6^{o}C (Nicholas Vandenberg) B&K 2270 S/N 2679354	M5 R4 (109) (35 dBA)	89	81	71	55	68	M1 Traffic ~ 54 to 58 dBA Mandalong Rd Traffic ~ 67 to 89 dBA Other industry ~ 60 to 64 dBA Mandalong Gate ~ 31 Mandalong Bang ~ 64 dBA
		Mandalong Colliery Audible Estimated LAeq (15 minute) 34dBA					
19/08/2013 7:47 am W = Calm Temp = 8.2^{o}C (Nicholas Vandenberg) B&K 2270 S/N 2679354	M6 R5 (110) (36 dBA)	86	71	62	57	62	Local Traffic ~ 71 to 85 dBA M1 Traffic ~ 55 to 70 dBA Birds ~ 60 to 69 dBA Animals ~ 55 to 63 dBA Mandalong Rd Traffic ~ 60 to 64 dBA
		Mandalong Colliery Inaudible					
19/08/2013 12:24 pm W = 4.7m/s W Temp = 21.7^{o}C (Tristan Robertson) Svan 957 S/N23293	M7 R6 (86) (87) (40 dBA) R7 (85) (89) (43 dBA)	83	71	66	60	64	Traffic noise dominant (M1); 61– 65 (constant) Intermittent Traffic Noise (Gimberts Road) 74 - 83 Wind in Trees 61 – 63 Mandalong mine inaudible.
		Mandalong Colliery inaudible					
19/08/2013 10:46 am W = 4.2m/s N Temp = 19.6^{o}C (Tristan Robertson) Svan 957 S/N23293	M8 R8 (72) (43 dBA)	79	70	66	54	62	Traffic noise dominant (M1); 56 – 60 (constant) Intermittent Traffic Noise (Gimberts Road) 75 - 79 Birds 64. Wind in Trees 64 – 65 Plane flyover 75 - 79 Mandalong mine inaudible.
		Mandalong Colliery inaudible					
19/08/2013 9:10 am W = 1.9m/s N Temp = 17.6^{o}C (Tristan Robertson) Svan 957 S/N23293	M9 R9 (73) (40 dBA)	86	69	56	50	59	Traffic noise dominant (M1); 49 – 58 (constant) Intermittent Traffic Noise (Gimberts Road) 79 - 86 Birds 57 - 64. Mandalong mine inaudible.
		Mandalong Colliery inaudible					
19/08/2013 7:35 am W = Calm Temp = 8.2^{o}C (Tristan Robertson) Svan 957 S/N23293	M10 R10 (66) (41 dBA)	92	68	59	51	60	Traffic noise dominant (M1); 58– 60 (constant) Intermittent Traffic Noise (Gimberts Road) 83 -92 Birds 61 - 78. Mandalong mine inaudible.
		Mandalong Colliery inaudible					

Table 4 Evening Time Operator Attended Noise Monitoring Results

Date/Start Time Weather (operator) SLM Details	Measurement Location (Relevant criteria LAeq(15mintue)	Primary Noise Descriptor (dBA re 20 µPa) LAmax	LA1	LA10	LA90	LAeq	Description of Noise Emission and Typical Maximum Levels LAmax – dBA
20/08/2012 8:25 pm W = 1.7m/s WSW Temp = 10°C (Tristan Robertson) Svan 957 S/N23293	M1 23 Gradwells Rd (38 dBA) 26 Gradwells Rd (37 dBA)	59	48	44	37	42	Intermittent Traffic Noise (Gradwells Road) 62 - 91 Tress in wind 48 - 50 Birds 41 - 63. Plane flyover 46-53 Train passby 44-53 Dog barking 43 Horse 41-42 Mandalong mine audible 40
		Mandalong Colliery Audible Estimated LAeq (15 minute) 40 dBA					
20/08/2013 6:00 pm W = 3.6m/s W Temp = 12.5°C (Nicholas Vandenberg) B&K 2270 S/N 2679354	M2 R1 (64) (35 dBA)	85	77	64	41	64	Local Traffic ~ 78 to 85 dBA Insects ~ 39 to 40 dBA Trees Rustling ~ 42 to 44 dBA Birds ~ 42 to 44 dBA Resident ~ 42 dBA Dog Barking ~ 47 dBA Distant Traffic ~ <30 to 32 dBA
		Mandalong Colliery inaudible					
20/08/2013 06:35 pm W = 3.1m/s W Temp = 12°C (Nicholas Vandenberg) B&K 2270 S/N 2679354	M3 R2 (82) (35 dBA)	84	73	62	37	60	Local Traffic ~ 70 to 79 dBA Trees rustling ~ 35 to 41 dBA Insects ~ <30 dBA Operator ~ 53 dBA Dog Barking ~ <30 to 40 dBA Plane ~ 46 dBA
		Mandalong Colliery inaudible					
20/08/2013 07:07 pm W = 3.1m/s W Temp = 11.6°C (Nicholas Vandenberg) B&K 2270 S/N 2679354	M4 R3 (97) (37 dBA)	78	69	58	41	57	M1 Traffic ~ 40 to 47 dBA Insects ~ 40 to 44 dBA Wind ~ 38 to 47 dBA Local Traffic ~ 69 to 78 dBA Operator ~ 47 dBA Birds ~ 50 to 53 dBA Mandalong Bang ~ 46 dBA
		Mandalong Colliery Audible Estimated LAeq (15 minute) <30dBA					
18/10/2012 08:14 pm W = 1.7m/s WSW Temp = 10°C (Nicholas Vandenberg) B&K 2270 S/N 2679354	M5 R4 (109) (35 dBA)	86	78	63	42	64	Local Traffic ~ 78 to 85 dBA M1 Traffic ~ 40 to 48 dBA Insects ~ 40 to 47 dBA Plane ~ 52 dBA Dog Barking ~ 51 dBA Gate Alarm ~ 33 dBA Mandalong Bang ~44 to 53
		Mandalong Colliery Audible Estimated LAeq (15 minute) 32dBA					
20/08/2013 07:40 pm W = 3.1m/s W Temp = 11°C (Nicholas Vandenberg) B&K 2270 S/N 2679354	M6 R5 (110) (36 dBA)	75	63	58	49	55	Local Traffic ~ 74 dBA M1 Traffic ~ 47 to 65 dBA Dog Barking ~ 50 to 53 dBA
		Mandalong Colliery inaudible					
18/10/2012 7:42 pm W = 3.1m/s W Temp = 11°C (Tristan Robertson) Svan 957 S/N23293	M7 R6 (86) (87) (40 dBA) R7 (85) (89) (43 dBA)	78	66	59	53	58	Traffic noise dominant (M1); 61– 65 (constant) Intermittent Traffic Noise (Gimberts Road) 74 - 83 Wind in Trees 61 – 63 Mandalong mine inaudible.
		Mandalong Colliery inaudible					
20/08/2013 7:07 pm W = 3.6m/s W Temp = 12.5°C (Tristan Robertson) Svan 957 S/N23293	M8 R8 (72) (43 dBA)	86	66	60	54	60	Traffic noise dominant (M1); 56 – 60 (constant) Intermittent Traffic Noise (Gimberts Road) 75 - 79 Birds 64. Wind in Trees 64 – 65 Plane flyover 75 - 79
		Mandalong Colliery inaudible					

Date/Start Time Weather (operator) SLM Details	Measurement Location (Relevant criteria LAeq(15mintue)	Primary Noise Descriptor (dBA re 20 µPa)					Description of Noise Emission and Typical Maximum Levels LAmax – dBA
		LAmax	LA1	LA10	LA90	LAeq	
							Mandalong mine inaudible.
20/08/2013 6:34 pm W = 3.1m/s W Temp = 12ºC (Tristan Robertson) Svan 957 S/N23293	M9 R9 (73) (40 dBA)	79	66	62	55	60	Traffic noise dominant (M1); 49 – 58 (constant) Intermittent Traffic Noise (Gimberts Road) 79 - 86 Birds 57 - 64. Mandalong mine inaudible.
		Mandalong Colliery inaudible					
20/08/2013 6:00 pm W = 3.6m/s W Temp = 12.5ºC (Tristan Robertson) Svan 957 S/N23293	M10 R10 (66) (41 dBA)	78	64	61	56	59	Traffic noise dominant (M1); 58– 60 (constant) Intermittent Traffic Noise (Gimberts Road) 83 -92 Birds 61 - 78. Mandalong mine inaudible.
		Mandalong Colliery inaudible					

Table 5 Night Time Operator Attended Noise Monitoring Results

Date/Start Time Weather (operator) SLM Details	Measurement Location (Relevant criteria LAeq(15mintue)	Primary Noise Descriptor (dBA re 20 µPa) LAmax	LA1	LA10	LA90	LAeq	Description of Noise Emission and Typical Maximum Levels LAmax – dBA
21/08/2013 10:00 pm W = calm Temp = 6.7oC (Tristan Robertson) Svan 957 S/N23293	M1 23 Gradwells Rd (38 dBA) 26 Gradwells Rd (37 dBA)	56	50	44	39	42	Distant Road Traffic Noise 43-48 Birds 43 - 55. Plane flyover 45-48 Train passby 46-56 Insects 39-40 Mandalong mine audible 44
		Mandalong Colliery Audible LAeq (15 minute) 40 dBA LA1 (1minte) <45dBA					
21/08/2013 10:00 pm W = calm Temp = 6.7oC (Nicholas Vandenberg) B&K 2270 S/N 2679354	M2 R1 (64) (35 dBA)	87	72	54	33	60	Local Traffic ~ 72 to 87 dBA Plane ~ 41 to 42 dBA M1 Traffic ~ 33 to 42 dBA Insects ~ 33 to 38 dBA Resident ~ 30 to 39 dBA Operator ~ 39 to 48 dBA Dog Barking ~ 36 to 42 dBA Animals ~ 38 to 41 dBA
		Mandalong Colliery inaudible					
21/08/2013 11:06 pm W = Calm Temp = 5oC (Nicholas Vandenberg) B&K 2270 S/N 2679354	M3 R2 (82) (35 dBA)	82	68	49	31	54	Local Traffic ~ 67 to 82 dBA Birds ~ 36 to 44 dBA Insects ~ <30 to 32 dBA M1 Traffic ~ 30 to 43 dBA Dog Barking ~ 30 to 34 dBA Animal ~ 44 dBA Operator ~ 44 dBA Resident ~ 36 dBA
		Mandalong Colliery inaudible					
22/08/2013 12:10 am W = 1.1m/s WNW Temp = 4.8oC (Nicholas Vandenberg) B&K 2270 S/N 2679354	M4 R3 (97) (37 dBA)	75	66	54	41	53	M1 Traffic ~ 43 to 62 dBA Insects ~ 47 dBA Birds ~ 44 to 54 dBA Local Traffic ~ 70 to 75 dBA Fire alarm ~ 33 to 36 dBA Mandalong Bang ~ 45 to 48 dBA
		Mandalong Colliery Audible LAeq (15 minute) <30 dBA LA1 (1minte) <45dBA					
22/08/2013 02:19 am W = Calm Temp = 2.6oC (Nicholas Vandenberg) B&K 2270 S/N 2679354	M5 R4 (109) (35 dBA)	81	68	62	49	59	Local Traffic ~ 65 to 81 dBA M1 Traffic ~ 53 to 64 dBA Other Industry ~ 61 to 65 dBA Plane ~ 52 to 55 dBA Operator ~ 57 dBA Birds ~ <45 dBA Gate Alarm ~ 33 Beep~ 36
		Mandalong Colliery Audible LAeq (15 minute) <30 dBA LA1 (1minte) <45dBA					
22/08/2013 01:15 am W = Calm Temp = 3.3oC (Nicholas Vandenberg) B&K 2270 S/N 2679354	M6 R5 (110) (36 dBA)	71	68	64	50	60	Fire Alarm ~ 54 to 58 dBA M1 Traffic ~ 42 to 71 dBA Birds ~ 48 to 56 dBA Mandalong Rd Traffic ~ <55 to 57 dBA Gate Alarm ~ <30
		Mandalong Colliery Audible LAeq (15 minute) <30 dBA					
21/08/2013 2:22 am W = Calm Temp = 2.6oC (Tristan Robertson) Svan 957 S/N23293	M7 R6 (86) (87) (40 dBA) R7 (85) (89) (43 dBA)	71	66	62	51	59	Traffic noise dominant (F3); 56– 71 (constant) Mandalong mine audible. 39 (constant) Plane flyover 55
		Mandalong Colliery Audible LAeq (15 minute) 39 dBA LA1 (1minte) <45dBA					
21/08/2013 1:19 am W = Calm Temp = 3.3oC (Tristan Robertson) Svan 957 S/N23293	M8 R8 (72) (43 dBA)	68	65	61	49	58	Traffic noise dominant (F3); 54– 68 (constant) Mandalong mine audible. 39 (constant) Emico/PJB truck horn 58 Birds 56
		Mandalong Colliery Audible LAeq (15 minute) 39 dBA LA1 (1minte) <45dBA					

Date/Start Time Weather (operator) SLM Details	Measurement Location (Relevant criteria LAeq(15mintue)	Primary Noise Descriptor (dBA re 20 µPa)					Description of Noise Emission and Typical Maximum Levels LAmax – dBA
		LAmax	LA1	LA10	LA90	LAeq	
							Frogs/insects 41-42
21/08/2013 12:18 am W = 1.1m/s WNW Temp = 4.8^{o}C (Tristan Robertson) Svan 957 S/N23293	M9 R9 (73) (40 dBA)	75	68	64	48	60	Traffic noise dominant (F3); 69– 77 (constant) Mandalong mine audible. 39 (constant) Emico/PJB truck horn 53 -58
		Mandalong Colliery Audible LAeq (15 minute) 39 dBA LA1 (1minte) <45dBA					
21/08/2013 11:15 pm W = Calm Temp = 4^{o}C (Tristan Robertson) Svan 957 S/N23293	M10 R10 (66) (42 dBA)	71	65	61	49	57	Traffic noise dominant (F3); 51– 71 (constant) Mandalong mine audible. 39 (constant) Emico/PJB truck horn 40 -48 Dropping of Material 60-61
		Mandalong Colliery Audible LAeq (15 minute) 39 dBA LA1 (1minte) <45dBA					

The operator attended noise monitoring results presented **Table 3**, **Table 4** and **Table 5** show that the noise contributions from Mandalong mine comply with the relevant noise criteria at all monitoring locations and during all time periods with the exception of M1. The mine contributed noise levels at M1 during the evening and night-time attended surveys was estimated to be LAeq(15mintue) 40 dBA; 3 dBA exceeded noise level above the criteria of LAeq(15mintue) 37 dBA. It is noted that the consent criteria are based on the assumption that the coal handling plant (CHP) and rotary crushing facilities are upgraded with additional cladding. Centennial are in the process of upgrading these facilities and once this has been completed, the mine noise contributions are predicted to comply with the consent criteria.

6 CONCLUSION

SLR were engaged by Centennial Coal Company Limited to conduct a noise compliance assessment for the Mandalong Mine and Cooranbong Colliery in accordance with the Mandalong Mine Noise Monitoring Program August 2013.

Operator-attended noise measurements were conducted at the ten (10) focus locations surrounding the mine site during the day on Monday 19 August 2013, evening on Tuesday 20 August 2013 and night-time period on Wednesday 21 August 2013. Measurements were conducted during worst case operational scenarios for both Mandalong and Cooranbong sites in order to capture associated worst case noise levels.

Mine operations noise contributions were found to be within the relevant consent conditions at all monitoring locations with the exception of a 3dBA exceedance during the evening and night-time at location M1.

It is noted that the consent criteria for location M1 are based on the assumption that the CHP and rotary crushing facilities are upgraded with additional cladding. Centennial are in the process of upgrading these facilities and once this has been completed, the mine noise source contributions are predicted to comply with the consent criteria.

1 Sound Level or Noise Level

The terms "sound" and "noise" are almost interchangeable, except that in common usage "noise" is often used to refer to unwanted sound.

Sound (or noise) consists of minute fluctuations in atmospheric pressure capable of evoking the sense of hearing. The human ear responds to changes in sound pressure over a very wide range. The loudest sound pressure to which the human ear responds is ten million times greater than the softest. The decibel (abbreviated as dB) scale reduces this ratio to a more manageable size by the use of logarithms.

The symbols SPL, L or L_P are commonly used to represent Sound Pressure Level. The symbol L_A represents A-weighted Sound Pressure Level. The standard reference unit for Sound Pressure Levels expressed in decibels is 2E-5 Pa.

2 "A" Weighted Sound Pressure Level

The overall level of a sound is usually expressed in terms of dBA, which is measured using a sound level meter with an "A-weighting" filter. This is an electronic filter having a frequency response corresponding approximately to that of human hearing.

People's hearing is most sensitive to sounds at mid frequencies (500 Hz to 4000 Hz), and less sensitive at lower and higher frequencies. Thus, the level of a sound in dBA is a good measure of the loudness of that sound. Different sources having the same dBA level generally sound about equally loud.

A change of 1 dBA or 2 dBA in the level of a sound is difficult for most people to detect, whilst a 3 dBA to 5 dBA change corresponds to a small but noticeable change in loudness. A 10 dBA change corresponds to an approximate doubling or halving in loudness. The table below lists examples of typical noise levels

Sound Pressure Level (dBA)	Typical Source	Subjective Evaluation
130	Threshold of pain	Intolerable
120 110	Heavy rock concert Grinding on steel	Extremely noisy
100 90	Loud car horn at 3 m Construction site with pneumatic hammering	Very noisy
80 70	Kerbside of busy street Loud radio or television	Loud
60 50	Department store General Office	Moderate to quiet
40 30	Inside private office Inside bedroom	Quiet to very quiet
20	Unoccupied recording studio	Almost silent

Other weightings (eg B, C and D) are less commonly used than A-weighting. Sound Levels measured without any weighting are referred to as "linear", and the units are expressed as dB(lin) or dB.

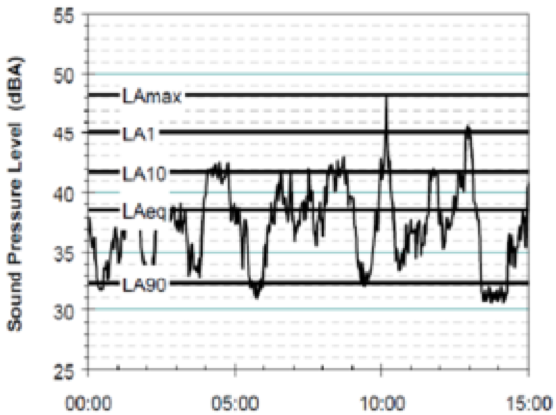
3 Sound Power Level

The Sound Power of a source is the rate at which it emits acoustic energy. As with Sound Pressure Levels, Sound Power Levels are expressed in decibel units (dB or dBA), but may be identified by the symbols SWL or LW, or by the reference unit 1E-12 W.
The relationship between Sound Power and Sound Pressure may be likened to an electric radiator, which is characterised by a power rating, but has an effect on the surrounding environment that can be measured in terms of a different parameter, temperature.

4 Statistical Noise Levels

Sounds that vary in level over time, such as road traffic noise and most community noise, are commonly described in terms of the statistical exceedance levels L_{AN}, where L_{AN} is the A-weighted sound pressure level exceeded for N% of a given measurement period. For example, the L_{A1} is the noise level exceeded for 1% of the time, L_{A10} the noise exceeded for 10% of the time, and so on.

The following figure presents a hypothetical 15 minute noise survey, illustrating various common statistical indices of interest.



Of particular relevance, are:

- L_{A1} The noise level exceeded for 1% of the 15 minute interval.
- L_{A10} The noise level exceed for 10% of the 15 minute interval. This is commonly referred to as the average maximum noise level.
- L_{A90} The noise level exceeded for 90% of the sample period. This noise level is described as the average minimum background sound level (in the absence of the source under consideration), or simply the background level.
- L_{Aeq} The A-weighted equivalent noise level (basically the average noise level). It is defined as the steady sound level that contains the same amount of acoustical energy as the corresponding time-varying sound.

When dealing with numerous days of statistical noise data, it is sometimes necessary to define the typical noise levels at a given monitoring location for a particular time of day. A standardised method is available for determining these representative levels.

This method produces a level representing the "repeatable minimum" L_{A90} noise level over the daytime and night-time measurement periods, as required by the EPA. In addition the method produces mean or "average" levels representative of the other descriptors (L_{Aeq}, L_{A10}, etc).

5 Tonality

Tonal noise contains one or more prominent tones (ie distinct frequency components), and is normally regarded as more offensive than "broad band" noise.

6 Impulsiveness

An impulsive noise is characterised by one or more short sharp peaks in the time domain, such as occurs during hammering.

7 Frequency Analysis

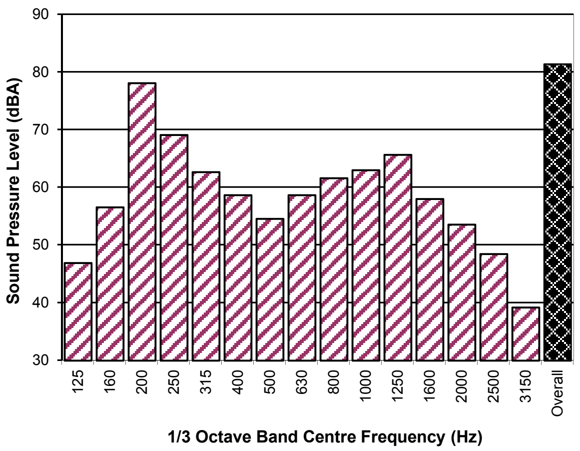
Frequency analysis is the process used to examine the tones (or frequency components) which make up the overall noise or vibration signal. This analysis was traditionally carried out using analogue electronic filters, but is now normally carried out using Fast Fourier Transform (FFT) analysers.

The units for frequency are Hertz (Hz), which represent the number of cycles per second.

Frequency analysis can be in:

- Octave bands (where the centre frequency and width of each band is double the previous band)
- 1/3 octave bands (3 bands in each octave band)
- Narrow band (where the spectrum is divided into 400 or more bands of equal width)

The following figure shows a 1/3 octave band frequency analysis where the noise is dominated by the 200 Hz band. Note that the indicated level of each individual band is less than the overall level, which is the logarithmic sum of the bands.



8 Vibration

Vibration may be defined as cyclic or transient motion. This motion can be measured in terms of its displacement, velocity or acceleration. Most assessments of human response to vibration or the risk of damage to buildings use measurements of vibration velocity. These may be expressed in terms of "peak" velocity or "rms" velocity.

The former is the maximum instantaneous velocity, without any averaging, and is sometimes referred to as "peak particle velocity", or PPV. The latter incorporates "root mean squared" averaging over some defined time period.

Vibration measurements may be carried out in a single axis or alternatively as triaxial measurements. Where triaxial measurements are used, the axes are commonly designated vertical, longitudinal (aligned toward the source) and transverse.

The common units for velocity are millimetres per second (mm/s). As with noise, decibel units can also be used, in which case the reference level should always be stated. A vibration level V, expressed in mm/s can be converted to decibels by the formula 20 log (V/V_o), where V_o is the reference level (1E-6 mm/s). Care is required in this regard, as other reference levels are used by some organizations.

9 Human Perception of Vibration

People are able to "feel" vibration at levels lower than those required to cause even superficial damage to the most susceptible classes of building (even though they may not be disturbed by the motion). An individual's perception of motion or response to vibration depends very strongly on previous experience and expectations, and on other connotations associated with the perceived source of the vibration. For example, the vibration that a person responds to as "normal" in a car, bus or train is considerably higher than what is perceived as "normal" in a shop, office or dwelling.

10 Over-Pressure

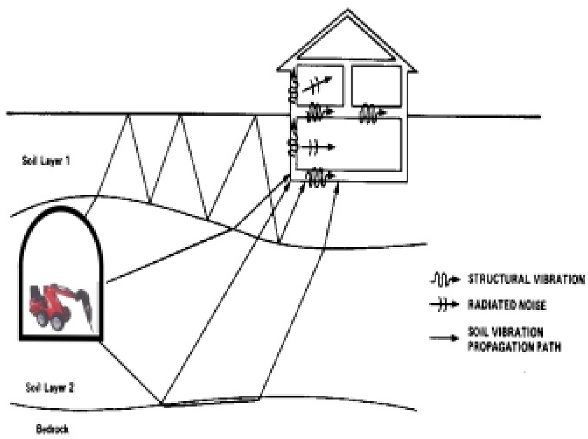
The term "over-pressure" is used to describe the air pressure pulse emitted during blasting or similar events. The peak level of an event is normally measured using a microphone in the same manner as linear noise (ie unweighted), at frequencies both in and below the audible range.

11 Regenerated Noise

Noise that propagates through a structure as vibration and is radiated by vibrating wall and floor surfaces is termed "regenerated noise", "structure-borne noise", or sometimes "ground-borne noise". Regenerated noise originates as vibration and propagates between the source and receiver through the ground and/or building structural elements, rather than through the air.

Typical sources of regenerated noise include tunnelling works, underground railways, excavation plant (eg rockbreakers), and building services plant (eg fans, compressors and generators).

The following figure presents the various paths by which vibration and regenerated noise may be transmitted between a source and receiver for construction activities occurring within a tunnel.



The term "regenerated noise" is also used to describe other types of noise that are emitted from the primary source as a different form of energy. One example would be a fan with a silencer, where the fan is the energy source and primary noise source. The silencer may effectively reduce the fan noise, but some additional noise may be created by the aerodynamic effect of the silencer in the airstream. This "secondary" noise may be referred to as regenerated noise.

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Project No.:	630.02130.00000
Date:	04/10/2013
Drawn by:	KC
Scale:	1:35,000
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Projection:	GDA 1994 MGA Zone 56

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Centennial Coal Mandalong Pty Ltd

Compliance Monitoring Mandalong - Annual

Operator-Attended Noise Monitoring Location

APPENDIX B

18 February 2014

630.02130.00100 LR Blast Monitoring 2013 20131003.docx

Centennial Coal Company Limited
PO Box 100
Toronto NSW 2283

Attention: Jeffrey Dunwoodie

Dear Jeffrey

Blast Monitoring Mandalong Mine February 2013 to August 2013

1 Introduction

SLR Consulting Australia Pty Ltd (SLR) has been engaged by Centennial Coal Company Limited (Centennial) to measure vibration and airblast levels at Mandalong Coal Project Site (Mandalong). Airblast and ground vibration monitoring was conducted from February 2013 to December 2013. This report presents the results of blasting overpressure and ground vibration monitoring.

2 Vibration and Overpressure Criteria

The Office of Environment & Heritage (EOH) recommends that blasting overpressure and ground vibration be assessed in accordance with the Australian and New Zealand Environment Council's (ANZEC) *Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration* (1990).

The ANZEC guideline provides the following recommended criteria in relation to blasting overpressure and ground vibration:

2.1 Airblast

2.1.1 The recommended maximum level for airblast is 115 dB (Lin Peak)

2.1.2 The level of 115 dB may be exceeded on up to 5% of the total number of blasts over a period of 12 months. However, the level should not exceed 120 dB (Lin Peak) at and time.

2.2 Ground Vibration

2.2.1 The recommended maximum level for ground vibration is 5 mm/sec (peak particle velocity (ppv).

2.2.2 The ppv level of 5 mm/sec may be exceeded on up to 5% of the total number of blasts over a period of 12 months. The level should not exceed 10 mm/sec at any time.

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2.2.3 *Experience has shown that for almost all sites a ppv of less than 1 mm/sec is generally achieved. It is recognised that it is not practicable to achieve a ppv of this level at all sites and hence a recommended maximum level of 5 mm/sec has been selected. However, it is recommended that a level of 2 mm/sec (ppv) be considered as the long term regulatory goal for the control of ground vibration.*

Note this is an annoyance criteria and significantly below levels that would cause damage.

3 Monitoring Locations

The monitoring locations and guide values for vibration and overpressure are contained within **Table 1**.

Table 1 Monitoring Locations

Monitoring Location	Guide Values for Vibration Velocity mm/s and Blasting Overpressure dB (Lin peak)	Monitor ID
229 Sauls Road, Mandalong	5 mm/s Ground Vibration	BE 10614
Mandalong Coal Project Site (Approximately 90m from the under ground access portal)	5 mm/s Ground Vibration 115 dB (Lin Peak) Airblast	BE 10608

4 Results

The results summary for blast monitoring conducted on dates and times identified in the dyke shot firing log presented in **Table 2** are contained in **Table 3** and **Table 4**.

Table 2 Dyke Shot Firing Log

Date	Time
20/02/2013	Between 1.00 pm and 3:30 pm
25/02/2013	Between 1.00 pm and 3:30 pm
07/03/2013	Between 1.00 pm and 3:30 pm
06/06/2013	Between 1.00 pm and 3:30 pm
13/06/2013	Between 1.00 pm and 3:30 pm
30/06/2013	Between 1.00 pm and 3:30 pm
01/07/2013	Between 1.00 pm and 3:30 pm
04/07/2013	Between 1.00 pm and 3:30 pm
05/07/2013	Between 1.00 pm and 3:30 pm
08/07/2013	Between 1.00 pm and 3:30 pm
11/07/2013	Between 1.00 pm and 3:30 pm
14/07/2013	Between 1.00 pm and 3:30 pm
22/08/2013	At 9.00 am
26/10/2013	At 11.00am
26/10/2013	At 2.00pm

Table 3 Motoring Results Summary – 229 Sauls Road, Mandalong

Date/Time	Vibration Level				
		Trans.	Vert.	Long.	PVS
20/02/2013 Between 1 pm and 3:30 pm	Peak Particle Velocity (mm/s)	N/A[1]	N/A[1]	N/A[1]	N/A[1]
25/02/2013 Between 1 pm and 3:30 pm	Peak Particle Velocity (mm/s)	N/A[1]	N/A[1]	N/A[1]	N/A[1]
7/03/2013 Between 1 pm and 3:30 pm	Peak Particle Velocity (mm/s)	N/A[1]	N/A[1]	N/A[1]	N/A[1]
6/06/2013 Between 1 pm and 3:30 pm	Peak Particle Velocity (mm/s)	N/A[1]	N/A[1]	N/A[1]	N/A[1]
13/06/2013 Between 1 pm and 3:30 pm	Peak Particle Velocity (mm/s)	N/A[1]	N/A[1]	N/A[1]	N/A[1]
30/06/2013 Between 1 pm and 3:30 pm	Peak Particle Velocity (mm/s)	N/A[1]	N/A[1]	N/A[1]	N/A[1]
1/07/2013 Between 1 pm and 3:30 pm	Peak Particle Velocity (mm/s)	N/A[1]	N/A[1]	N/A[1]	N/A[1]
4/07/2013 Between 1 pm and 3:30 pm	Peak Particle Velocity (mm/s)	N/A[1]	N/A[1]	N/A[1]	N/A[1]
5/07/2013 Between 1 pm and 3:30 pm	Peak Particle Velocity (mm/s)	N/A[1]	N/A[1]	N/A[1]	N/A[1]
8/07/2013 Between 1 pm and 3:30 pm	Peak Particle Velocity (mm/s)	N/A[1]	N/A[1]	N/A[1]	N/A[1]
11/07/2013 Between 1 pm and 3:30 pm	Peak Particle Velocity (mm/s)	N/A[1]	N/A[1]	N/A[1]	N/A[1]
14/07/2013 Between 1 pm and 3:30 pm	Peak Particle Velocity (mm/s)	N/A[1]	N/A[1]	N/A[1]	N/A[1]
22/09/2013 at 9am	Peak Particle Velocity (mm/s)	0.064	0.080	0.064	0.081
26/10/2013 At 11am	Peak Particle Velocity (mm/s)	0.064	0.080	0.064	0.087
26/10/2013 At 2pm	Peak Particle Velocity (mm/s)	0.079	0.079	0.079	0.086

Note: 1. Due to unforeseen circumstances the blast monitoring geo phone cable which connected to the data logger was faulty and valid vibration data was not recorded.

Vibration monitoring results conducted during September and October are consistent with the background vibration levels in the area when blasting did not occur and are well below the relevant criteria presented in **Section 2**. Furthermore SLR has been conducting blast monitoring at the site since November 2011 (refer to SLR previous reports *630.02130.00100 LR November - December 20120109* and *630.02130.00100 LR August - December 20121205*) and the measured vibration levels have always been significally below the vibration level criteria presented in **Section 2.** Hence, it is expected that the levels measured during September and October are representative of the vibration levels that would have been experienced at this location during the time when the blast monitor was not recording.

Table 4 Motoring Results Summary – Mandalong Coal Project Site (portal)

Date/Time	Airblast (dB Lin peak)	Vibration Level				
			Trans.	Vert.	Long.	PVS
20/02/2013 Between 1 pm and 3:30 pm	106 @ >1.8 Hz	Peak Particle Velocity (mm/s)	0.317	0.556	0.921	1.08
25/02/2013 Between 1 pm and 3:30 pm	103 @ 6.4 Hz	Peak Particle Velocity (mm/s)	0.317	0.317	0.286	0.331
7/03/2013 Between 1 pm and 3:30 pm	106 @ <100 Hz	Peak Particle Velocity (mm/s)	0.651	0.794	1.11	1.18
6/06/2013 Between 1 pm and 3:30 pm	115 @ 1.9 Hz	Peak Particle Velocity (mm/s)	N/A[1]	N/A[1]	N/A[1]	N/A[1]
13/06/2013 Between 1 pm and 3:30 pm	115 @ 2.8 Hz	Peak Particle Velocity (mm/s)	N/A[1]	N/A[1]	N/A[1]	N/A[1]
30/06/2013 Between 1 pm and 3:30 pm	110 @ 5.8Hz	Peak Particle Velocity (mm/s)	N/A[1]	N/A[1]	N/A[1]	N/A[1]
1/07/2013 Between 1 pm and 3:30 pm	115 @ 85Hz	Peak Particle Velocity (mm/s)	N/A[1]	N/A[1]	N/A[1]	N/A[1]
4/07/2013 Between 1 pm and 3:30 pm	115 @ 1.3 Hz	Peak Particle Velocity (mm/s)	N/A[1]	N/A[1]	N/A[1]	N/A[1]
5/07/2013 Between 1 pm and 3:30 pm	115 @ 1.4Hz	Peak Particle Velocity (mm/s)	N/A[1]	N/A[1]	N/A[1]	N/A[1]
8/07/2013 Between 1 pm and 3:30 pm	114 @ 1.5Hz	Peak Particle Velocity (mm/s)	N/A[1]	N/A[1]	N/A[1]	N/A[1]
11/07/2013 Between 1 pm and 3:30 pm	114 @ 1.1Hz	Peak Particle Velocity (mm/s)	N/A[1]	N/A[1]	N/A[1]	N/A[1]
14/07/2013 Between 1 pm and 3:30 pm	114 @ 1.1Hz	Peak Particle Velocity (mm/s)	N/A[1]	N/A[1]	N/A[1]	N/A[1]
22/09/2013 at 9am	98.8 @ 6.5Hz	Peak Particle Velocity (mm/s)	0.079	0.079	0.079	0.106
26/10/2013 At 11am	98 @ 5.9Hz	Peak Particle Velocity (mm/s)	0.079	0.079	0.079	0.103
26/10/2013 At 2pm	104 @ 3.4Hz	Peak Particle Velocity (mm/s)	0.079	0.064	0.064	0.094

Note: 1. Due to for unforeseen circumstances the blast monitoring geo phones cable which connected to the minimate was faulty and didn't record valid vibration data.

Vibration monitoring results conducted during February, March, September and October are consistent with the background vibration levels in the area when blasting did not occur and are well below the relevant criteria presented in **Section 2**. Furthermore SLR has been conducting blast monitoring at the site since May 2010 (refer to SLR previous reports 30-2130 30-400 LR May 20100526, 30-2130 30-400 LR May-July 20100809, 630.02130.00100 LR August - October 20101026, 630.02130.00100 LR February - April 20110419, *630.02130.00100 LR November - December 20120109* and *630.02130.00100 LR August - December 20121205*) and the measured vibration levels have always been significantly below the vibration level criteria presented in **Section 2.** Hence, it is expected that the levels measured during June and July are representative of the vibration levels that would have been experienced at this location during the time when the blast monitor was not recording

All blast overpressure monitoring results presented in **Table 4** are at or below the respective limit of 115 dB (Lin peak) at each location monitored. It is also relevant to note that the frequency range for normal hearing is between 20 Hz and 20 kHz.

5 Conclusion

Monitored blasting overpressure and ground vibration levels from blasting conducted at Mandalong mine for the period from February 2013 to December 2013 were found to be:

- Below the 5 mm/s ground vibration guideline at the nearest potentially affected receiver location.
- Below the 115 dB (Lin peak) airblast guideline at the nearest potentially affected receiver location.

If you require any further information on this project please do not hesitate to contact me on phone (02) 4037 3200 or email trobertson@slrconsulting.com.

Regards,

Tristan Robertson
SLR Consulting

APPENDIX 9
Floodpath Condition Report 2013

Centennial Mandalong Mine Floodpath Condition Report 2013

For the Period 1 January 2013 to 31 December 2013

Owned & Operated by Centennial Mandalong
ABN 74101 508 892
(dated February 2014)

Table of Contents

Appendices

DOCUMENT DETAILS	Name:	Mandalong Mine Floodpath Condition Report 2013
	Author:	Morgan Gleeson
	Reference:	
	Revision No.:	
	Document Status	Approved for Submission

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	M Hartwell	EPA	1
	B. Bell	LMCC	1
	M. MacDonald-Hill	MMCCC	4
	J. Trotter	DRE	1

1.0 Induction and Objectives

1.1 Background

Mandalong Mine is owned and operated by Centennial Mandalong ('Centennial Mandalong'), a subsidiary of Centennial Coal Company Limited ('Centennial'). Mandalong Mine is a modern underground longwall operation located in Lake Macquarie, near Morisset west of the Pacific Motorway and is situated in the sub catchment of Mandalong. The Mandalong catchment is locate to the west of Lake Macquarie consisting of alluvial floodplain that contains Stockton and Moran's Creek, draining into Dora Creek. The Mine extends beneath a number of surface features including rural residential properties, an alluvial floodplain and the foot slopes of the Watagan Ranges.

The Mine's development consent requires the condition of major floodpaths in an area subject to a Section 138 approval (superseded by Subsidence Management Plan's (SMP), be inspected every six months or following a flood event. The floodpaths at Mandalong have been identified by the Hughes and Trueman report titled "Flood Study Mandalong Coal Mine" dated December 2004 and are as shown overlying the longwall panels one to fourteen in Figure 1 (Umwelt 2008) of Appendix One. The floodpaths within the current longwall mining area generally consist of ephemeral tributaries draining to Stockton Creek.

Previously the condition of floodpaths and properties on the floodplain were described in the reports submitted to the NSW Office of Water (NOW) titled:-

- "Longwall Panels 1 to 6 Property and Creek Line Pre and Post Mining Assessments" dated November 2006 by International Environmental Consultants Pty Ltd; and
- "Centennial Mandalong Mine Flood Path Condition Report 2007" dated January 2008 by Centennial Mandalong.
- "Centennial Mandalong Mine Flood Path Condition Report 2008" dated January 2009 by Centennial Mandalong.
- "Centennial Mandalong Mine Flood Path Condition Report 2009" dated January 2010 by Centennial Mandalong.
- "Centennial Mandalong Mine Flood Path Condition Report 2010" dated January 2011 by Centennial Mandalong.
- Centennial Mandalong Mine Flood Path Condition Report 2011" dated January 2012 by Centennial Mandalong.
- Centennial Mandalong Mine Flood Path Condition Report 2012" dated January 2013 by Centennial Mandalong.

Following on from the information contained in the above documents, this report compiles survey information and photographic records of floodpath as per methodology in section 2.0.

1.2 Scope

The report assesses the changes to the condition of floodpaths along stream reaches undermined by longwall 14 and 15 in 2013 and previously subsided longwall 1 to 13, identifying the effects of subsidence on the floodpaths. The pre-mining condition of the floodpaths above longwall 15 is also documented in this report.

1.3 Predicated Changes to Streams and Flooding Regime

Longwall 14 and 15 were mined beneath Stockton Creek in 2013. In this area the longwall is mined beneath the middle and upper reaches of Stockton Creek. The creek has a generally poorly defined channel system, in which creek lines give way to undefined overland flow paths in several areas (Hughes Trueman 2004). The channels sections of Stockton Creek in this area have an average channel bed slope of 0.31 % with typical channel widths of 7.5 m to 25 m and typical channel depths of 1.0 m to 2.0m (Hughes Trueman 2004).

The creek meanders considerably through these areas and as such a length of approximately 1100 m and 1300 m was undermined by longwall 14 and 15. The maximum predicted subsidence in the vicinity of Stockton Creek longwall 14 and 15 is approximately 0.3m with a predicted maximum differential subsidence (from the chain pillar to the centre of the longwall) of approximately 0.2m.

The levels of predicted subsidence and associated grade changes along Stockton Creek over proposed Longwalls 14 and 15 are of a similar order of magnitude to the existing creek bed slopes. The levels of predicted subsidence along Stockton Creek are relatively small over proposed Longwalls 14 and 15 and it is therefore considered that these will not significantly alter the flow conveyance capacity of the existing channels. The associated impacts on the maximum flood depths and flood hazards that have been modelled are not considered to be significant. There is minimal potential for channel realignment due to the proposed underground mining of Longwalls 1 to 15. The potential to increase erosion on the landform is expected to be minimal because of the limited amount of exposed soils, high level of groundcover and the relatively low in channel and out of channel velocities.

2.0 Methodology

2.1 Survey Methodology

The assessment methodology comprised of detailed surveys of the floodpath condition within current and planned longwall mining areas with specific attention given to major flood paths including the tributaries and reaches of Stockton Creek and flood prone areas. Field surveys were undertaken on 19th June 2013 and 5th December 2013.

The assessment methodology consisted of surveying subsidence along Stockton Creek to measure vertical subsidence movement as to derive longitudinal grades from the surveys. Stream condition surveys where undertaken at the photographic monitoring points. These monitoring points where sited at the locations shown in Figure MG10687 of Appendix One. The monitoring points are in areas of highest potential differential subsidence, typically above the edges of Maingate roadways, to monitor the effects of subsidence on stream condition and changes in stream grade. Observations on the stream's condition where recorded as presented in Appendix Three at these points including, stream geomorphology, bank height and width, bed condition (where observable), erosion, channel flood brake out, vegetation community and subsidence deformation.

2.2 Impact Assessment

The predicted subsidence related changes to stream channel condition are assessed in the report for each reach above the longwall panels, by using the photographic monitoring points to define the pre-mining channel condition and subsidence induced changes to stream characteristics. The stream grade changes and subsidence effects (i.e. ponded or pooled areas, soil cracking) are assessed to determine if these have resulted in evidence of erosion or significant channel realignment. These changes are then evaluated in relation to relevant trigger conditions contained in the Mine's "Underground Mining Environmental Management Plan" as, shown in **Table 1** below.

Table 1 - Trigger Action Response Plan (TARP) Stream Monitoring

Feature to be Monitored	No Response Required – ongoing monitoring	Anomalous Results	Continued Anomalous Results
Subsidence Monitoring Streams	1. Subsidence results are within predictions. 2. Changes in stream gradients no greater than 1 percent recorded by long-section surveys Continue with routine monitoring	1. Subsidence results area greater than two times predicted. 2. Change in stream gradients greater than 2 percent recorded by long-section surveys. Management Solution Investigate cause of increase subsidence, conduct field inspections on stream condition, review stream water quality and flow data and assesses increase subsidence effect on stream.	1. Subsidence results are greater than three times predicted. 2. Change of stream gradient greater 5 percent recorded by Long-section surveys Potential Engineering Solution Re-grade stream sections to remove remnant ponding and improve water carrying capacity. Fill in cracks on streams

Feature to be Monitored	No Response Required – ongoing monitoring	Anomalous Results	Continued Anomalous Results
			with soil and revegetate where evident. Report effectiveness of stream remediation measures to DNR.
Stream Surveys	No noticeable change in stream bank or bed condition.	1. Subsidence cracking on stream bed or banks greater than 100mm -200mm 2. Evidence of increased in stream water pooling or water loss downstream 3. Unexpected erosion in streams Management Solution Investigate cause of stream deterioration, review subsidence data and long section surveys. Consult with DNR on extent of stream effects. Undertake remediation measures where appropriate, infill cracks with soil and revegetate, control erosion by re-vegetation to stabilise area.	1. Significant subsidence cracking (greater than 200mm) /scouring/erosion or ponding. 2. Significant increase in pooling in streams or loss of water downstream 3. Vegetation die back caused by remnant ponding. Potential Engineering Solution See points 1-7 below. Report effectiveness of stream remediation measures to DNR.

Source: “Underground Mining Environmental Management Plan” (Centennial Mandalong Mine)

3.0 Floodpath Survey Assessment

This section of the report describes the floodpath and stream condition recorded for the longwall mining areas in relation to geomorphic units, subsidence and vegetation characteristics in relation to their position of the stream reach above longwall panels.

3.1 Stockton Creek (Main Tributary) Longwall 14 and 15

3.1.1 Pre-mining Survey Assessment

Monitoring points 50 & 51 (Appendix 4) are located above Maingate 14 and are typical of the stream reach above longwall 15. The reach consists of channel widths 5 -10 m wide. Bank heights of are between 3-5m and a sand to gravel stream bed was observed. Stream flows were minor with pool sequence observed in December 2012. The water quality was moderately turbid. Stockton Creek along this reach has remnant vegetation some 50 to 90 wide either side of the creek banks, consistent with the Coastal Warm Temperate Subtropical Rainforest (MU1a) mapped by Hunter Eco (June 2009).

3.1.2 Post-Mining Survey Assessment

The post mining survey conducted in December 2013 observed minor flows above longwall 14 and 15. The pooled water conditions were similar to the pre mining conditions. The stream conditions where similar to those found in the pre mining survey (2012) with no observable change in channel widths or bank heights above longwall 14. Evidence of subsidence induced soil cracking or additional erosion on the stream's banks or bed were not observed at this monitoring point in 2013. The vegetation communities, Redgum Rough-bark Apple Forest (Hunter Eco 2008) and pasture species remained unchanged following mining.

3.1.3 Impact Assessment

The largest vertical subsidence recorded during the retreat of Longwall 14 was 0.53m measured on Crossline 9 at the intersection of Sauls Rd and Walls Lane, near the commencement end of the panel and the greatest depth of cover. Maximum subsidence over the majority of the panel was between 0.25m and 0.35m. All measured tilts and strains over the longwall panel were low and below SSR criteria for dwellings.

The extraction of Longwall 14 occurred over a period of six months, commencing on the 16 February 2013 and finishing on the 5 August 2013. Longwall 14 had an extraction width of 160m and chain pillars 46m wide, the same as the previous nine panels. The depth of cover was approximately 280m at the commencement of the panel, decreasing to around 230m at the end of the panel. The variation in depth of cover is primarily driven by the surface topography over Longwall 14.

Maximum recorded subsidence for the report period along Stockton Creek over Longwall 14 was 0.38m, being slightly above the maximum predicted. The maximum differential recorded between the centerline of Longwall 14 and Maingate 14 was 0.33m, representing a 0.1% change in grade along the creek. No results were available for Longwall 15 during the report period. During the December flood path inspections there was no evidence of surface cracking, ponding or erosion.

The subsidence and stream grade changes are below the anomalous results triggers in the UMEMP therefore, further stream impact assessment or remedial works are not required. Given the unchanged stream condition recorded following mining and the low subsidence levels on Stockton Creek, it is likely that recent subsidence above Longwall 14 has had minimal adverse impacts to the stream flow conveyance.

3.2 Stockton Creek (Main Tributary) Longwall 12 and 13

3.2.1 Pre-mining Survey Assessment

Monitoring points 46 & 47 presented in Appendix a above Maingate 12 are typical of the stream reach above Longwall 12. The reach consists of channel widths 5 m wide with bank heights of 3-4m and incised between 0.5-1m above the stream bed. The reach consisted of pooled water in July 2011 with no or little water flow prior to mining. Water was observed to be highly turbid in July 2011. The bed characteristic was not observed prior to mining due to pooled water. Stockton Creek along this reach has remnant vegetation 5m wide either side of the creek banks, consistent with the Warm Temperate Subtropical Rainforest (MU1a) mapped by Hunter Eco (June 2009).

Monitoring points 48 & 49 (Appendix 4) are located above Maingate 13 and are typical of the stream reach above Longwall 13. The reach consists of channel widths 5 -10 m wide. Bank heights of are between 3-4m and a sand to gravel stream bed was observed. The banks were observed with some minor erosion possible from feral animals observed in the area. Stream flows were minor with a running pool sequence observed in December 2011. The water quality was moderately turbid. Stockton Creek along this reach has remnant vegetation some 50 to 90 wide either side of the creek banks, consistent with the Coastal Warm Temperate Subtropical Rainforest (MU1a) mapped by Hunter Eco (June 2009).

3.2.2 Post -mining Survey Assessment

The monitoring survey in December 2013 observed minor flows above longwall 12 and 13. The pooled water conditions were similar to the pre mining conditions. The stream conditions where similar to those found in the pre mining survey (2011) with no observable change in channel widths or bank heights above longwall 12 and 13. Evidence of subsidence induced soil cracking or additional erosion on the stream's banks or bed were not observed at this monitoring point in 2013. The vegetation communities, Redgum Rough-bark Apple Forest (Hunter Eco 2008) and pasture species remained unchanged following mining.

3.2.3 Impact Assessment

There has been minimal movement observed over Longwall 12, typically less than 40mm. The maximum subsidence recorded on Stockton Creek was 0.55m in September 2013. This is an increase of 0.1m from 2012 as a result of settlement of Longwall 12 following the extraction of the adjacent Longwall 13 and Longwall 14. The maximum differential subsidence of 0.34m was measured on the creek above the Maingate 11 and the center of the Longwall 12. Maximum change in stream grade of 0.1 % was recorded above Longwall 12. Stockton Creek has average pre-mining stream grades up to 0.31% along these reaches.

Consistent with previous longwalls, the settlement of Longwall 13 has occurred as expected with the extraction of Longwall 14, providing an additional 0.1m to 0.2m subsidence over the chain pillars and maximum subsidence at the centre of the panel.

Maximum subsidence above Longwall 13 was 0.65m recorded in September 2013 and maximum differential subsidence 0.36m was measured between the creek above the Maingate 12 and the center of the Longwall 13. Maximum change in stream grade of 0.6 % was recorded above Longwall 13. Stockton Creek has average pre-mining stream grades up to 0.31% along these reaches. No visible evidence of cracking , erosion or ponding from subsidence was observed during the post-mining surveys in 2013 at this location.

The maximum subsidence levels recorded in 2013 on Longwall 12 to 13 are within the predicted maximums of 0.75m for both panels. Changes in stream grade over Longwall 12 was similar to 2012, while an increase was observed over Longwall 13, resulting in an increase in grade by 0.6% over a relatively short section of the creek (60m). The longest section of the creek (175m) from Maingate 13 to the centre of Longwall 13 resulted in a 0.18% change in grade.

All subsidence and stream grade changes are below the anomalous results triggers in the UMEMP therefore, further stream impact assessment or remedial works are not required. Given the unchanged stream condition recorded following mining and the low subsidence levels on Stockton Creek, it is likely that recent subsidence above Longwall 13 has had minimal adverse impacts to the stream flow conveyance.

3.3 Stockton Creek (Main Tributary) Longwall 11

3.3.1 Pre-mining Survey Assessment

Monitoring point 44 presented in Appendix 4 above Maingate 11 is typical of the stream reach above longwall 11. The channel widths at this point are 10 m wide with banks heights of 2-3 m, incised 1m above the bed. The reach consists of pooled water with no visible flow and highly turbid water observed during the December 2010 inspection. Stream bed characteristics were not observed during the inspection due to the presence of water. Stockton Creek along this reach consists of a 10-20m wide area of Redgum Rough-bark Apple vegetation community, consistent with the vegetation mapped by Hunter Eco (2008). The properties along this reach consist largely of pasture areas used for stock and horse agistment.

3.3.2 Post -mining Survey Assessment

The post-mining surveys in 2011 and 2012 observed minor above longwall panel eleven. High water levels prevented access to point 44 in December 2011. The pooled water conditions are similar to the pre mining conditions. The stream conditions where similar to those found in the pre mining survey (2010) with no observable change in channel widths or bank heights above longwall 11. Evidence of subsidence induced soil cracking or additional erosion on the stream's banks or bed were not observed at this monitoring point in the 2013 monitoring survey. The vegetation communities, Redgum Rough-bark Apple Forest (Hunter Eco 2008) and pasture species remained unchanged.

3.1.3 Impact Assessment

Subsidence monitoring over the major crosslines including annual surveys has shown that subsidence has remained stable in 2013. This included subsidence monitoring along Stockton Creek in July 2013. Maximum subsidence above Longwall 11 was 605 mm recorded in October 2012 and maximum differential subsidence 470 mm was measured on the creek above the Maingate 11 and the center of the longwall. Maximum change in stream grade of 0.18 % was recorded above Longwall 11. Stockton Creek has average pre-mining stream grades up to 0.31% along these reaches. No visible evidence of cracking or erosion from subsidence was observed during the post-mining surveys in 2013.

There was no evidence during the 2013 surveys that subsidence had resulted in bank or bed erosion as, the stream reach above the longwall remained stable and in condition similar to that recorded prior to mining. The changes in stream grade as described, are below the anomalous trigger values in the UMEMP (refer to table 1). Accordingly, ongoing subsidence and field surveys are planned to continue to monitor the condition of Stockton Creek.

Remnant ponding was evident on a Centennial property above Longwall 11 in 2012 and 2013. The ponding is located on an area of Redgum Rough-bark Apple Forest and pasture. To date only minor dieback of the vegetation community has occurred and an ecologist is monitoring the area to assess the effects of ponding on this vegetation community. At present due to limited impact, remediation works are being assessed and may be considered if recommended by the external ecologist.

3.1 Stockton Creek (Main Tributary) Longwall 7 to 10

3.1.1 Pre-mining Survey Assessment

Monitoring points 27 and 35 presented in Appendix 4 above Maingates 7 to 10 are typical of the stream reach above longwall 8 to 10. At points 27 & 29 the channel widths broadening to some 7 to 20 m wide and lower bank heights of 1 – 2 m. Stream banks are incised at points 27 and 28, one metre above the stream bed. The stream bed consists of coarse sands and clays similar to the bed condition along other reaches of Stockton Creek. Point 28 is a small ephemeral tributary draining into the main reach of Stockton Creek. The stream reach above Maingate 8 is monitored at points 30 and 31 consisting of undefined or less than 1 m high banks. The stream reach above longwalls 9 and 10 observed at monitoring Points 41 to 43 (Maingates 9 and 10) consists of a channel with widths 5 to 10 m and low bank heights between 0.5 to 2m.

Vegetation communities above this reach of Stockton Creek were mapped by Hunter Eco (2009) as, Riparian Melaleuca Swamp and Woodland Redgum Rough-bark Apple Forest however; this community is only present as remnant stands along a limited section of creek. The riparian zone has been extensively cleared and predominately consists of exotic grass species and in stream sedges. Stock accessing this stream reach has resulted in some erosion, mainly cattle ruts and bank de-stabilisation along creek sections.

3.1.2 Post -mining Survey Assessment

The post-mining survey observed minor flows in June and high flows in December 2011 above longwall 8 to 10 due to rainfall events at that time (refer to photos of monitoring points 27 to 43 in Appendix 4). The stream conditions where similar to those found in the pre mining survey (December 2009) with no observable change in channel widths or bank heights above longwall 8 to 10. Evidence of subsidence induced soil cracking or additional erosion on the stream's banks or bed were not observed at these monitoring points in 2013.

The vegetation communities, Riparian Melaleuca Swamp and Redgum Rough-bark Apple Forest (Hunter Eco 2008) and pasture species remained unchanged with some regrowth evident in 2013.

3.1.3 Impact Assessment

While there has been no subsidence monitoring along Stockton Creek over Longwalls 1 to 10 during 2013, subsidence monitoring over the major crosslines and centerlines have shown that subsidence has been stable up to Longwall 12. Only minor movements of less than 40mm have been recorded over Longwall 12. The next scheduled survey (2 yearly) over this section of Stockton Creek is due in 2014.

Subsidence above longwall 8 and 9 is stable with 452mm & 439mm recorded in September 2011. Subsidence above longwall 10 in January 2012 was 432mm. Maximum differential subsidence of 209mm, 115mm & 432mm was measured on the creek above the Maingate and the centre of these longwall panels. Maximum change in stream grade 0.163%, 0.112% and 0. 282% were recorded above longwall panels 7, 8 and 9. Stockton Creek has average pre-mining stream grades up to 0.36% along these reaches. No visible evidence of cracking or erosion from subsidence was observed during the post-mining surveys in 2013.

The recorded subsidence levels and stream grade changes described above are unlikely to have resulted in significant changes to stream flow conveyance capacity above longwall 7, 8 and 9 when taking into consideration the average bank heights of up to 0.5 -2 m. There was no evidence during the 2013 surveys that, subsidence had resulted in bank or bed erosion as, the stream reach above these longwall panels remained stable and in condition similar to that recorded prior to mining. The changes in stream grade as described, are below the anomalous trigger values in the UMEMP (refer to table 1), requiring investigations into stream impacts or remedial works. Accordingly ongoing subsidence and field surveys are planned to continue to monitor the condition of Stockton Creek.

Vegetation communities above this reach of Stockton Creek were similarly observed to be unaffected by subsidence with no visible evidence of vegetation die back from ponding. Remnant ponding was evident in the 2013 inspections on the flood plain in a limited area above longwall 7 to 8 situated on an existing low lying area of Centennial property. The area consists of exotic pasture species primarily used for horse grazing.

Centennial Mandalong will undertaken an Investigation to determine whether fencing or drainage is possible for ponding above longwall 7 and 8.

3.2 Stockton Creek (Main Tributary) Longwall 4 to 6.

3.2.1 Pre-mining Survey Assessment

The results of pre-mining surveys undertaken in 2007 above longwall 6 indicate that Stockton creek, along this reach, has stream banks some 5 - 8 m wide with banks heights of 2 - 4 m. The stream condition at monitoring points 1 & 2 as shown in Appendix 4 are typical of baseline conditions for this reach above longwall 6, with vertical to high sloping banks and incised banks one metre from the creek bed. The stream banks pre-mining did not display any significant erosion along this section, although some minor scouring of the incised banks were evident at point one. Stock access along this reach is restricted with little evidence of erosion caused by stock.

A pre-mining survey of longwall 4 and 5 was undertaken in April 2007. The survey indicated that above longwall 5 Stockton Creek is characterised by (monitoring points 4 and 5, Appendix 4) a wider channel between 15-20 m and bank heights of 3-4 m. The bank condition at point 4 is eroded, has incised banks 2 metres from the bank top and is poorly vegetated on the western side. There is evidence of stock accessing the stream along the reach between monitoring points 4 and 5 resulting in stock ruts and bank erosion. The bank condition at monitoring point 5 consists of highly sloping to incised banks, well vegetated to within one metre of the stream bed and has some evidence of erosion upstream caused by stock access.

The pre-mining survey of Stockton Creek above longwall 4 recorded the stream condition at photographic monitoring points 6 and 7 (refer to Appendix 4). The stream along this reach has narrower bank with widths of 8-10 metres and similar bank heights of 2-3 metres. The bank condition along this section is incised one metre from the bed and well vegetated above this level. Pre-mining surveys at monitoring points 6 and 7 found some evidence of limited bank erosion along sections with incised banks.

The floodplain above longwall 6 has been extensively cleared and consists predominately of pasture areas. At monitoring point 3 the stream channel widens to around 10 m consisting of incised banks with heights of 3 m. At this location there is evidence of bank failure prior to mining on the eastern bank likely to be a result of a change in stream flows direction, concentrating flows onto the eastern bank. The stream above longwall 4 and 5 typically forms a pool sequence during low rainfall periods and the stream bed condition is similar to the reach above longwall 6 consisting of coarse sand and gravel. Stock access above longwall 5 is evident along this reach, resulting in cattle ruts and bank erosion. The mapped vegetation community, Redgum Rough-bark Apple Forest (Hunter Eco 2008) is present along this stream section in limited remnant communities.

3.2.2 Post-mining Survey Assessment

As evident in the photos of points 1 and 2 in Appendix 4, the streams condition in June and December 2013 were similar to previous surveys. No change to stream bank or bed condition was evident during the surveys with the exception of point three. Evidence of subsidence induced soil cracking or additional erosion on the stream's banks or bed were not observed at these points. Erosion of the eastern bank of the stream at point three as shown in Appendix 4, identified in the pre-mining surveys continued in 2013 caused by the upstream change in direction of flows. This process is further discussed in Section 3.2.3. This stream reach has been fenced to prevent stock access.

The post-mining surveys conducted in 2009, 2010, 2011, 2012 and 2013 as, shown in the photos of monitoring points 4 to 6, found similar stream conditions to those prior to mining with no observable change in channel widths or bank heights above longwall 4 and 5. Although some limited pre-mining erosion was evident at these points along incised banks, no further bank erosion except for the pre-mining erosion on longwall 6 was evident in the 2013 surveys. No evidence of subsidence induced soil cracking or additional erosion on the stream's banks or bed were observed at these points in 2013.

The vegetation communities, Redgum Rough-bark Apple Forest (Hunter Eco 2008) and pasture species remained unchanged with some limited regrowth observed in 2013. Similar to pre-mining conditions, a high level of groundcover and riparian species were found in 2013 above longwall 4, predominately consisting of pasture and sedge species at monitoring points 6 and 7 (refer to Appendix 4). The presence of riparian species above longwall 4 compared to the fewer recorded species above longwall 5 is largely a result of restricted stock access along this stream reach.

3.2.3 Impact Assessment

The last subsidence monitoring undertaken over this section of Stockton Creek was in May 2011. Other subsidence monitoring has indicated that Longwalls 4 to 6 have remained stable since 2011.

The maximum subsidence recorded in 2011 was 0.82m, 0.64m, & 0.27m at longwall 6, 5 and 4 respectively.. The subsidence levels resulted in maximum changes to stream grades of 0.49%, 0.5%, and 0.02% between the Maingate pillars and the centre of longwall 6, 5 and 4. Stockton Creek has typical pre-mining stream grades up to 0.4 % along this reach. The stream grade and condition changes on Stockton Creek associated with the subsidence recorded on longwall 6 to 4 are all below the anomalous trigger values in the UMEMP (refer to table 1), requiring investigations into stream impacts or remedial works.

The 2013 surveys did not observe evidence of subsidence causing bank erosion or requiring channel realignment as, the stream reach remained stable, with the exception of natural bank erosion observed at point 3 and in similar condition to that recorded prior to mining.

3.3 Stockton Creek (Main Tributary) – Longwall 1 to 3

3.3.1 Pre-mining Survey Assessment

The condition of Stockton Creek was recorded at photographic monitoring point's 7 to 12 as shown in Appendix 4. The pre-mining survey indicates that the reaches of Stockton Creek above these longwall panels are characterised as having a narrower channel between 3-4 m wide and bank heights of 2-3 m. The bank condition is typically well vegetated for the top 2 metres, steeply sloping and incised near the bottom metre towards the stream bed. Along the incised bank there is some evidence of exposed soils with minor erosion. Above the incised banks the stream banks are well vegetated with the mapped vegetation community, Redgum Rough-bark Apple Forest (Hunter Eco 2008) present in limited remnant stands, along this stream section. The floodplain area above longwall 1 to 3 has been extensively cleared and consists primarily of pasture areas.

3.3.2 Post-mining Survey Assessment

The post-mining survey in December 2007 observed high flows in the reaches above longwall 1 to 3 as, recorded by photo monitoring points 8 to 12 (refer to Appendix 4). Further post-mining surveys conducted in 2013 recorded similar stream conditions to those found prior to mining with no observable change in channel widths or bank heights. No evidence of subsidence induced soil cracking or additional erosion on the stream's banks or bed was observed at these points in 2013.

The vegetation communities, Redgum Rough-bark Apple Forest (Hunter Eco 2008) and pasture species remained unchanged following mining in 2013. Similar to pre-mining conditions, a high level of groundcover and riparian species were found in 2013 above longwall 1 to 3, predominately consisting of larger Eucalyptus and sedge species. The restriction of stock along the stream reaches above longwall 1 to 3 and the presence of riparian species on stream banks were observed to have provided relatively undisturbed groundcover thereby, minimising further erosion.

3.3.3 Impact Assessment

The stream condition in 2013 above Longwall 1 to 3 and 6, where stock have been excluded, were in a similar condition to that recorded pre mining. No change to the well-established riparian vegetation was found on stream banks and with no further bank erosion. The 2013 surveys did not find evidence subsidence had caused bank erosion or channel realignment as, the stream reach above longwall 1 to 3 remained stable and in similar condition to that recorded prior to mining. Subsidence monitoring had recorded maximum subsidence levels of 0.2m and 0.23m at crossline 5 and crossline 8 above longwall panel's two to three in 2012. Subsidence from these longwall panels resulted in maximum stream grade change of 0.08 % between the edge of Maingates and the centre longwall. The subsidence, stream grade and condition changes on Stockton Creek above longwall 1, 2 and 3 are all below the anomalous trigger values in the UMEMP, requiring further investigations into stream impacts or remedial works.

3.4 Stockton Creek (Tributary) – Longwall 2 to 6

3.4.1 Pre-mining Survey Assessment

A tributary of Stockton Creek positioned above longwall 2 to 6 as shown in the Plan MG 10687 flows into Stockton Creek. The photographic monitoring points 13 to 20 provide a visual representation of the tributary (Appendix 4). Photographic monitoring point 18 was not surveyed as access was not permitted. The tributary consists of low height banks (0 -1 metres) with some sections giving way to overland flow paths with no defined channel. Typical streams widths of 1-2 m are present on the upstream and downstream sections of the tributary (photographic monitoring points 13, 19 & 20). The stream widens to an undefined channel with a flow path between 20-30 m wide (photographic monitoring points 16, 17 and 18). The tributary is well vegetated and displays little to no erosion along the sections above longwall 2 to 6. Stock access the tributary, however there was little evidence of cattle ruts or erosion channels. Access to the private property to undertake creek surveys above longwall 1 was not granted by the landowners.

3.4.2 Post-mining Survey Assessment

Prior to the June 2007 flood event stream flows were pooled along defined channel sections and dry along low lying tributary sections. Following the June 2007 flood event and December 2007 moderate stream flows were observed for a limited period but these reverted to pools soon after. Some out of bank flows were observed during the June 2007 flood event where the tributary flows beneath Deave's road. As of December 2013 the tributary was well vegetated and displayed little to no erosion along the sections above longwall 2 to 6. Pooled water was observed at the monitoring point locations.

3.4.3 Impact Assessment

Subsidence levels of up to 0.66m above longwall 5 and 6 remained unchanged from the 2009 results. Maximum stream grade changes of up to 0.4 % and 1.5 % resulted on longwall 5 and 6. While these subsidence levels are slightly higher then those measured above the main tributary of Stockton Creek, no evidence of bank erosion or channel realignment was observed from the post mining surveys. The results of surveys and photographic monitoring indicate that, stream grade changes of this order have resulted in little observable changes in stream condition. Some minor remnant ponding was observed above the center of longwall 5 (point 16) in June and December 2013. The subsidence levels, stream grade changes and stream condition were all below the trigger conditions in the UMEP requiring further investigations.

3.5 Stockton Creek (Watagan Foothill Tributary) – Longwall 4 to 6

3.5.1 Pre-mining Survey Assessment

The Watagan Foothill tributary, outside the defined floodpath area and draining into Stockton Creek above longwall 4 to 6, was inspected in June 2007. This tributary terminates above longwall panel six and upstream of this point is defined as a gully feeding into the tributary. Photographic monitoring points 22 to 26 (refer to Appendix 4) recorded the condition of the tributary and dam structures observing little to no flow in the tributary in June and December 2007. The tributary is characterised as pooled with stream banks of less than one metre high and consisting of some exposed soil sections. Large dams constructed on the private properties near the tributary capture flows from the feed gullies. The dams at the time of both surveys were full with minimal free board. The dam walls where free of cracking and the overflow weirs were in a reasonable condition.

3.5.2 Post-mining Survey Assessment

Post mining surveys in June and December 2008 indicate that the dam structures are in similar condition to that recorded prior to mining with no changes to the freeboard or dam wall condition following mining. The tributary does not display any additional erosion and pooling effects following mining. The condition of this tributary and water structures on the private properties remain similar to there pre mining state with little to no mining related changes observed in 2008. No further post mining surveys were conducted in 2011, 2012 or 2013 due to access not being granted by landowners. Subsidence above these longwall panels remains unchanged as reported in 2009.

3.5.3 Impact Assessment

No additional subsidence was recorded above longwall panel's four to six in this area with maximum subsidence levels remaining unchanged at 160 mm and 600. Post mining surveys in 2012 indicate that the dam structure is in similar condition to that recorded prior to mining and the tributary does not display any additional erosion and pooling effects following mining. The only changes to the dam and the drainage line were as a result of the tenant undertaking earthworks in 2012. The levels of subsidence are unlikely to have resulted in significant reduction in the tributary's flow conveyance and dam structures on the tributary have not lost freeboard capacity following mining. No assessment against the triggers in the UMEMP is required as this tributary is located outside of the floodpath area defined in the flood model.

4.0 Discussion

On the basis of the information obtained from field surveys the pre mining characteristics of Stockton Creek and the associated tributary in the mining area, are described as having a deep bed, broad stream sections with some pre mining erosion on bank areas above longwall 4 and 5. Pre-mining stream condition above longwall 7 to 10 has stream widths broadening to some 7 to 20 m wide and low bank heights of 0.5 – 2 m. Surveys in June and December 2013 recorded no evidence of erosion of stream banks along these stream sections.

The subsidence levels above longwall 3 to 6 remained unchanged in 2013. The stream condition in 2013 above longwall 1 to 3 and 6, where stock have been excluded, were in a similar condition to that recorded pre mining. No changes to the well established riparian vegetation was found on stream banks and with no further bank erosion.

The bank widening and erosion process above longwall 4 and 5 in Stockton Creek had been occurring prior to mining and for a considerable length of time prior to mining given the large difference in stream widths compared to other stream sections. This erosion process is unlikely to have been caused by subsidence as the areas of erosion were observed in June 2008 to be a result of the concentrated flows on the opposing bank causing further erosion.

The maximum subsidence levels recorded in 2013 on longwall 11 to 14 are within the predicted range. The changes in stream grade above these is similar to pre-existing grades occurring on Stockton creek. Their is one recorded gradient change, from longwall 13 at 0.6%, which is above the Stockton Creek average pre-mining stream grades up to 0.31% for this reach. The maximum subsidence was within the predicted range and no evidence of impact to the flood plain was observed. All subsidence and stream grade changes are below the anomalous results triggers in the UMEMP therefore, further stream impact assessment or remedial works are not required. Given the unchanged stream condition recorded following mining and the low subsidence levels on Stockton Creek, it is likely that recent subsidence above longwall 13 and 14 has had minimal adverse impacts to the stream flow conveyance.

5.0 References

- Centennial Mandalong Pty Ltd - "Centennial Mandalong Mine Flood Path Condition Report 2007" January 2008.
- Centennial Mandalong Pty Ltd - "Centennial Mandalong Mine Flood Path Condition Report 2008" January 2009.
- Centennial Mandalong Pty Ltd - "Centennial Mandalong Mine Flood Path Condition Report 2009" dated January 2010 by Centennial Coal.
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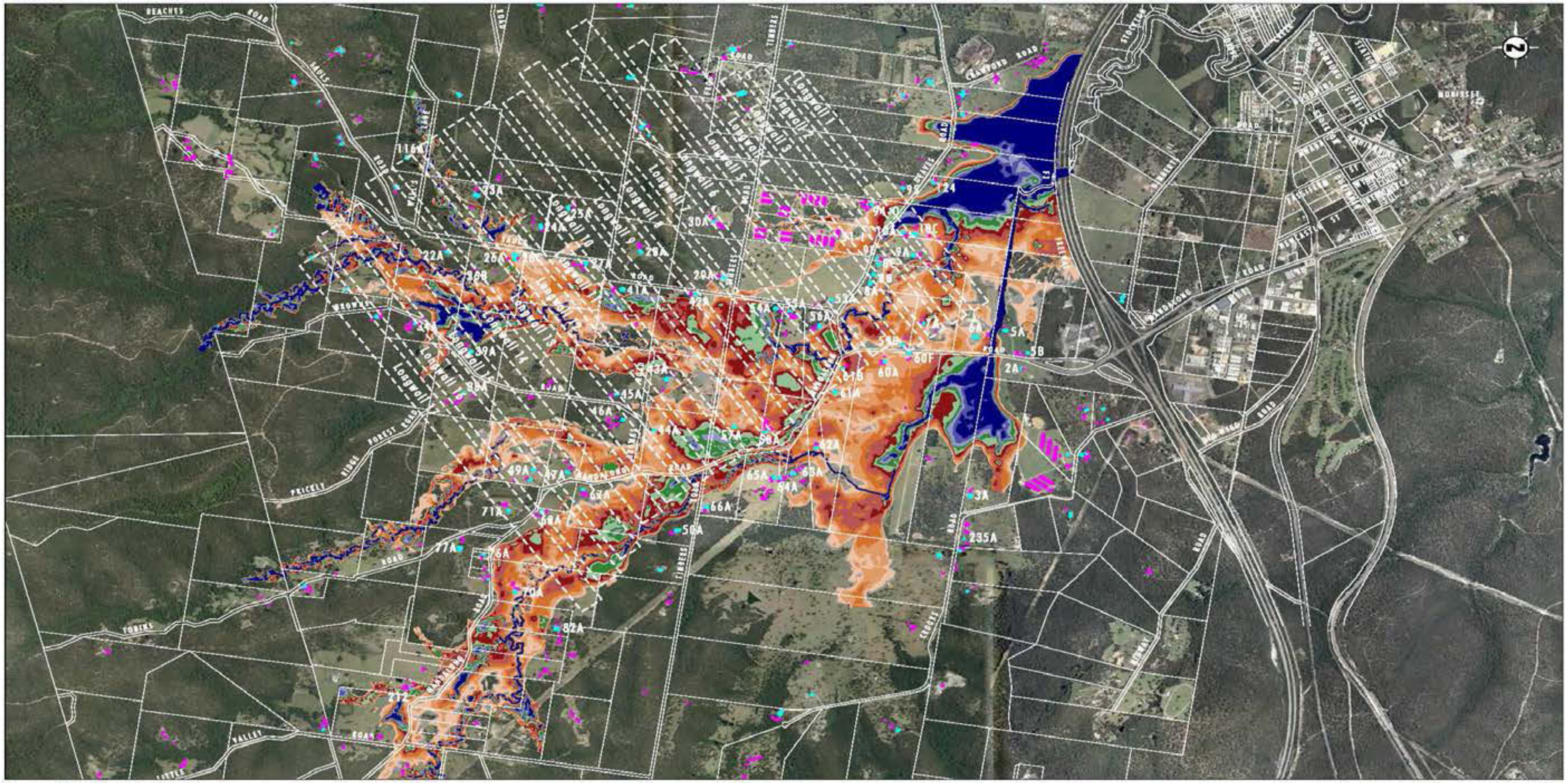
- Centennial Mandalong Pty Ltd - "Centennial Mandalong Mine Flood Path Condition Report 2012" January 2013.
- Hughes and Trueman Pty Ltd – "Flood Study Mandalong Coal Mine" dated December 2004.
- Hunter Eco – "Centennial Coal Mandalong Mine Longwall 11-14 SMP Ecology Assessment"; dated June 2009.
- International Environmental Consultants Pty Ltd - "Longwall Panels 1 to 6 Property and Creek Line Pre and Post Mining Assessments" November 2006.
- Umwelt Australia Pty Ltd – "Flood Modelling and Hazard Assessment Reporting Longwall Panel One to Nine" August 2007.
- Umwelt Australia Pty Ltd – "Flood Modelling and Hazard Assessment Reporting Longwall Panel One to Fourteen" May 2009.
- Umwelt Australia Pty Ltd – "Flood Modelling and Hazard Assessment Reporting Longwall Panel 15 to 17 Feb 2012.

APPENDIX 3 -
Figure 1.1 100 year ARI storm event – maximum flood depths pre mining landform & Photographic Location Points (Plan MG10687)

Umwelt



Source: LPI - Cadastral Boundaries

0 0.5 1 1.25km
1:25 000 (A3)

Legend

- Longwall Locations
- Dwelling
- Other Structure
- Cadastral Boundary

Water Depth (m)

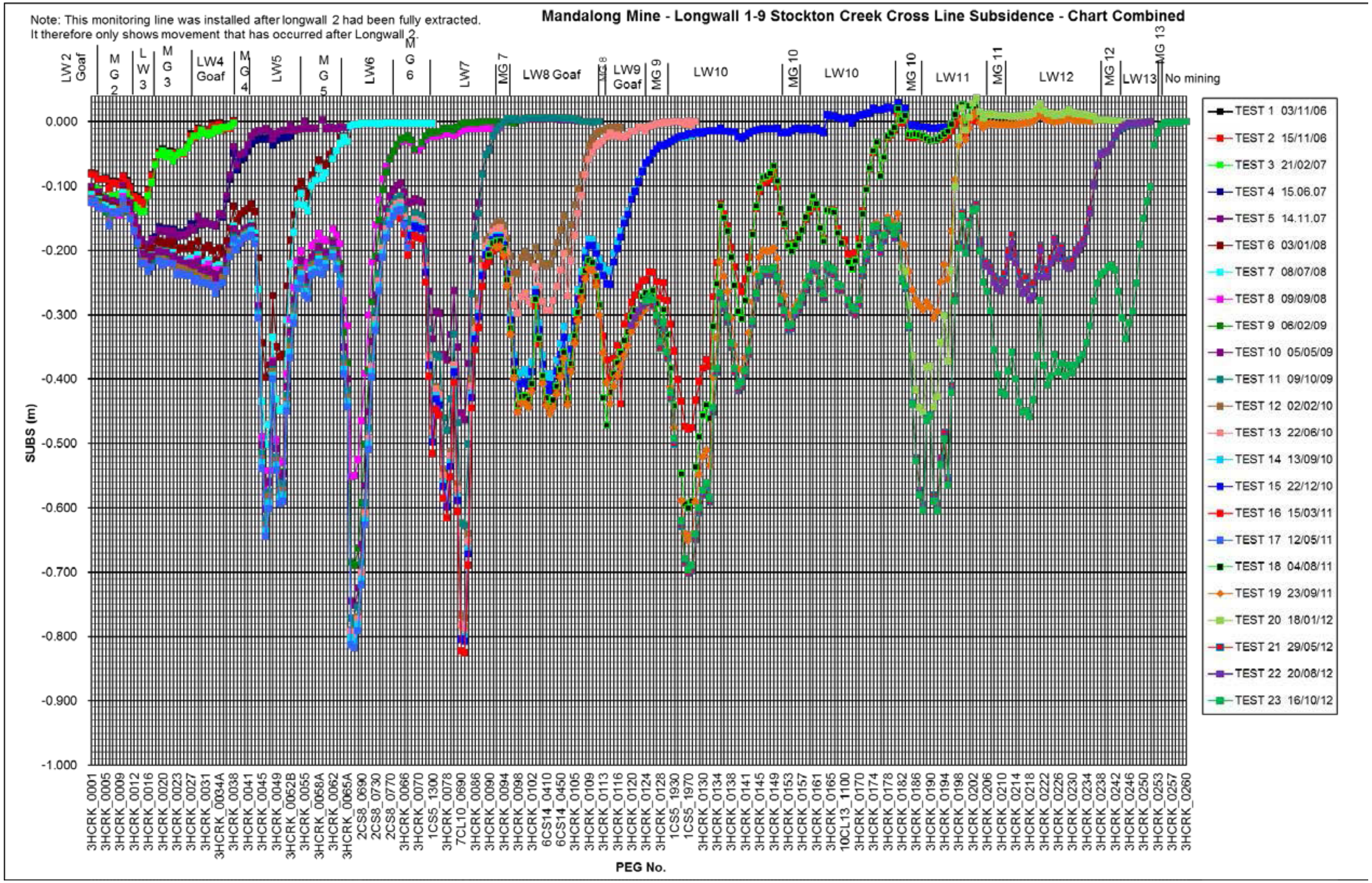
- Range [0.001 : 0.100]
- Range [0.100 : 0.300]
- Range [0.300 : 0.500]
- Range [0.500 : 0.700]
- Range [0.700 : 0.900]
- Range [0.900 : 1.100]
- Range [1.100 : 1.300]
- Range [1.300 : 1.500]
- Range [1.500 : 1.700]
- Range [1.700 : 1.900]
- Range [>1.900]

FIGURE 1

100 year ARI Storm Event: Maximum Flood Depth, Pre Mining Landform Extent of Mandalong Valley

File Name (A3): R01/3000_001.dgn
20111122 9.33

APPENDIX 4
Stockton Creek Subsidence Monitoring Line


Note: This monitoring line was installed after longwall 2 had been fully extracted.
It therefore only shows movement that has occurred after Longwall 2.
Mandalong Mine - Longwall 1-9 Stockton Creek Cross Line Subsidence - Chart Combined
LW 2 Goaf
MG 2
LW 3
MG 3
LW4 Goaf
MG 4
LW5
MG 5
LW6
MG 6
LW7
MG 7
LW8 Goaf
MG 8
LW9 Goaf
MG 9
LW10
MG 10
LW10
MG 10
LW11
MG 11
LW12
MG 12
LW13
MG 13
No mining
SUBS (m)
PEG No.
TEST 1 03/11/06
TEST 2 15/11/06
TEST 3 21/02/07
TEST 4 15.06.07
TEST 5 14.11.07
TEST 6 03/01/08
TEST 7 08/07/08
TEST 8 09/09/08
TEST 9 06/02/09
TEST 10 05/05/09
TEST 11 09/10/09
TEST 12 02/02/10
TEST 13 22/06/10
TEST 14 13/09/10
TEST 15 22/12/10
TEST 16 15/03/11
TEST 17 12/05/11
TEST 18 04/08/11
TEST 19 23/09/11
TEST 20 18/01/12
TEST 21 29/05/12
TEST 22 20/08/12
TEST 23 16/10/12

Appendix 5
Floodpath Condition Record

Photographic Monitoring Point	Survey Coordinates	Position above Longwalls	Drainage Path Description	Survey Date	Drainage Path Description	Visual Water Quality/Flow	Flood Brake Out	Pooling	Erosion	Subsidence Cracking	Soil Cracking	Veg Cover (%)
1	354964, 6334427	MG6 1 heading	Stockton Crk (South Arm)	30/04/07	Stockton Crk (Main Reach)	Visibly turbid/no flow	none	Pool	None	NA-no subsidence	None	90
1	354964, 6334427	MG6 1 heading	Stockton Crk (South Arm)	10/12/07	Stockton Crk (Main Reach)	Visibly turbid/high flow	none	Glide	None	NA-no subsidence	None	90
1	354964, 6334427	MG6 1 heading	Stockton Crk (South Arm)	09/06/08	Stockton Crk (Main Reach)	Clear No Flow	none	Pool	None	NA-no subsidence	None	90
1	354964, 6334427	MG6 1 heading	Stockton Crk (South Arm)	10/12/08	Stockton Crk (Main Reach)	Clear - Trickle flow	none	Pool	None	None	None	90
1	354964, 6334427	MG6 1 heading	Stockton Crk (South Arm)	16/06/09	Stockton Crk (Main Reach)	Clear - Trickle flow	none	Pool	None	None	None	90
1	354964, 6334427	MG6 1 heading	Stockton Crk (South Arm)	09/12/09	Stockton Crk (Main Reach)	No flow	none	Pool	None	None	None	90
1	354964, 6334427	MG6 1 heading	Stockton Crk (South Arm)	28/06/10	Stockton Crk (Main Reach)	No flow	none	Pool	None	None	None	90
1	354964, 6334427	MG6 1 heading	Stockton Crk (South Arm)	06/07/11	Stockton Crk (Main Reach)	visibly turbid/minor flow	none	run	none	none	none	90
1	354964, 6334427	MG6 1 heading	Stockton Crk (South Arm)	07/12/11	Stockton Crk (Main Reach)	visibly turbid/minor flow	none	run	none	none	none	90
1	354964, 6334427	MG6 1 heading	Stockton Crk (South Arm)	28/6/12	Stockton Crk (Main Reach)	Turbid / low flow	none	Pool	none	none	none	90
1	354964, 6334427	MG6 1 heading	Stockton Crk (South Arm)	17/12/12	Stockton Crk (Main Reach)	Turbid / low flow	none	Pool	none	none	none	100
1	354964, 6334427	MG6 1 heading	Stockton Crk (South Arm)	19/06/13	Stockton Crk (Main Reach)	Turbid / slow	none	Pool	None	none	none	90
1	354964, 6334427	MG6 1 heading	Stockton Crk (South Arm)	5/12/13	Stockton Crk (Main Reach)	Slight Turbid / slow	none	Pool	None	none	none	100

2	355018, 6334409	MG6 2 hd	Stockton Crk (South Arm)	30/04/07	Stockton Crk (Main Reach)	Visibly turbid/no flow	Yes	Pool	None	NA-no subsidence	None	95
2	355018, 6334409	MG6 2 hd	Stockton Crk (South Arm)	10/12/07	Stockton Crk (Main Reach)	Visibly turbid/high flow	Yes	Glide	None	NA-no subsidence	None	95
2	355018, 6334409	MG6 2 hd	Stockton Crk (South Arm)	09/06/08	Stockton Crk (Main Reach)	Visibly turbid/no flow	none	Pool	South Bank - Incised 2 m from bed	NA-no subsidence	None	90
2	355018, 6334409	MG6 2 hd	Stockton Crk (South Arm)	10/12/08	Stockton Crk (Main Reach)	Clear - Trickle flow	none	Pool	South Bank - Incised 2 m from bed	None	None	90
2	355018, 6334409	MG6 2 hd	Stockton Crk (South Arm)	16/06/09	Stockton Crk (Main Reach)	Clear - Trickle flow	none	Pool	South Bank - Incised 2 m from bed	None	None	90
2	355018, 6334409	MG6 2 hd	Stockton Crk (South Arm)	09/12/09	Stockton Crk (Main Reach)	No flow	none	Pool	South Bank - Incised 2 m from bed	None	None	90
2	355018, 6334409	MG6 2 hd	Stockton Crk (South Arm)	28/06/10	Stockton Crk (Main Reach)	No flow	none	pool	South Bank - Incised 2 m from bed	None	None	90
2	355018, 6334409	MG6 2 hd	Stockton Crk (South Arm)	07/12/10	Stockton Crk (Main Reach)	Minor flow	none	run	South Bank - Incised 2 m from bed	None	None	90
2	355018, 6334410	MG6 2 hd	Stockton Crk (South Arm)	06/07/11	Stockton Crk (Main Reach)	visibly turbid/minor flow	none	run	South Bank - Incised 2 m from bed	None	None	90
2	355018, 6334411	MG6 2 hd	Stockton Crk (South Arm)	07/12/11	Stockton Crk (Main Reach)	visibly turbid/minor flow	none	run	South Bank - Incised 2 m from bed	None	None	90
2	355018, 6334411	MG6 2 hd	Stockton Crk (South Arm)	28/6/12	Stockton Crk (Main Reach)	Turbid/lowflow	none	Pooled	South Bank - Incised 2 m from bed	None	None	90
2	355018, 6334411	MG6 2 hd	Stockton Crk (South Arm)	17/12/12	Stockton Crk (Main Reach)	Turbid / No flow	none	Pooled	South Bank - Incised 2 m from bed	None	None	100
2	355018, 6334411	MG6 2 hd	Stockton Crk (South Arm)	19/06/13	Stockton Crk (Main Reach)	Turbid / low flow	none	pooled	none	none	none	90
2	355018, 6334411	MG6 2 hd	Stockton Crk (South Arm)	5/12/13	Stockton Crk (Main Reach)	Slightly Turbid / low flow	none	pooled	none	none	none	95

3	355095, 6334552	MG5 1 hd	Stockton Crk (South Arm)	30/04/07	Stockton Crk (Main Reach)	Visibly turbid/no flow	Yes West Bank	Pooled	Yes- East Bank	NA-no subsidence	None	95
3	355095, 6334552	MG5 1 hd	Stockton Crk (South Arm)	14/06/07	Stockton Crk (Main Reach)	Visibly turbid/high flow	Yes West Bank	Run	Yes- East Bank	NA-no subsidence	None	95
3	355095, 6334552	MG5 1 hd	Stockton Crk (South Arm)	10/12/07	Stockton Crk (Main Reach)	Visibly turbid/high flow	Yes West Bank	Run	Yes- East Bank	NA-no subsidence	None	95
3	355095, 6334552	MG5 1 hd	Stockton Crk (South Arm)	09/06/08	Stockton Crk (Main Reach)	Visibly turbid/moderate flow	none	Run	Yes- East Bank	NA-no subsidence	None	80
3	355095, 6334552	MG5 1 hd	Stockton Crk (South Arm)	10/12/08	Stockton Crk (Main Reach)	Clear - Trickle flow	none	Pool	Yes- East Bank	None	None	80
3	355095, 6334552	MG5 1 hd	Stockton Crk (South Arm)	16/06/09	Stockton Crk (Main Reach)	Clear - Trickle flow	none	Pool	Yes- East Bank	None	None	80
3	355095, 6334552	MG5 1 hd	Stockton Crk (South Arm)	09/12/09	Stockton Crk (Main Reach)	No flow	none	Pool	Yes- East Bank	None	None	80
3	355095, 6334552	MG5 1 hd	Stockton Crk (South Arm)	28/06/10	Stockton Crk (Main Reach)	No flow	none	Pool	Yes- East Bank	None	None	80
3	355095, 6334552	MG5 1 hd	Stockton Crk (South Arm)	07/12/10	Stockton Crk (Main Reach)	Minor flow	none	Pool	Yes- East Bank	None	None	80
3	355095, 6334552	MG5 1 hd	Stockton Crk (South Arm)	06/07/11	Stockton Crk (Main Reach)	Minor flow	none	Pool	Yes- East Bank	None	None	80
3	355095, 6334552	MG5 1 hd	Stockton Crk (South Arm)	28/6/12	Stockton Crk (Main Reach)	Turbid / low flow	none	Pool	Yes – East bank	None	None	80
3	355095, 6334552	MG5 1 hd	Stockton Crk (South Arm)	17/12/12	Stockton Crk (Main Reach)	Clear – No flow	none	Pool	Yes – East bank	None	None	75
3	355095, 6334552	MG5 1 hd	Stockton Crk (South Arm)	19/06/13	Stockton Crk (Main Reach)	Turbid – low flow	None	Pool	Yes – East bank	None	None	75
3	355095, 6334552	MG5 1 hd	Stockton Crk (South Arm)	5/12/13	Stockton Crk (Main Reach)	Slightly Turbid – low flow	None	Pool	Yes – East bank	None	None	50
4	355095, 6334553	MG5 2hg	Stockton Crk (South Arm)	07/12/11	Stockton Crk (Main Reach)	Minor flow	none	Pool	Yes- East Bank	None	None	80
4	355076, 6334700	MG5 2hg	Stockton Crk (South Arm)	30/04/07	Stockton Crk (Main Reach)	Visibly turbid/no flow	Yes flood channel U/S	Pooled	Yes- Erosion on incised 2m from Bank Top	None	None	90

4	355076, 6334700	MG5 2hg	Stockton Crk (South Arm)	16/06/07	Stockton Crk (Main Reach)	Visibly turbid/high flow	Yes flood channel U/S	run	Yes- Erosion on incised 2m from Bank Top	None	None	90
4	355076, 6334700	MG5 2hg	Stockton Crk (South Arm)	10/12/07	Stockton Crk (Main Reach)	Visibly turbid/no flow	Yes flood channel U/S	run	Yes- Erosion on incised 2m from Bank Top	None	None	90
4	355076, 6334700	MG5 2hg	Stockton Crk (South Arm)	09/06/08	Stockton Crk (Main Reach)	Visibly turbid/moderate flow	Yes flood channel U/S	run	Yes- Erosion on incised 2m from Bank Top	None	None	80
4	355076, 6334700	MG5 2hg	Stockton Crk (South Arm)	10/12/08	Stockton Crk (Main Reach)	Visibly turbid/no flow	Yes flood channel U/S	pooled	Yes- Erosion on incised 2m from Bank Top	None	None	90
4	355076, 6334700	MG5 2hg	Stockton Crk (South Arm)	16/06/09	Stockton Crk (Main Reach)	Visibly turbid/no flow	Yes flood channel U/S	pooled	Yes- Erosion on incised 2m from Bank Top	None	None	90
4	355076, 6334700	MG5 2hg	Stockton Crk (South Arm)	09/12/09	Stockton Crk (Main Reach)	No flow	Yes flood channel U/S	pooled	Yes- Erosion on incised 2m from Bank Top	None	None	90
4	355076, 6334700	MG5 2hg	Stockton Crk (South Arm)	28/06/10	Stockton Crk (Main Reach)	No flow	Yes flood channel U/S	pooled	Yes- Erosion on incised 2m from Bank Top	None	None	90
4	355076, 6334700	MG5 2hg	Stockton Crk (South Arm)	07/12/10	Stockton Crk (Main Reach)	Visibly turbid/no flow	Yes flood channel U/S	pooled	Yes- Erosion on incised 2m from Bank Top	None	None	90
4	355076, 6334701	MG5 2hg	Stockton Crk (South Arm)	06/07/11	Stockton Crk (Main Reach)	visibly turbid/minor flow	Yes flood channel U/S	pooled	Yes- Erosion on incised 2m from Bank Top	None	None	90
4	355076, 6334701	MG5 2hg	Stockton Crk (South Arm)	28/6/12	Stockton Crk (Main Reach)	Clear/no flow	Yes flood channel U/S	pooled	Yes- Erosion on incised 2m from Bank Top	None	None	90
4	355076, 6334701	MG5 2hg	Stockton Crk (South Arm)	17/12/12	Stockton Crk (Main Reach)	Clear/no flow	Yes flood channel U/S	pooled	Yes- Erosion on incised 2m from Bank Top	None	None	100

4	355076, 6334701	MG5 2hg	Stockton Crk (South Arm)	19/06/13	Stockton Crk (Main Reach)	Turbid – slow	None	Pooled	Yes- Erosion on incised 2m from Bank Top	None	None	90
4	355076, 6334701	MG5 2hg	Stockton Crk (South Arm)	5/12/13	Stockton Crk (Main Reach)	Turbid – slow	None	Pooled	No	None	None	90
5	355076, 6334701	MG5 2hg	Stockton Crk (South Arm)	07/12/11	Stockton Crk (Main Reach)	visibly turbid/minor flow	Yes flood channel U/S	pooled	Yes- Erosion on incised 2m from Bank Top	None	None	90
5	355225, 6334723	MG4 1 hd	Stockton Crk (South Arm)	30/04/07	Stockton Crk (Main Reach)	Visibly turbid/no flow	Yes flood channel U/S	Pooled	Yes- Major erosion (cattle access) U/S	None	None	75
5	355225, 6334723	MG4 1 hd	Stockton Crk (South Arm)	14/06/07	Stockton Crk (Main Reach)	Visibly turbid/high flow	Yes flood channel U/S	run	Yes- Major erosion (cattle access) U/S	None	None	75
5	355225, 6334723	MG4 1 hd	Stockton Crk (South Arm)	10/12/07	Stockton Crk (Main Reach)	Visibly turbid/high flow	Yes flood channel U/S	run	Yes- Major erosion (cattle access) U/S	None	None	80
5	355225, 6334723	MG4 1 hd	Stockton Crk (South Arm)	09/06/08	Stockton Crk (Main Reach)	Visibly turbid/moderate flow	Yes flood channel U/S	run	Yes- Major erosion (cattle access) U/S	None	None	80
5	355225, 6334723	MG4 1 hd	Stockton Crk (South Arm)	10/12/08	Stockton Crk (Main Reach)	Visibly turbid/no flow	Yes flood channel U/S	pooled	Yes- Major erosion (cattle access) U/S	None	None	90
5	355225, 6334723	MG4 1 hd	Stockton Crk (South Arm)	16/06/09	Stockton Crk (Main Reach)	Visibly turbid/no flow	Yes flood channel U/S	pooled	Yes- Major erosion (cattle access) U/S	None	None	90
5	355225, 6334723	MG4 1 hd	Stockton Crk (South Arm)	09/12/09	Stockton Crk (Main Reach)	Dry	Yes flood channel U/S	pooled	Yes- Major erosion (cattle access) U/S	None	None	90
5	355225, 6334723	MG4 1 hd	Stockton Crk (South Arm)	28/06/10	Stockton Crk (Main Reach)	Dry	Yes flood channel U/S	pooled	Yes- Major erosion (cattle access) U/S	None	None	90
5	355225, 6334723	MG4 1 hd	Stockton Crk (South Arm)	07/12/10	Stockton Crk (Main Reach)	visibly turbid/minor flow	Yes flood channel U/S	pooled	Yes- Major erosion (cattle access) U/S	None	None	90

5	355225, 6334724	MG4 1 hd	Stockton Crk (South Arm)	06/07/11	Stockton Crk (Main Reach)	visibly turbid/minor flow	Yes flood channel U/S	run	Yes- Major erosion (cattle access) U/S	None	None	90
5	355225, 6334724	MG4 1 hd	Stockton Crk (South Arm)	07/12/11	Stockton Crk (Main Reach)	visibly turbid/moderate flow	Yes flood channel U/S	run	Yes- Major erosion (cattle access) U/S	None	None	90
5	355225, 6334724	MG4 1 hd	Stockton Crk (South Arm)	28/6/12	Stockton Crk (Main Reach)	Turbid / low flow	Yes flood channel U/S	pooled	Yes- Major erosion (cattle access) U/S	None	None	90
5	355225, 6334724	MG4 1 hd	Stockton Crk (South Arm)	17/12/12	Stockton Crk (Main Reach)	Clear / no flow	Yes flood channel U/S	pooled	Yes- Major erosion (cattle access) U/S	None	None	80
5	355225, 6334724	MG4 1 hd	Stockton Crk (South Arm)	19/06/13	Stockton Crk (Main Reach)	Turbidity light, low flow	None	Pooled	Yes- (cattle access) U/S	None	None	80
5	355225, 6334724	MG4 1 hd	Stockton Crk (South Arm)	5/12/13	Stockton Crk (Main Reach)	Turbid, low flow	None	Pooled	None	None	None	90
6	355308, 6334724	MG4 2 hd	Stockton Crk (South Arm)	30/04/07	Stockton Crk (Main Reach)	Visibly turbid/no flow	Yes U/S flood Shute	Pooled	None	None	None	90
6	355308, 6334724	MG4 2 hd	Stockton Crk (South Arm)	14/06/07	Stockton Crk (Main Reach)	Visibly turbid/high flow	Yes U/S flood Shute	Pooled	None	None	None	90
6	355308, 6334724	MG4 2 hd	Stockton Crk (South Arm)	10/12/07	Stockton Crk (Main Reach)	Visibly turbid/high flow	Yes U/S flood Shute	Pooled	None	None	None	90
6	355308, 6334724	MG4 2 hd	Stockton Crk (South Arm)	09/06/08	Stockton Crk (Main Reach)	Visibly turbid/moderate flow	Yes U/S flood Shute	Pooled	None	None	None	95
6	355308, 6334724	MG4 2 hd	Stockton Crk (South Arm)	10/12/08	Stockton Crk (Main Reach)	Visibly turbid/no flow	Yes U/S flood Shute	Pooled	None	None	None	90
6	355308, 6334724	MG4 2 hd	Stockton Crk (South Arm)	16/06/09	Stockton Crk (Main Reach)	Visibly turbid/no flow	Yes U/S flood Shute	Pooled	None	None	None	90
6	355308, 6334724	MG4 2 hd	Stockton Crk (South Arm)	09/12/09	Stockton Crk (Main Reach)	dry	Yes U/S flood Shute	Pooled	None	None	None	90
6	355308, 6334724	MG4 2 hd	Stockton Crk (South Arm)	28/06/10	Stockton Crk (Main Reach)	dry	Yes U/S flood Shute	Pooled	None	None	None	90
6	355308, 6334724	MG4 2 hd	Stockton Crk (South Arm)	07/12/10	Stockton Crk (Main Reach)	Visibly turbid/no flow	Yes U/S flood Shute	Pooled				

6	355308, 6334724	MG4 2 hd	Stockton Crk (South Arm)	06/07/11	Stockton Crk (Main Reach)	visibly turbid/minor flow	Yes U/S flood Shute	Pooled				
6	355308, 6334724	MG4 2 hd	Stockton Crk (South Arm)	07/12/11	Stockton Crk (Main Reach)	visibly turbid/moderate flow	Yes U/S flood Shute	Pooled				
6	355308, 6334724	MG4 2 hd	Stockton Crk (South Arm)	28/6/12	Stockton Crk (Main Reach)	Turbid / low	Yes U/S flood Shute	Pooled	None	None	None	95
6	355308, 6334724	MG4 2 hd	Stockton Crk (South Arm)	17/12/12	Stockton Crk (Main Reach)	Clear /no flow	Yes U/S flood Shute	Pooled	None	None	None	90
6	355308, 6334724	MG4 2 hd	Stockton Crk (South Arm)	19/06/13	Stockton Crk (Main Reach)	Light turbidity, low flow	None	None	None	None	None	90
6	355308, 6334724	MG4 2 hd	Stockton Crk (South Arm)	5/12/13	Stockton Crk (Main Reach)	turbid, low flow	None	Pooled	None	None	None	90
7	355364, 6334826	MG3 1 hd	Stockton Crk (South Arm)	30/04/07	Stockton Crk (Main Reach)	Visibly turbid/no flow	none	pooled	None - Bank Incised 1 m from bed	None	None	90
7	355364, 6334826	MG3 1 hd	Stockton Crk (South Arm)	10/12/07	Stockton Crk (Main Reach)	Visibly turbid/high flow	none	pooled	None - Bank Incised 1 m from bed	None	None	90
7	355364, 6334826	MG3 1 hd	Stockton Crk (South Arm)	09/06/08	Stockton Crk (Main Reach)	Visibly turbid/no flow	none	pooled	None - Bank Incised 1 m from bed	None	None	90
7	355364, 6334826	MG3 1 hd	Stockton Crk (South Arm)	10/12/08	Stockton Crk (Main Reach)	Visibly turbid/no flow	none	pooled	None - Bank Incised 1 m from bed	None	None	90
7	355364, 6334826	MG3 1 hd	Stockton Crk (South Arm)	16/06/09	Stockton Crk (Main Reach)	Visibly turbid/no flow	none	pooled	None - Bank Incised 1 m from bed	None	None	90
7	355364, 6334826	MG3 1 hd	Stockton Crk (South Arm)	09/12/09	Stockton Crk (Main Reach)	Visibly turbid/no flow	none	pooled	None - Bank Incised 1 m from bed	None	None	90
7	355364, 6334826	MG3 1 hd	Stockton Crk (South Arm)	28/06/10	Stockton Crk (Main Reach)	Visibly turbid/no flow	none	pooled	None - Bank Incised 1 m from bed	None	None	90

7	355364, 6334826	MG3 1 hd	Stockton Crk (South Arm)	07/12/10	Stockton Crk (Main Reach)	Visibly turbid/no flow	none	pooled	None - Bank Incised 1 m from bed	None	None	90
7	355364, 6334826	MG3 1 hd	Stockton Crk (South Arm)	06/07/11	Stockton Crk (Main Reach)	visibly turbid/minor flow	none	pooled	None - Bank Incised 1 m from bed	None	None	90
7	355364, 6334826	MG3 1 hd	Stockton Crk (South Arm)	07/12/11	Stockton Crk (Main Reach)	visibly turbid/moderate flow	none	pooled	None - Bank Incised 1 m from bed	None	None	90
7	355364, 6334826	MG3 1 hd	Stockton Crk (South Arm)	28/6/12	Stockton Crk (Main Reach)	Turbid / low flow	none	pooled	None - Bank Incised 1 m from bed	None	None	90
7	355364, 6334826	MG3 1 hd	Stockton Crk (South Arm)	17/12/12	Stockton Crk (Main Reach)	Clear / no flow	none	pooled	None - Bank Incised 1 m from bed	None	None	90
7	355364, 6334826	MG3 1 hd	Stockton Crk (South Arm)	19/06/13	Stockton Crk (Main Reach)	Light turbidity, low flow	none	Pooled	None	None	None	90
7	355364, 6334826	MG3 1 hd	Stockton Crk (South Arm)	5/12/13	Stockton Crk (Main Reach)	turbid, low flow	none	Pooled	None	None	None	90
8	355356, 6334943	MG 3 2 hd	Stockton Crk (South Arm)	30/04/07	Stockton Crk (Main Reach)	Visibly turbid/no flow	none	Pooled	None	None	None	95
8	355356, 6334943	MG 3 2 hd	Stockton Crk (South Arm)	10/12/07	Stockton Crk (Main Reach)	Visibly turbid/high flow	none	Pooled	None	None	None	95
8	355356, 6334943	MG 3 2 hd	Stockton Crk (South Arm)	10/12/08	Stockton Crk (Main Reach)	Visibly turbid/high flow	none	Pooled	None	None	None	95
8	355356, 6334943	MG 3 2 hd	Stockton Crk (South Arm)	16/06/09	Stockton Crk (Main Reach)	Visibly turbid/no flow	none	Pooled	None	None	None	95
8	355356, 6334943	MG 3 2 hd	Stockton Crk (South Arm)	09/12/09	Stockton Crk (Main Reach)	Visibly turbid/no flow	none	Pooled	None	None	None	95
8	355356, 6334943	MG 3 2 hd	Stockton Crk (South Arm)	28/06/10	Stockton Crk (Main Reach)	Visibly turbid/no flow	none	Pooled	None	None	None	95

8	355356, 6334943	MG 3 2 hd	Stockton Crk (South Arm)	07/12/10	Stockton Crk (Main Reach)	Visibly turbid/no flow	none	Pooled	None	None	None	90
8	355356, 6334943	MG 3 2 hd	Stockton Crk (South Arm)	06/07/11	Stockton Crk (Main Reach)	visibly turbid/minor flow	none	Pooled	None	None	None	90
8	355356, 6334943	MG 3 2 hd	Stockton Crk (South Arm)	07/12/11	Stockton Crk (Main Reach)	Visibly turbid/no flow	none	Pooled	None	None	None	90
8	355356, 6334943	MG 3 2 hd	Stockton Crk (South Arm)	28/6/12	Stockton Crk (Main Reach)	Turbid / low flow	none	Pooled	None	None	None	90
8	355356, 6334943	MG 3 2 hd	Stockton Crk (South Arm)	17/12/12	Stockton Crk (Main Reach)	Turbid / no flow	none	Pooled	None	None	None	90
8	355356, 6334943	MG 3 2 hd	Stockton Crk (South Arm)	19/06/13	Stockton Crk (Main Reach)	Light Turbidity / low flow	none	Pooled	None	None	None	100
8	355356, 6334943	MG 3 2 hd	Stockton Crk (South Arm)	5/12/13	Stockton Crk (Main Reach)	Turbid / low flow	none	Pooled	None	None	None	100
9	355444, 6335029	MG2 1 hd	Stockton Crk (South Arm)	30/04/07	Stockton Crk (Main Reach)	Visibly turbid/no flow	none	Pooled	Minor at base of bank	None	None	95
9	355444, 6335029	MG2 1 hd	Stockton Crk (South Arm)	14/10/07	Stockton Crk (Main Reach)	Visibly turbid/high flow	none	Pooled	Minor at base of bank	None	None	95
9	355444, 6335029	MG2 1 hd	Stockton Crk (South Arm)	10/12/07	Stockton Crk (Main Reach)	Visibly turbid/high flow	none	Pooled	Minor at base of bank	None	None	95
9	355444, 6335029	MG2 1 hd	Stockton Crk (South Arm)	10/12/08	Stockton Crk (Main Reach)	Visibly turbid/high flow	none	Pooled	Minor at base of bank	None	None	95
9	355444, 6335029	MG2 1 hd	Stockton Crk (South Arm)	16/06/09	Stockton Crk (Main Reach)	Visibly turbid/no flow	none	Pooled	Minor at base of bank	None	None	95
9	355444, 6335029	MG2 1 hd	Stockton Crk (South Arm)	09/12/09	Stockton Crk (Main Reach)	Visibly turbid/no flow	none	Pooled	Minor at base of bank	None	None	95
9	355444, 6335029	MG2 1 hd	Stockton Crk (South Arm)	28/06/10	Stockton Crk (Main Reach)	Visibly turbid/no flow	none	Pooled	Minor at base of bank	None	None	95

9	355444, 6335029	MG2 1 hd	Stockton Crk (South Arm)	07/12/10	Stockton Crk (Main Reach)	Visibly turbid/minor flow	none	Pooled	Minor at base of bank	None	None	95
9	355444, 6335029	MG2 1 hd	Stockton Crk (South Arm)	06/07/11	Stockton Crk (Main Reach)	visibly turbid/minor flow	none	Pooled	Minor at base of bank	None	None	95
9	355444, 6335029	MG2 1 hd	Stockton Crk (South Arm)	07/12/11	Stockton Crk (Main Reach)	visibly turbid/moderate flow	none	Pooled	Minor at base of bank	None	None	95
9	355444, 6335029	MG2 1 hd	Stockton Crk (South Arm)	28/6/12	Stockton Crk (Main Reach)	Turbid / low	none	Pooled	Minor at base of bank	None	None	100
9	355444, 6335029	MG2 1 hd	Stockton Crk (South Arm)	17/12/12	Stockton Crk (Main Reach)	Turbid / no flow	none	Pooled	Minor at base of bank	None	None	100
9	355444, 6335029	MG2 1 hd	Stockton Crk (South Arm)	19/06/13	Stockton Crk (Main Reach)	Turbid / no flow	none	Pooled	None	None	None	100
9	355444, 6335029	MG2 1 hd	Stockton Crk (South Arm)	5/12/13	Stockton Crk (Main Reach)	Turbid / low flow	none	Pooled	None	None	None	80
10	355466, 6335047	MG 2 2hd	Stockton Crk (South Arm)	30/04/07	Stockton Crk (Main Reach)	Visibly turbid/no flow	none	Pooled	Minor at base of bank	None	None	95
10	355466, 6335047	MG 2 2hd	Stockton Crk (South Arm)	11/12/08	Stockton Crk (Main Reach)	Visibly turbid/high flow	none	Pooled	Minor at base of bank	None	None	95
10	355466, 6335047	MG 2 2hd	Stockton Crk (South Arm)	16/06/09	Stockton Crk (Main Reach)	Visibly turbid/no flow	none	Pooled	Minor at base of bank	None	None	95
10	355466, 6335047	MG 2 2hd	Stockton Crk (South Arm)	09/12/09	Stockton Crk (Main Reach)	Visibly turbid/no flow	none	Pooled	Minor at base of bank	None	None	95
10	355466, 6335047	MG 2 2hd	Stockton Crk (South Arm)	28/06/10	Stockton Crk (Main Reach)	Visibly turbid/no flow	none	Pooled	Minor at base of bank	None	None	95
10	355466, 6335047	MG 2 2hd	Stockton Crk (South Arm)	07/12/10	Stockton Crk (Main Reach)	Visibly turbid/minor flow	none	Pooled	Minor at base of bank	None	None	95
10	355466, 6335047	MG 2 2hd	Stockton Crk (South Arm)	06/07/11	Stockton Crk (Main Reach)	visibly turbid/minor flow	none	Pooled	Minor at base of bank	None	None	95
10	355466, 6335047	MG 2 2hd	Stockton Crk (South Arm)	07/12/11	Stockton Crk (Main Reach)	visibly turbid/moderate flow	none	Pooled	Minor at base of bank	None	None	95
10	355466, 6335047	MG 2 2hd	Stockton Crk (South Arm)	28/6/12	Stockton Crk (Main Reach)	Turbid / low flow	none	Pooled	Minor at base of bank	None	None	90

10	355466, 6335047	MG 2 2hd	Stockton Crk (South Arm)	17/12/12	Stockton Crk (Main Reach)	Turbid / no flow	none	Pooled	Minor at base of bank	None	None	100
10	355466, 6335047	MG 2 2hd	Stockton Crk (South Arm)	19/06/13	Stockton Crk (Main Reach)	Turbid / no flow	none	Pooled	None	None	None	100
10	355466, 6335047	MG 2 2hd	Stockton Crk (South Arm)	5/12/13	Stockton Crk (Main Reach)	Turbid / low flow	none	Pooled	None	None	None	90
11	355587, 6335080	MG1 1hd	Stockton Crk (South Arm)	30/04/07	Stockton Crk (Main Reach)	Visibly turbid/no flow	None	Pooled	Minor on North Bank	None	None	90
11	355587, 6335080	MG1 1hd	Stockton Crk (South Arm)	10/12/07	Stockton Crk (Main Reach)	Visibly turbid/high flow	None	Pooled	Minor on North Bank	None	None	90
11	355587, 6335080	MG1 1hd	Stockton Crk (South Arm)	10/12/08	Stockton Crk (Main Reach)	Visibly turbid/high flow	None	Pooled	Minor on North Bank	None	None	90
11	355587, 6335080	MG1 1hd	Stockton Crk (South Arm)	10/12/08	Stockton Crk (Main Reach)	Visibly turbid/high flow	None	Pooled	Minor on North Bank	None	None	90
11	355587, 6335080	MG1 1hd	Stockton Crk (South Arm)	16/06/09	Stockton Crk (Main Reach)	Visibly turbid/no flow	None	Pooled	Minor on North Bank	None	None	90
11	355587, 6335080	MG1 1hd	Stockton Crk (South Arm)	09/12/09	Stockton Crk (Main Reach)	No flow	None	Pooled	Minor on North Bank	None	None	90
11	355587, 6335080	MG1 1hd	Stockton Crk (South Arm)	28/06/10	Stockton Crk (Main Reach)	Visibly turbid/no flow	None	Pooled	Minor on North Bank	None	None	90
11	355587, 6335080	MG1 1hd	Stockton Crk (South Arm)	07/12/10	Stockton Crk (Main Reach)	Visibly turbid/no flow	None	running	Minor on North Bank	None	None	95
11	355587, 6335080	MG1 1hd	Stockton Crk (South Arm)	06/07/11	Stockton Crk (Main Reach)	visibly turbid/minor flow	None	running	Minor on North Bank	None	None	95
11	355587, 6335080	MG1 1hd	Stockton Crk (South Arm)	07/12/11	Stockton Crk (Main Reach)	visibly turbid/moderate flow	None	running	Minor on North Bank	None	None	95
11	355587, 6335080	MG1 1hd	Stockton Crk (South Arm)	28/6/12	Stockton Crk (Main Reach)	Turbid / low flow	None	Pooled	Minor on North Bank	None	None	90
11	355587, 6335080	MG1 1hd	Stockton Crk (South Arm)	17/12/12	Stockton Crk (Main Reach)	Turbid / low flow	None	Pooled	Minor on North Bank	None	None	100
11	355587, 6335080	MG1 1hd	Stockton Crk (South Arm)	19/06/13	Stockton Crk (Main Reach)	Turbid / no flow	None	Pooled	None	None	None	100
11	355587, 6335080	MG1 1hd	Stockton Crk (South Arm)	5/12/13	Stockton Crk (Main Reach)	Turbid / low flow	None	Pooled	None	None	None	90

12	355712, 6335200	Flank	Stockton Crk (South Arm)	30/04/07	Stockton Crk (Main Reach)	Visibly turbid/no flow	None	Pooled	Minor on North Bank	None	None	90
12	355712, 6335200	Flank	Stockton Crk (South Arm)	14/06/07	Stockton Crk (Main Reach)	Visibly turbid/high flow	Yes d/s.	Pooled	No immediate erosion. Some d/s.	None	None	80
12	355712, 6335200	Flank	Constructed Drainage Ln- (U/S Stockton Crk (Mid Arm))	11/12/07	Stockton Crk (Main Reach)	Visibly turbid/high flow	Yes overflow	Pooled	Minor erosion (cattle)	NA (no subsidence)	None	90
12	355712, 6335200	Flank	Constructed Drainage Ln- (U/S Stockton Crk (Mid Arm))	11/12/08	Stockton Crk (Main Reach)	Visibly turbid/high flow	Yes overflow	Pooled	Minor erosion (cattle)	NA (no subsidence)	None	90
12	355712, 6335200	Flank	Constructed Drainage Ln- (U/S Stockton Crk (Mid Arm))	16/06/09	Stockton Crk (Main Reach)	Visibly turbid/no flow	Yes overflow	Pooled	Minor erosion (cattle)	NA (no subsidence)	None	90
12	355712, 6335200	Flank	Constructed Drainage Ln- (U/S Stockton Crk (Mid Arm))	09/12/09	Stockton Crk (Main Reach)	Visibly turbid/no flow	Yes overflow	Pooled	Minor erosion (cattle)	NA (no subsidence)	None	90
12	355712, 6335200	Flank	Natural Drainage Line (Stockton Creek)	28/06/10	Stockton Crk (Main Reach)	Visibly turbid/no flow	Yes overflow	Pooled	Minor erosion (cattle)	None	None	100
12	355712, 6335200	Flank	Natural Drainage Line Stockton Creek	07/12/10	Stockton Crk (Main Reach)	Visibly turbid/no flow	Yes overflow	Pooled	Minor erosion (cattle)	None	None	95
12	355712, 6335200	Flank	Natural Drainage Line (Stockton Creek)	06/12/11	Stockton Crk (Main Reach)	visibly turbid/minor flow	Yes overflow	Pooled	none	None	None	100
12	355712, 6335200	Flank	Natural Drainage Line (Stockton Creek)	07/12/11	Stockton Crk (Main Reach)	visibly turbid/moderate flow	Yes overflow	Pooled	none	None	None	100
12	355712, 6335200	Flank	Natural Drainage Line	28/6/12	Stockton Crk (Main Reach)	visibly turbid/minor flow	Yes overflow	Pooled	none	None	None	90

			(Stockton Creek)									
12	355712, 6335200	Flank	Natural Drainage Line (Stockton Creek)	17/12/12	Stockton Crk (Main Reach)	visibly turbid/ no flow	Yes overflow	Pooled	none	None	None	80
12	355712, 6335200	Flank	Natural Drainage Line (Stockton Creek)	19/06/13	Stockton Crk (Main Reach)	turbid/ no flow	None	Pooled	none	None	None	90
12	355712, 6335200	Flank	Natural Drainage Line (Stockton Creek)	5/12/13	Stockton Crk (Main Reach)	turbid/ low flow	None	Pooled	Erosion (cattle)	None	None	70
13	354634, 6334936	MG6, 2hd	Drainage Ln- (U/S Stockton Crk (Mid Arm))	30/04/07	Stockton Crk (Tributary)	Visibly turbid/no flow	Yes overflow	Pooled	Minor erosion (cattle)	NA (no subsidence)	None	90
13	354634, 6334936	MG6, 2hd	Drainage Ln- (U/S Stockton Crk (Mid Arm))	11/12/07	Stockton Crk (Tributary)	Visibly turbid/high flow	Yes overflow	Pooled	Minor erosion (cattle)	NA (no subsidence)	None	90
13	354634, 6334936	MG6, 2hd	Drainage Ln- (U/S Stockton Crk (Mid Arm))	11/12/08	Stockton Crk (Tributary)	Visibly turbid/high flow	Yes overflow	Pooled	Minor erosion (cattle)	none	None	90
13	354634, 6334936	MG6, 2hd	Drainage Ln- (U/S Stockton Crk (Mid Arm))	16/06/09	Stockton Crk (Tributary)	Visibly turbid/no flow	Yes overflow	Pooled	Minor erosion (cattle)	none	None	90
13	354634, 6334936	MG6, 2hd	Drainage Ln- (U/S Stockton Crk (Mid Arm))	09/12/09	Stockton Crk (Tributary)	Dry	Yes overflow	Pooled	Minor erosion (cattle)	none	None	90
13	354634, 6334936	MG6, 2hd	Drainage Ln- (U/S Stockton Crk (Mid Arm))	28/06/10	Stockton Crk (Tributary)	Dry	Yes overflow	Pooled	Minor erosion (cattle)	none	None	90
13	354634, 6334936	MG6, 2hd	Drainage Ln- (U/S Stockton Crk (Mid Arm))	07/12/10	Stockton Crk (Tributary)	Visibly turbid/no flow	Yes overflow	Pooled	Minor erosion (cattle)	none	None	90
13	354634, 6334936	MG6, 2hd	Drainage Ln- (U/S Stockton Crk (Mid Arm))	06/07/11	Stockton Crk (Tributary)	Visibly turbid/no flow	Yes overflow	Pooled	Minor erosion (cattle)	none	None	90

13	354634, 6334936	MG6, 2hd	Drainage Ln- (U/S Stockton Crk (Mid Arm))	07/12/11	Stockton Crk (Tributary)	visibly turbid/minor flow	Yes overflow	Pooled	Minor erosion (cattle)	none	None	90
13	354634, 6334936	MG6, 2hd	Drainage Ln- (U/S Stockton Crk (Mid Arm))	28/6/12	Stockton Crk (Tributary)	visibly turbid/minor flow	Yes overflow	Pooled	Minor erosion (cattle)	none	None	90
13	354634, 6334936	MG6, 2hd	Drainage Ln- (U/S Stockton Crk (Mid Arm))	17/12/12	Stockton Crk (Tributary)	visibly turbid/no flow	Yes overflow	Pooled	Minor erosion (cattle)	none	None	100
13	354634, 6334936	MG6, 2hd	Drainage Ln- (U/S Stockton Crk (Mid Arm))	19/06/13	Stockton Crk (Tributary)	Clear /no flow	None	Pooled	None	none	None	100
13	354634, 6334936	MG6, 2hd	Drainage Ln- (U/S Stockton Crk (Mid Arm))	5/12/13	Stockton Crk (Tributary)	no flow	None	None	None	None	None	100
14	354763, 6335022	MG5, 1hd	Drainage Ln- (U/S Stockton Crk (Mid Arm))	30/04/07	Stockton Crk (Tributary)	Visibly turbid/no flow	Yes overflow	Pooled	Minor erosion (cattle)	None	None	90
14	354763, 6335022	MG5, 1hd	Drainage Ln- (U/S Stockton Crk (Mid Arm))	14/12/07	Stockton Crk (Tributary)	Visibly turbid/high flow	Yes overflow	Pooled	Minor erosion (cattle)	None	None	90
14	354763, 6335022	MG5, 1hd	Drainage Ln- (U/S Stockton Crk (Mid Arm))	11/12/07	Stockton Crk (Tributary)	Visibly turbid/high flow	Yes overflow	Pooled	Minor erosion (cattle)	None	None	90
14	354763, 6335022	MG5, 1hd	Drainage Ln- (U/S Stockton Crk (Mid Arm))	11/12/08	Stockton Crk (Tributary)	Visibly turbid/high flow	Yes overflow	Pooled	Minor erosion (cattle)	None	None	90
14	354763, 6335022	MG5, 1hd	Drainage Ln- (U/S Stockton Crk (Mid Arm))	16/06/09	Stockton Crk (Tributary)	Visibly turbid/no flow	Yes overflow	Pooled	Minor erosion (cattle)	None	None	90
14	354763, 6335022	MG5, 1hd	Drainage Ln- (U/S Stockton Crk (Mid Arm))	09/12/09	Stockton Crk (Tributary)	Dry	Yes overflow	Pooled	Minor erosion (cattle)	None	None	90
14	354763, 6335022	MG5, 1hd	Drainage Ln- (U/S Stockton Crk (Mid Arm))	28/06/10	Stockton Crk (Tributary)	Dry	Yes overflow	Pooled	Minor erosion (cattle)	None	None	90
14	354763, 6335022	MG5, 1hd	Drainage Ln- (U/S Stockton Crk (Mid Arm))	07/12/10	Stockton Crk (Tributary)	Visibly turbid/no flow	Yes overflow	Pooled	Minor erosion (cattle)	None	None	100

14	354763, 6335022	MG5, 1hd	Drainage Ln- (U/S Stockton Crk (Mid Arm))	06/07/11	Stockton Crk (Tributary)	Visibly turbid/no flow	Yes overflow	Pooled	Minor erosion (cattle)	None	None	80
14	354763, 6335022	MG5, 1hd	Drainage Ln- (U/S Stockton Crk (Mid Arm))	07/12/11	Stockton Crk (Tributary)	Visibly turbid/no flow	Yes overflow	Pooled	Minor erosion (cattle)	None	None	100
14	354763, 6335022	MG5, 1hd	Drainage Ln- (U/S Stockton Crk (Mid Arm))	28/6/12	Stockton Crk (Tributary)	Visibly turbid/no flow	Yes overflow	Pooled	Minor erosion (cattle)	None	None	100
14	354763, 6335022	MG5, 1hd	Drainage Ln- (U/S Stockton Crk (Mid Arm))	17/12/12	Stockton Crk (Tributary)	Dry	Yes overflow	No	Minor erosion (cattle)	None	None	50
14	354763, 6335022	MG5, 1hd	Drainage Ln- (U/S Stockton Crk (Mid Arm))	19/06/13	Stockton Crk (Tributary)	Clear / No flow	None	pooled	None	None	None	100
14	354763, 6335022	MG5, 1hd	Drainage Ln- (U/S Stockton Crk (Mid Arm))	5/12/13	Stockton Crk (Tributary)	Slightly turbid / No flow	None	pooled	None	None	None	100
15	354826, 6335019	MG5, 2hd	Drainage Ln- (U/S Stockton Crk (Mid Arm))	30/04/07	Stockton Crk (Tributary)	Visibly turbid/no flow	Yes overflow	Pooled	Minor erosion (cattle)	None	None	90
15	354826, 6335019	MG5, 2hd	Drainage Ln- (U/S Stockton Crk (Mid Arm))	14/12/07	Stockton Crk (Tributary)	Visibly turbid/high flow	Yes overflow	Pooled	Minor erosion (cattle)	None	None	90
15	354826, 6335019	MG5, 2hd	Drainage Ln- (U/S Stockton Crk (Mid Arm))	11/12/07	Stockton Crk (Tributary)	Visibly turbid/high flow	Yes overflow	Pooled	Minor erosion (cattle)	None	None	90
15	354826, 6335019	MG5, 2hd	Drainage Ln- (U/S Stockton Crk (Mid Arm))	11/12/08	Stockton Crk (Tributary)	Visibly turbid/high flow	Yes overflow	Pooled	Minor erosion (cattle)	None	None	90
15	354826, 6335019	MG5, 2hd	Drainage Ln- (U/S Stockton Crk (Mid Arm))	16/06/09	Stockton Crk (Tributary)	Visibly turbid/no flow	Yes overflow	Pooled	Minor erosion (cattle)	None	None	90
15	354826, 6335019	MG5, 2hd	Drainage Ln- (U/S Stockton Crk (Mid Arm))	09/12/09	Stockton Crk (Tributary)	dry	Yes overflow	Pooled	Minor erosion (cattle)	None	None	90
15	354826, 6335019	MG5, 2hd	Drainage Ln- (U/S Stockton Crk (Mid Arm))	28/06/10	Stockton Crk (Tributary)	dry	Yes overflow	Pooled	Minor erosion (cattle)	None	None	90

15	354826, 6335019	MG5, 2hd	Drainage Ln- (U/S Stockton Crk (Mid Arm))	06/07/11	Stockton Crk (Tributary)	Visibly turbid/no flow	Yes overflow	Pooled	Minor erosion (cattle)	None	None	90
15	354826, 6335019	MG5, 2hd	Drainage Ln- (U/S Stockton Crk (Mid Arm))	07/12/11	Stockton Crk (Tributary)	Visibly turbid/no flow	Yes overflow	Pooled	Minor erosion (cattle)	None	None	90
15	354826, 6335019	MG5, 2hd	Drainage Ln- (U/S Stockton Crk (Mid Arm))	28/6/12	Stockton Crk (Tributary)	Visibly turbid/no flow	Yes overflow	Pooled	Minor erosion (cattle)	None	None	90
15	354826, 6335019	MG5, 2hd	Drainage Ln- (U/S Stockton Crk (Mid Arm))	17/12/12	Stockton Crk (Tributary)	Dan turbid	Yes overflow	Pooled	Minor erosion (cattle) & earthworks	None	None	50
15	354826, 6335019	MG5, 2hd	Drainage Ln- (U/S Stockton Crk (Mid Arm))	19/06/13	Stockton Crk (Tributary)	Clear / no flow	None	Pooled	Yes, dam wall	None	None	75
15	354826, 6335019	MG5, 2hd	Drainage Ln- (U/S Stockton Crk (Mid Arm))	5/12/13	Stockton Crk (Tributary)	no flow	None	Pooled	None	None	None	100
16	354894, 6335072	LW 5 Centre Ln	Drainage Ln- (U/S Stockton Crk (Mid Arm))	30/04/07	Stockton Crk (Tributary)	Visibly turbid/no flow	Yes overflow	Pooled	Minor erosion (cattle)	None	None	90
16	354894, 6335072	LW 5 Centre Ln	Drainage Ln- (U/S Stockton Crk (Mid Arm))	11/12/07	Stockton Crk (Tributary)	Visibly turbid/high flow	Yes overflow	Pooled	Minor erosion (cattle)	None	None	90
16	354894, 6335072	LW 5 Centre Ln	Drainage Ln- (U/S Stockton Crk (Mid Arm))	11/12/08	Stockton Crk (Tributary)	Visibly turbid/high flow	Yes overflow	Pooled	Minor erosion (cattle)	None	None	90
16	354894, 6335072	LW 5 Centre Ln	Drainage Ln- (U/S Stockton Crk (Mid Arm))	16/06/09	Stockton Crk (Tributary)	dry	Yes overflow	Pooled	Minor erosion (cattle)	None	None	90
16	354894, 6335072	LW 5 Centre Ln	Drainage Ln- (U/S Stockton Crk (Mid Arm))	09/12/09	Stockton Crk (Tributary)	dry	Yes overflow	Pooled	Minor erosion (cattle)	None	None	90
16	354894, 6335072	LW 5 Centre Ln	Drainage Ln- (U/S Stockton Crk (Mid Arm))	28/06/10	Stockton Crk (Tributary)	dry	Yes overflow	Pooled	Minor erosion (cattle)	None	None	90
16	354894, 6335072	LW 5 Centre Ln	Drainage Ln- (U/S Stockton Crk (Mid Arm))	07/12/10	Stockton Crk (Tributary)	dry	Yes overflow	Pooled	Minor erosion (cattle)	None	None	90

16	354894, 6335072	LW 5 Centre Ln	Drainage Ln- (U/S Stockton Crk (Mid Arm))	06/07/11	Stockton Crk (Tributary)	Visibly turbid/no flow	Yes overflow	Pooled	Minor erosion (cattle)	None	None	85
16	354894, 6335072	LW 5 Centre Ln	Drainage Ln- (U/S Stockton Crk (Mid Arm))	07/12/11	Stockton Crk (Tributary)	Visibly turbid/no flow	Yes overflow	Pooled	None	None	None	90
16	354894, 6335072	LW 5 Centre Ln	Drainage Ln- (U/S Stockton Crk (Mid Arm))	28/6/12	Stockton Crk (Tributary)	No water	Yes overflow	No	None	None	None	90
16	354894, 6335072	LW 5 Centre Ln	Drainage Ln- (U/S Stockton Crk (Mid Arm))	17/12/12	Stockton Crk (Tributary)	No water	Yes overflow	No	None	None	None	80
16	354894, 6335072	LW 5 Centre Ln	Drainage Ln- (U/S Stockton Crk (Mid Arm))	19/06/13	Stockton Crk (Tributary)	Clear, no flow	None	Pooled	None	None	None	100
16	354894, 6335072	LW 5 Centre Ln	Drainage Ln- (U/S Stockton Crk (Mid Arm))	5/12/13	Stockton Crk (Tributary)	Clear, no flow	None	Pooled	None	None	None	100
17	354955, 6335127	MG4 1hd	Drainage Ln- (U/S Stockton Crk (Mid Arm))	30/04/07	Stockton Crk (Tributary)	Visibly turbid/no flow	Yes overflow	Pooled	Minor erosion (cattle)	None	None	100
17	354955, 6335127	MG4 1hd	Drainage Ln- (U/S Stockton Crk (Mid Arm))	11/12/07	Stockton Crk (Tributary)	Visibly turbid/high flow	Yes overflow	Pooled	Minor erosion (cattle)	None	None	100
17	354955, 6335127	MG4 1hd	Drainage Ln- (U/S Stockton Crk (Mid Arm))	11/12/08	Stockton Crk (Tributary)	Visibly turbid/high flow	Yes overflow	Pooled	Minor erosion (cattle)	None	None	100
17	354955, 6335127	MG4 1hd	Drainage Ln- (U/S Stockton Crk (Mid Arm))	16/06/09	Stockton Crk (Tributary)	dry	Yes overflow	Pooled	Minor erosion (cattle)	None	None	100
17	354955, 6335127	MG4 1hd	Drainage Ln- (U/S Stockton Crk (Mid Arm))	09/12/09	Stockton Crk (Tributary)	dry	Yes overflow	Pooled	Minor erosion (cattle)	None	None	100
17	354955, 6335127	MG4 1hd	Drainage Ln- (U/S Stockton Crk (Mid Arm))	28/06/10	Stockton Crk (Tributary)	dry	Yes overflow	Pooled	Minor erosion (cattle)	None	None	100
17	354955, 6335127	MG4 1hd	Drainage Ln- (U/S Stockton Crk (Mid Arm))	07/12/10	Stockton Crk (Tributary)	dry	Yes overflow	Pooled	Minor erosion (cattle)	None	None	100

17	354955, 6335127	MG4 1hd	Drainage Ln- (U/S Stockton Crk (Mid Arm))	06/07/11	Stockton Crk (Tributary)	dry	Yes overflow	Pooled	Minor erosion (cattle)	None	None	100
17	354955, 6335127	MG4 1hd	Drainage Ln- (U/S Stockton Crk (Mid Arm))	07/12/11	Stockton Crk (Tributary)	dry	Yes overflow	Pooled	none	None	None	100
17	354955, 6335127	MG4 1hd	Drainage Ln- (U/S Stockton Crk (Mid Arm))	28/6/12	Stockton Crk (Tributary)	dry	Yes overflow	No	none	None	None	90
17	354955, 6335127	MG4 1hd	Drainage Ln- (U/S Stockton Crk (Mid Arm))	17/12/12	Stockton Crk (Tributary)	dry	Yes overflow	No	none	None	None	100
17	354955, 6335127	MG4 1hd	Drainage Ln- (U/S Stockton Crk (Mid Arm))	19/06/13	Stockton Crk (Tributary)	Clear / no flow	None	Pooled	none	None	None	100
17	354955, 6335127	MG4 1hd	Drainage Ln- (U/S Stockton Crk (Mid Arm))	5/12/13	Stockton Crk (Tributary)	No flow	None	None	none	None	None	100
18	355135, 6335221	MG3, 1hd	Natural Drainage Line Stockton Creek	30/04/07	Stockton Crk (Tributary)	Visibly turbid/no flow	Yes overflow	Pooled	None	None	None	100
18	355135, 6335221	MG3, 1hd	Natural Drainage Line Stockton Creek	11/12/07	Stockton Crk (Tributary)	Visibly turbid/high flow	Yes overflow	Pooled	None	None	None	100
18	355135, 6335221	MG3, 1hd	Natural Drainage Line Stockton Creek	11/12/08	Stockton Crk (Tributary)	Visibly turbid/high flow	Yes overflow	Pooled	None	None	None	100
18	355135, 6335221	MG3, 1hd	Natural Drainage Line Stockton Creek	16/06/09	Stockton Crk (Tributary)	Visibly turbid/high flow	Yes overflow	Pooled	None	None	None	100
18	355135, 6335221	MG3, 1hd	Natural Drainage Line Stockton Creek	09/12/09	Stockton Crk (Tributary)	Visibly turbid/high flow	Yes overflow	Pooled	None	None	None	100
18	355135, 6335221	MG3, 1hd	Natural Drainage Line Stockton Creek	06/07/11	not accessible							
18	355135, 6335221	MG3, 1hd	Natural Drainage Line Stockton Creek	07/12/11	not accessible							

18	355135, 6335221	MG3, 1hd	Natural Drainage Line Stockton Creek	28/6/12	not accessible							
18	355135, 6335221	MG3, 1hd	Natural Drainage Line Stockton Creek	17/12/12	not accessible							
19	355295, 63352470	Mg2, 2hd	Natural Drainage Line Stockton Creek	30/04/07	Stockton Crk (Tributary)	Visibly turbid/no flow	Yes overflow	Pooled	Yes bank erosion	None	None	80
19	355295, 63352470	Mg2, 2hd	Natural Drainage Line Stockton Creek	14/06/07	Stockton Crk (Tributary)	Visibly turbid/high flow	Yes overflow	Pooled	Yes bank erosion	None	None	80
19	355295, 63352470	Mg2, 2hd	Natural Drainage Line Stockton Creek	11/12/07	Stockton Crk (Tributary)	Visibly turbid/high flow	Yes overflow	Pooled	Yes bank erosion	None	None	80
19	355295, 63352470	Mg2, 2hd	Natural Drainage Line Stockton Creek	11/12/08	Stockton Crk (Tributary)	Visibly turbid/high flow	Yes overflow	Pooled	Yes bank erosion	None	None	80
19	355295, 63352470	Mg2, 2hd	Natural Drainage Line Stockton Creek	16/06/09	Stockton Crk (Tributary)	Visibly turbid/no flow	Yes overflow	Pooled	Yes bank erosion	None	None	80
19	355295, 63352470	Mg2, 2hd	Natural Drainage Line Stockton Creek	09/12/09	Stockton Crk (Tributary)	dry	Yes overflow	Pooled	Yes bank erosion	None	None	80
19	355295, 63352470	Mg2, 2hd	Natural Drainage Line Stockton Creek	not accessible	Stockton Crk (Tributary)							
19	355295, 63352470	Mg2, 2hd	Natural Drainage Line Stockton Creek	07/12/10	Stockton Crk (Tributary)	Visibly turbid/no flow	Yes overflow	Pooled	Yes bank erosion	None	None	80
19	355295, 63352470	Mg2, 2hd	Natural Drainage Line Stockton Creek	06/07/11	Stockton Crk (Tributary)	Visibly turbid/no flow	Yes overflow	Pooled	Yes bank erosion	None	None	80
19	355295, 63352470	Mg2, 2hd	Natural Drainage Line Stockton Creek	28/6/12	Stockton Crk (Tributary)	Visibly turbid/ low flow	Yes overflow	Pooled	Yes bank erosion	None	None	80
19	355295, 63352470	Mg2, 2hd	Natural Drainage Line Stockton Creek	17/12/12	Stockton Crk (Tributary)	Visibly turbid/no flow	Yes overflow	Pooled	Yes bank erosion	None	None	90

19	355295, 63352470	Mg2, 2hd	Natural Drainage Line Stockton Creek	19/06/13	Stockton Crk (Tributary)	Clear /no flow	None	Pooled	None	None	None	90
19	355295, 63352470	Mg2, 2hd	Natural Drainage Line Stockton Creek	5/12/13	Stockton Crk (Tributary)	Slight Turbidity /no flow	None	Pooled	None	None	None	90
20	355315, 6335205	MG2 1hd	Natural Drainage Line Stockton Creek	30/04/07	Stockton Crk (Tributary)	Visibly turbid/no flow	Yes overflow	Pooled	Yes bank erosion	None	None	80
20	355315, 6335205	MG2 1hd	Natural Drainage Line Stockton Creek	14/06/07	Stockton Crk (Tributary)	Visibly turbid/high flow	Yes overflow	Pooled	Yes bank erosion	None	None	80
20	355315, 6335205	MG2 1hd	Natural Drainage Line Stockton Creek	11/12/07	Stockton Crk (Tributary)	Visibly turbid/high flow	Yes overflow	Pooled	Yes bank erosion	None	None	80
20	355315, 6335205	MG2 1hd	Natural Drainage Line Stockton Creek	11/12/08	Stockton Crk (Tributary)	Visibly turbid/high flow	Yes overflow	Pooled	Yes bank erosion	None	None	80
20	355315, 6335205	MG2 1hd	Natural Drainage Line Stockton Creek	11/12/08	Stockton Crk (Tributary)	Visibly turbid/high flow	Yes overflow	Pooled	Yes bank erosion	None	None	80
20	355315, 6335205	MG2 1hd	Natural Drainage Line Stockton Creek	16/06/09	Stockton Crk (Tributary)	Visibly turbid/no flow	Yes overflow	Pooled	Yes bank erosion	None	None	80
20	355315, 6335205	MG2 1hd	Natural Drainage Line Stockton Creek	09/12/09	Stockton Crk (Tributary)	dry	Yes overflow	Pooled	Yes bank erosion	None	None	80
20	355315, 6335205	MG2 1hd	Natural Drainage Line Stockton Creek	not accessible								
20	355315, 6335205	MG2 1hd	Natural Drainage Line Stockton Creek	07/12/10	Stockton Crk (Tributary)	dry	Yes overflow	Pooled	Yes bank erosion	None	None	80
20	355315, 6335205	MG2 1hd	Natural Drainage Line Stockton Creek	06/07/11	Stockton Crk (Tributary)	visibly turbid/minor flow	Yes overflow	Pooled	Yes bank erosion	None	None	80
20	355315, 6335205	MG2 1hd	Natural Drainage Line Stockton Creek	07/12/11	Stockton Crk (Tributary)	visibly turbid/minor flow	Yes overflow	Pooled	Yes bank erosion	None	None	80

20	355315, 6335205	MG2 1hd	Natural Drainage Line Stockton Creek	28/6/12	Stockton Crk (Tributary)	visibly turbid/minor flow	Yes overflow	Pooled	Yes bank erosion	None	None	90
20	355315, 6335205	MG2 1hd	Natural Drainage Line Stockton Creek	17/12/12	Stockton Crk (Tributary)	Clear / no flow	Yes overflow	Pooled	Yes bank erosion	None	None	90
20	355315, 6335205	MG2 1hd	Natural Drainage Line Stockton Creek	19/06/13	Stockton Crk (Tributary)	Clear / no flow	None	Pooled	None	None	None	90
20	355315, 6335205	MG2 1hd	Natural Drainage Line Stockton Creek	5/12/13	Stockton Crk (Tributary)	No flow	None	Pooled	Minor erosion	None	None	80
21		MG3, 1	Dam (Rear of House - Vandenburg Property Refer No. 108)	30/04/07		Visibly turbid/no flow	n/a	Pooled	n/a	None	None	n/a
21		MG3, 1	Dam (Rear of House - Vandenburg Property Refer No. 108)	13/12/07		Visibly turbid/no flow	n/a	Pooled	n/a	None	None	n/a
21		MG3, 1	Dam (Rear of House - Vandenburg Property Refer No. 108)	11/12/08		Visibly turbid/no flow	n/a	Pooled	n/a	None	None	n/a
22		MG3, 2 hd	Dam (Front of Property - Vandenburg Property Refer No. 108)	30/04/07		Visibly turbid/no flow	n/a	Pooled	n/a	None	None	n/a
22		MG3, 2 hd	Dam (Front of Property - Vandenburg Property Refer No. 108)	13/12/07		Visibly turbid/no flow	n/a	Pooled	n/a	None	None	n/a

22		MG3, 2 hd	Dam (Front of Property - Vandenburg Property Refer No. 108)	13/12/08		Visibly turbid/no flow	n/a	Pooled	n/a	None	None	n/a
23	354033, 6336530	MG4, 1hd	Dam (One - Vizzer Property Refer No. 109)	30/04/07		Visibly turbid/no flow	n/a	Pooled	n/a	None	None	n/a
23	354033, 6336530	MG4, 1hd	Dam (One - Vizzer Property Refer No. 109)	13/12/07		Visibly turbid/no flow	n/a	Pooled	n/a	None	None	n/a
23	354033, 6336530	MG4, 1hd	Dam (One - Vizzer Property Refer No. 109)	13/12/08		Visibly turbid/no flow	n/a	Pooled	n/a	None	None	n/a
24	354033, 6336530	MG4, 1hd	Dam (Two - Vizzer Property Refer No. 109)	30/04/07		Visibly turbid/no flow	n/a	Pooled	n/a	None	None	n/a
24	354033, 6336530	MG4, 1hd	Dam (Two - Vizzer Property Refer No. 109)	13/12/07		Visibly turbid/no flow	n/a	Pooled	n/a	None	None	n/a
24	354033, 6336530	MG4, 1hd	Dam (Two - Vizzer Property Refer No. 109)	13/12/08		Visibly turbid/no flow	n/a	Pooled	n/a	None	None	n/a
26	355 927, 633 6565	MG5, 1hd	Drainage Line (Rear Vizzer Property Refer No. 109)	30/04/07		Visibly turbid/no flow	n/a	Pooled	n/a	None	None	80
26	355 927, 633 6565	MG5, 1hd	Drainage Line (Rear Vizzer Property Refer No. 109)	13/12/07		Visibly turbid/no flow	n/a	Pooled	n/a	None	None	80
26	355 927, 633 6565	MG5, 1hd	Drainage Line (Rear Vizzer Property Refer No. 109)	13/12/08		Visibly turbid/no flow	n/a	Pooled	n/a	None	None	80
27	354683, 6334522	MG7, 2 hd	Stockton Creek (Centennial Property Ref No. 54	10/12/08	Stockton Crk (Main Reach) bank height 0.5m and	Visibly turbid/no flow	none	Pooled	None - (stock access)	None - pre mining	None	70

					width 0.5m							
27	354683, 6334522	MG7, 2 hd	Stockton Creek (Centennial Property Ref No. 54	16/06/09	Stockton Crk (Main Reach) bank height 0.5m and width 0.5m	Visibly turbid/no flow	none	Pooled	None - (stock access)	None - pre mining	None	70
27	354683, 6334522	MG7, 2 hd	Stockton Creek (Centennial Property Ref No. 54	09/12/09	Stockton Crk (Main Reach) bank height 0.5m and width 0.5m	Visibly turbid/no flow	none	Pooled	None - (stock access)	none	None	70
27	354683, 6334522	MG7, 2 hd	Stockton Creek (Centennial Property Ref No. 54	28/06/10	Stockton Crk (Main Reach) bank height 0.5m and width 0.5m	Visibly turbid/no flow	none	Pooled	None - (stock access)	none	None	70
27	354683, 6334522	MG7, 2 hd	Stockton Creek (Centennial Property Ref No. 54	07/12/10	Stockton Crk (Main Reach) bank height 0.5m and width 0.5m	Visibly turbid/no flow	none	Pooled	None - (stock access)	none	None	70
27	354683, 6334522	MG7, 2 hd	Stockton Creek (Centennial Property Ref No. 54	06/07/11	Stockton Crk (Main Reach) bank height 0.5m and width 0.5m	Visibly turbid/no flow	none	Pooled	None - (stock access)	none	None	80
27	354683, 6334522	MG7, 2 hd	Stockton Creek (Centennial Property Ref No. 54	07/12/11	Stockton Crk (Main Reach) bank height 0.5m and width 0.5m	Visibly turbid/minor flow	none	Pooled	None - (stock access)	none	None	90
27	354683, 6334522	MG7, 2 hd	Stockton Creek (Centennial Property Ref No. 54	28/6/12	Stockton Crk (Main Reach) bank height 0.5m and width 0.5m	Visibly turbid/minor flow	none	Pooled	None - (stock access)	none	None	80

27	354683, 6334522	MG7, 2 hd	Stockton Creek (Centennial Property Ref No. 54	17/12/12	Stockton Crk (Main Reach) bank height 0.5m and width 0.5m	Visibly turbid/ no flow	none	Pooled	None - (stock access)	none	None	90
27	354683, 6334522	MG7, 2 hd	Stockton Creek (Centennial Property Ref No. 54	19/06/13	Stockton Crk (Main Reach) bank height 0.5m and width 0.5m	Turbid/ no flow	none	Pooled	None	none	None	90
27	354683, 6334522	MG7, 2 hd	Stockton Creek (Centennial Property Ref No. 54	5/12/13	Stockton Crk (Main Reach) bank height 0.5m and width 0.5m	Slight Turbid/ no flow	none	Pooled	None	none	None	80
28	354591, 3664553	MG7, 1 hd (a)	Tributary of Stockton Creek (Centennial Property Ref No. 54)	10/12/08	Stockton Crk (Main Reach) bank height 1m and width 0.5m	Visibly turbid/no flow	none	Pooled - run d/s	None - (stock access)	None - pre mining	None	80
28	354591, 3664553	MG7, 1 hd (a)	Tributary of Stockton Creek (Centennial Property Ref No. 54)	16/06/09	Stockton Crk (Main Reach) bank height 1m and width 0.5m	Visibly turbid/no flow	none	Pooled - run d/s	None - (stock access)	None - pre mining	None	80
28	354591, 3664553	MG7, 1 hd (a)	Tributary of Stockton Creek (Centennial Property Ref No. 54)	09/12/09	Stockton Crk (Main Reach) bank height 1m and width 0.5m	Visibly turbid/no flow	none	Pooled - run d/s	None - (stock access)	none	None	80
28	354591, 3664553	MG7, 1 hd (a)	Tributary of Stockton Creek (Centennial Property Ref No. 54)	28/06/10	Stockton Crk (Main Reach) bank height 1m and width 0.5m	Visibly turbid/no flow	none	Pooled - run d/s	None - (stock access)	none	None	80
28	354591, 3664553	MG7, 1 hd (a)	Tributary of Stockton Creek (Centennial Property Ref	07/12/10	Stockton Crk (Main Reach) bank height 1m and width	Visibly turbid/minor flow	none	Pooled - run d/s	None - (stock access)	none	None	80

			No. 54)		0.5m						
28	354591, 3664553	MG7, 1 hd (a)	Tributary of Stockton Creek (Centennial Property Ref No. 54)	06/07/11	Stockton Crk (Main Reach) bank height 1m and width 0.5m	not accessible (bull in paddock)					
28	354591, 3664553	MG7, 1 hd (a)	Tributary of Stockton Creek (Centennial Property Ref No. 54)	07/12/11	Stockton Crk (Main Reach) bank height 1m and width 0.5m	visibly turbid/moderate flow	none	Pooled - run d/s	None - (stock access)	none	None	80
28	354591, 3664553	MG7, 1 hd (a)	Tributary of Stockton Creek (Centennial Property Ref No. 54)	28/6/12	Stockton Crk (Main Reach) bank height 1m and width 0.5m	visibly turbid/moderate flow	none	Pooled - run d/s	None - (stock access)	none	None	95
28	354591, 3664553	MG7, 1 hd (a)	Tributary of Stockton Creek (Centennial Property Ref No. 54)	17/12/12	Stockton Crk (Main Reach) bank height 1m and width 0.5m	Turbid / no flow	none	Pooled - run d/s	None - (stock access)	none	None	90
28	354591, 3664553	MG7, 1 hd (a)	Tributary of Stockton Creek (Centennial Property Ref No. 54)	19/06/13	Stockton Crk (Main Reach) bank height 1m and width 0.5m	Turbid / no flow	none	Pooled	None	none	None	90
28	354591, 3664553	MG7, 1 hd (a)	Tributary of Stockton Creek (Centennial Property Ref No. 54)	5/12/13	Stockton Crk (Main Reach) bank height 1m and width 0.5m	Clear / low flow	none	Pooled	None	none	None	90
29	354639, 6334488	MG7, 1 hd (b)	Stockton Creek (Centennial Property Ref No. 55)	10/12/08	Stockton Crk (Main Reach) bank height 1.5-2m and width 2m	Visibly turbid/no flow	none	Pooled - stagnan t	incised near bed - (stock access)	None - pre mining	minor	60

29	354639, 6334488	MG7, 1 hd (b)	Stockton Creek (Centennial Property Ref No. 55)	16/06/09	Stockton Crk (Main Reach) bank height 1.5-2m and width 2m	dry	none	Pooled - stagnan t	incised near bed - (stock access)	none	minor	60
29	354639, 6334488	MG7, 1 hd (b)	Stockton Creek (Centennial Property Ref No. 55)	09/12/09	Stockton Crk (Main Reach) bank height 1.5-2m and width 2m	dry	none	Pooled - stagnan t	incised near bed - (stock access)	none	minor	60
29	354639, 6334488	MG7, 1 hd (b)	Stockton Creek (Centennial Property Ref No. 55)	28/06/10	Stockton Crk (Main Reach) bank height 1.5-2m and width 2m	dry	none	Pooled - stagnan t	incised near bed - (stock access)	none	minor	60
29	354639, 6334488	MG7, 1 hd (b)	Stockton Creek (Centennial Property Ref No. 55)	07/12/10	Stockton Crk (Main Reach) bank height 1.5-2m and width 2m	pooled	none	running	incised near bed - (stock access)	none	minor	95
29	354639, 6334488	MG7, 1 hd (b)	Stockton Creek (Centennial Property Ref No. 55)	06/07/11	Stockton Crk (Main Reach) bank height 1.5-2m and width 2m	dry	none	none	incised near bed - (stock access)	none	minor	80
29	354639, 6334488	MG7, 1 hd (b)	Stockton Creek (Centennial Property Ref No. 55)	08/12/11	Stockton Crk (Main Reach) bank height 1.5-2m and width 2m	visibly turbid/moderate flow	none	run	incised near bed - (stock access)	none	minor	95
29	354639, 6334488	MG7, 1 hd (b)	Stockton Creek (Centennial Property Ref No. 55)	28/6/12	Stockton Crk (Main Reach) bank height 1.5-2m and width 2m	Turbid / low flow	none	none	incised near bed - (stock access)	none	minor	90
29	354639, 6334488	MG7, 1 hd (b)	Stockton Creek (Centennial Property Ref No. 55)	17/12/12	Stockton Crk (Main Reach) bank height 1.5-2m and	dry	none	none	incised near bed - (stock access)	none	minor	100

					width 2m							
29	354639, 6334488	MG7, 1 hd (b)	Stockton Creek (Centennial Property Ref No. 55)	19/06/13	Stockton Crk (Main Reach) bank height 1.5-2m and width 2m	Slight turbidity / no flow	none	Pooled	None	none	None	100
29	354639, 6334488	MG7, 1 hd (b)	Stockton Creek (Centennial Property Ref No. 55)	5/12/13	Stockton Crk (Main Reach) bank height 1.5-2m and width 2m	Clear / low flow	none	None	None	none	None	90
30	354537, 6334371	MG8, 2 hd	Stockton Creek (Centennial Property Ref No. 55)	10/12/08	Stockton Crk (Main Reach) bank height 1-1.5m and width 3-4m	Visibly turbid/no flow	none	Pooled - riffle sequence u/s	banks incised <0.5 m from bed - (stock access)	None - pre mining	minor	80
30	354537, 6334371	MG8, 2 hd	Stockton Creek (Centennial Property Ref No. 55)	16/06/09	Stockton Crk (Main Reach) bank height 1-1.5m and width 3-4m	Visibly turbid/no flow	none	Pooled - riffle sequence u/s	banks incised <0.5 m from bed - (stock access)	None - pre mining	minor	80
30	354537, 6334371	MG8, 2 hd	Stockton Creek (Centennial Property Ref No. 55)	09/12/09	Stockton Crk (Main Reach) bank height 1-1.5m and width 3-4m	dry	none	Pooled - riffle sequence u/s	banks incised <0.5 m from bed - (stock access)	None - pre mining	minor	80
30	354537, 6334371	MG8, 2 hd	Stockton Creek (Centennial Property Ref No. 55)	28/06/10	Stockton Crk (Main Reach) bank height 1-1.5m and width 3-4m	dry	none	Pooled - riffle sequence u/s	banks incised <0.5 m from bed - (stock access)	none	minor	80
30	354537, 6334371	MG8, 2 hd	Stockton Creek (Centennial Property Ref No. 55)	07/12/10	Stockton Crk (Main Reach) bank height 1-1.5m and width 3-4m	Visibly turbid/minor flow	none	Pooled - riffle sequence u/s	banks incised <0.5 m from bed - (stock access)	none	minor	80

30	354537, 6334371	MG8, 2 hd	Stockton Creek (Centennial Property Ref No. 55)	06/07/11	Stockton Crk (Main Reach) bank height 1-1.5m and width 3-4m	visibly turbid/minor flow	none	Pooled - riffle sequence u/s	banks incised <0.5 m from bed - (stock access)	none	minor	80
30	354537, 6334371	MG8, 2 hd	Stockton Creek (Centennial Property Ref No. 55)	08/12/11	Stockton Crk (Main Reach) bank height 1-1.5m and width 3-4m	visibly turbid/moderate flow	none	Pooled - riffle sequence u/s	banks incised <0.5 m from bed - (stock access)	none	minor	90
30	354537, 6334371	MG8, 2 hd	Stockton Creek (Centennial Property Ref No. 55)	28/6/12	Stockton Crk (Main Reach) bank height 1-1.5m and width 3-4m	visibly turbid/ low flow	none	Pooled - riffle sequence u/s	banks incised <0.5 m from bed - (stock access)	none	minor	90
30	354537, 6334371	MG8, 2 hd	Stockton Creek (Centennial Property Ref No. 55)	17/12/12	Stockton Crk (Main Reach) bank height 1-1.5m and width 3-4m	No flow	none	Pooled - riffle sequence u/s	banks incised <0.5 m from bed - (stock access)	none	minor	80
30	354537, 6334371	MG8, 2 hd	Stockton Creek (Centennial Property Ref No. 55)	19/06/13	Stockton Crk (Main Reach) bank height 1-1.5m and width 3-4m	Clear, slow flow	none	Pooled - riffle sequence u/s	None	none	None	90
30	354537, 6334371	MG8, 2 hd	Stockton Creek (Centennial Property Ref No. 55)	5/12/13	Stockton Crk (Main Reach) bank height 1-1.5m and width 3-4m	Clear, slow flow	none	Pooled	None	none	None	90
31	354508, 6334315	MG8, 1 hd	Stockton Creek (Centennial Property Ref No. 55)	10/12/08	Stockton Crk (Main Reach) bank height 1-2m and width 8-10m	Visibly turbid/no flow	none	Pooled - stagnant	banks incised <1 -2 m from bed - (stock access)	None - pre mining	minor	80
31	354508, 6334315	MG8, 1 hd	Stockton Creek (Centennial Property Ref No. 55)	16/06/09	Stockton Crk (Main Reach) bank height 1-2m and width	Visibly turbid/no flow	none	Pooled - stagnant	banks incised <1 -2 m from bed - (stock access)	None - pre mining	minor	80

					8-10m							
31	354508, 6334315	MG8, 1 hd	Stockton Creek (Centennial Property Ref No. 55)	09/12/09	Stockton Crk (Main Reach) bank height 1-2m and width 8-10m	dry	none	Pooled - stagnant	banks incised <1 -2 m from bed - (stock access)	none	minor	80
31	354508, 6334315	MG8, 1 hd	Stockton Creek (Centennial Property Ref No. 55)	28/06/10	Stockton Crk (Main Reach) bank height 1-2m and width 8-10m	dry	none	Pooled - stagnant	banks incised <1 -2 m from bed - (stock access)	none	minor	80
31	354508, 6334315	MG8, 1 hd	Stockton Creek (Centennial Property Ref No. 55)	07/12/10	Stockton Crk (Main Reach) bank height 1-2m and width 8-10m	Visibly turbid/minor flow	none	pooled	banks incised <1 -2 m from bed - (stock access)	none	minor	80
31	354508, 6334315	MG8, 1 hd	Stockton Creek (Centennial Property Ref No. 55)	07/07/11	Stockton Crk (Main Reach) bank height 1-2m and width 8-10m	visibly turbid/moderate flow	none	pooled	banks incised <1 -2 m from bed - (stock access)	none	minor	80
31	354508, 6334315	MG8, 1 hd	Stockton Creek (Centennial Property Ref No. 55)	08/12/11	Stockton Crk (Main Reach) bank height 1-2m and width 8-10m	visibly turbid/moderate flow	none	pooled	banks incised <1 -2 m from bed - (stock access)	none	minor	90
31	354508, 6334315	MG8, 1 hd	Stockton Creek (Centennial Property Ref No. 55)	28/6/12	Stockton Crk (Main Reach) bank height 1-2m and width 8-10m	visibly turbid/low flow	none	pooled	banks incised <1 -2 m from bed - (stock access)	none	minor	80
31	354508, 6334315	MG8, 1 hd	Stockton Creek (Centennial Property Ref No. 55)	17/12/12	Stockton Crk (Main Reach) bank height 1-2m and width 8-10m	No flow	none	pooled	banks incised <1 -2 m from bed - (stock access)	none	minor	90

31	354508, 6334315	MG8, 1 hd	Stockton Creek (Centennial Property Ref No. 55)	19/06/13	Stockton Crk (Main Reach) bank height 1-2m and width 8-10m	Turbid, no flow	none	pooled	Yes / stock access	none	None	90
31	354508, 6334315	MG8, 1 hd	Stockton Creek (Centennial Property Ref No. 55)	5/12/13	Stockton Crk (Main Reach) bank height 1-2m and width 8-10m	Clear / low flow	none	pooled	None	none	None	50
36	354453, 6334304	LW9 Centre	Stockton Creek (Centennial Property Ref No. 55)	09/12/09	Constructed Drainage Line (draining to Stockton Creek)	dry	None	None	None	None-pre mining	none	100
36	354453, 6334304	LW9 Centre	Stockton Creek (Centennial Property Ref No. 55)	28/06/10	Constructed Drainage Line (draining to Stockton Creek)	dry	None	None	None	None-pre mining	none	100
36	354453, 6334304	LW9 Centre	Stockton Creek (Centennial Property Ref No. 55)	07/12/10	Constructed Drainage Line (draining to Stockton Creek)	dry	None	None	None	None-pre mining	none	100
36	354453, 6334304	LW9 Centre	Stockton Creek (Centennial Property Ref No. 55)	07/07/11	Constructed Drainage Line (draining to Stockton Creek)	dry	None	None	None	None-pre mining	none	80
36	354453, 6334304	LW9 Centre	Stockton Creek (Centennial Property Ref No. 55)	08/12/11	Constructed Drainage Line (draining to Stockton Creek)	pooled water in drain	None	None	None	None-pre mining	none	100
36	354453, 6334304	LW9 Centre	Stockton Creek (Centennial Property Ref No. 55)	28/6/12	Constructed Drainage Line (draining to Stockton	No water	None	None	None	Minor erosion	none	80

					Creek)							
36	354453, 6334304	LW9 Centre	Stockton Creek (Centennial Property Ref No. 55)	18/12/12	Constructed Drainage Line (draining to Stockton Creek)	No flow	None	None	None	Minor erosion	none	100
36	354453, 6334304	LW9 Centre	Stockton Creek (Centennial Property Ref No. 55)	19/06/13	Constructed Drainage Line (draining to Stockton Creek)	Turbid No flow	None	Pooled	None	None	none	100
36	354453, 6334304	LW9 Centre	Stockton Creek (Centennial Property Ref No. 55)	5/12/13	Constructed Drainage Line (draining to Stockton Creek)	No flow	None	None	None	None	none	100
37	354543, 6334452	LW 8 Centre	Stockton Creek (Centennial Property Ref No. 55)	16/06/09	Paddock containing billabong	Pooled Water (Billabong)	None	Pooled - stagnan t	None	None-pre mining	none	100
37	354543, 6334452	LW 8 Centre	Stockton Creek (Centennial Property Ref No. 55)	09/12/09	Paddock containing billabong	Pooled Water (Billabong)	None	Pooled - stagnan t	None	None-pre mining	none	100
41	3543710, 6334250	MG9 , 1 hd	Stockton Creek (Centennial Property Ref No. 57)	09/12/09	Stockton Creek (Main Reach) Bank height <1m, width 3m	dry	None	None	None	None-pre mining	None-pre mining	100
41	3543710, 6334250	MG9 , 1 hd	Stockton Creek (Centennial Property Ref No. 57)	28/06/10	Stockton Creek (Main Reach) Bank height <1m, width 3m	dry	None	None	None	none	none	100

41	3543710, 6334250	MG9 , 1 hd	Stockton Creek (Centennial Property Ref No. 57)	07/12/10	Stockton Creek (Main Reach) Bank height <1m, width 3m	pooled/minor flow	None	None	None	none	none	100
41	3543710, 6334250	MG9 , 1 hd	Stockton Creek (Centennial Property Ref No. 57)	07/07/11	Stockton Creek (Main Reach) Bank height <1m, width 3m	pooled/minor flow	Yes some evidence of overbank flow prior to survey	Pooled	None	none	none	90
41	3543710, 6334250	MG9 , 1 hd	Stockton Creek (Centennial Property Ref No. 57)	08/12/11	Stockton Creek (Main Reach) Bank height <1m, width 3m	visibly turbid/moderate flow	None	run	None	none	none	100
41	3543710, 6334250	MG9 , 1 hd	Stockton Creek (Centennial Property Ref No. 57)	29/6/12	Stockton Creek (Main Reach) Bank height <1m, width 3m	No water	None	run	None	none	none	100
41	3543710, 6334250	MG9 , 1 hd	Stockton Creek (Centennial Property Ref No. 57)	17/12/12	Stockton Creek (Main Reach) Bank height <1m, width 3m	No water	None	run	None	none	none	100
41	3543710, 6334250	MG9 , 1 hd	Stockton Creek (Centennial Property Ref No. 57)	19/06/13	Stockton Creek (Main Reach) Bank height <1m, width 3m	Clear / no flow	None	Pooled	None	none	none	100
41	3543710, 6334250	MG9 , 1 hd	Stockton Creek (Centennial Property Ref No. 57)	5/12/13	Stockton Creek (Main Reach) Bank height <1m, width 3m	Clear / slow flow	None	Pooled	None	none	none	100
42	354392, 6334122,	MG9, 2 hd	Stockton Creek (Centennial Property Ref No. 57)	09/12/09	Stockton Creek (Main Reach) Bank height <1m,	dry	None	None	None	None-pre mining	None-pre mining	100

					width 3m							
42	354392, 6334122,	MG9, 2 hd	Stockton Creek (Centennial Property Ref No. 57)	28/06/10	Stockton Creek (Main Reach) Bank height <1m, width 3m	dry	None	None	None	None-pre mining	None-pre mining	100
42	354392, 6334122,	MG9, 2 hd	Stockton Creek (Centennial Property Ref No. 57)	07/12/10	Stockton Creek (Main Reach) Bank height <1m, width 3m	Visibly turbid/minor flow	None	run	none	none	none	100
42	354392, 6334122,	MG9, 2 hd	Stockton Creek (Centennial Property Ref No. 57)	07/07/11	Stockton Creek (Main Reach) Bank height <1m, width 3m	Visibly turbid/minor flow	None	run	none	none	none	90
42	354392, 6334122,	MG9, 2 hd	Stockton Creek (Centennial Property Ref No. 57)	08/12/11	Stockton Creek (Main Reach) Bank height <1m, width 3m	No water	None	run	Minor erosion from motor bikes.	none	none	80
42	354392, 6334122,	MG9, 2 hd	Stockton Creek (Centennial Property Ref No. 57)	29/6/12	Stockton Creek (Main Reach) Bank height <1m, width 3m	No water	None	run	Erosion caused by motor bikes.	none	none	50
42	354392, 6334122,	MG9, 2 hd	Stockton Creek (Centennial Property Ref No. 57)	18/12/12	Stockton Creek (Main Reach) Bank height <1m, width 3m	visibly turbid/moderate flow	None	run	none	none	none	100
42	354392, 6334122,	MG9, 2 hd	Stockton Creek (Centennial Property Ref No. 57)	19/06/13	Stockton Creek (Main Reach) Bank height <1m, width 3m	Clear, slow flow	None	Pooled	none	none	none	90

42	354392, 6334122,	MG9, 2 hd	Stockton Creek (Centennial Property Ref No. 57)	5/12/13	Stockton Creek (Main Reach) Bank height <1m, width 3m	Clear, slow flow	None	Pooled	none	none	none	80
43	353979, 633442	MG10 2hd	Stockton Creek (Centennial Property Ref No. 44)	28/06/10	Stockton Creek (Main Reach) Bank height 2m, width 4m	Visibly turbid/minor flow	none	pooled	incised 1m from bed	none pre-mining	none pre-mining	70
43	353979, 633442	MG10 2hd	Stockton Creek (Centennial Property Ref No. 44)	07/12/10	Stockton Creek (Main Reach) Bank height 2m, width 4m	Visibly turbid/minor flow	none	pooled	incised 1m from bed	none	none	70
43	353979, 633442	MG10 2hd	Stockton Creek (Centennial Property Ref No. 44)	07/07/11	Stockton Creek (Main Reach) Bank height 2m, width 4m	Visibly turbid/minor flow	none	pooled	incised 1m from bed	none	none	71
43	353979, 633442	MG10 2hd	Stockton Creek (Centennial Property Ref No. 44)	08/12/11	Stockton Creek (Main Reach) Bank height 2m, width 4m	not accessible (flood flows)						
43	353979, 633442	MG10 2hd	Stockton Creek (Centennial Property Ref No. 44)	28/6/12	Stockton Creek (Main Reach) Bank height 2m, width 4m	Visibly turbid/minor flow	none	pooled	incised 1m from bed	none	none	90
43	353979, 633442	MG10 2hd	Stockton Creek (Centennial Property Ref No. 44)	18/12/12	Stockton Creek (Main Reach) Bank height 2m, width 4m	Visibly turbid/minor flow	none	pooled	incised 1m from bed	none	none	90
43	353979, 633442	MG10 2hd	Stockton Creek (Centennial Property Ref No. 44)	19/06/13	Stockton Creek (Main Reach) Bank height 2m,	Slight turbid/ no flow	none	pooled	None	none	none	90

					width 4m							
43	353979, 633442	MG10 2hd	Stockton Creek (Centennial Property Ref No. 44)	5/12/13	Stockton Creek (Main Reach) Bank height 2m, width 4m	Clear / no flow	none	pooled	None	none	none	90
44	353866, 6334501	MG10, 2 hd	Stockton Creek (Centennial Property Ref No. 44)	09/12/09	Stockton Creek (Main Reach) Bank height <1m, width 10 m	dry	None	None	None	None-pre mining	None-pre mining	80
44	353866, 6334501	MG10, 2 hd	Stockton Creek (Centennial Property Ref No. 44)	28/06/10	Stockton Creek (Main Reach) Bank height <1m, width 10 m	dry	None	None	None	None-pre mining	None-pre mining	80
44	353866, 6334501	MG10, 2 hd	Stockton Creek (Centennial Property Ref No. 44)	07/12/10	Stockton Creek (Main Reach) Bank height <1m, width 10 m	dry	None	None	None	none	None-pre mining	80
44	353866, 6334501	MG10, 2 hd	Stockton Creek (Centennial Property Ref No. 44)	08/07/11	Stockton Creek (Main Reach) Bank height <1m, width 10 m	dry	None	None	None	none	None-pre mining	81
44	353866, 6334501	MG10, 2 hd	Stockton Creek (Centennial Property Ref No. 44)	08/12/11	Stockton Creek (Main Reach) Bank height <1m, width 10 m	not accessible (flood flows)						
44	353866, 6334501	MG10, 2 hd	Stockton Creek (Centennial Property Ref No. 44)	29/6/12	Stockton Creek (Main Reach) Bank height <1m, width 10 m	dry	None	None	None	none	None	90

44	353866, 6334501	MG10, 2 hd	Stockton Creek (Centennial Property Ref No. 44)	18/12/12	Stockton Creek (Main Reach) Bank height <1m, width 10 m	dry	None	None	None	none	None	80
44	353866, 6334501	MG10, 2 hd	Stockton Creek (Centennial Property Ref No. 44)	19/06/13	Stockton Creek (Main Reach) Bank height <1m, width 10 m	No flow	None	None	None	none	None	100
44	353866, 6334501	MG10, 2 hd	Stockton Creek (Centennial Property Ref No. 44)	5/12/13	Stockton Creek (Main Reach) Bank height <1m, width 10 m	No flow	None	None	None	none	None	50
45	3535444, 6334562	Mg11, 1hd	Stockton Creek (Ref No. 41)	07/12/10	Stockton Creek (Main Reach) Bank height 5 m, width 2-3 m	Pooled/visibly turbid/no flow	none	none	incised 1m at bed	none pre-mining	none pre-mining	70
45	3535444, 6334562	Mg11, 1hd	Stockton Creek (Ref No. 41)	07/07/11	Stockton Creek (Main Reach) Bank height 5 m, width 2-3 m	Pooled/visibly turbid/no flow	none	pooled	incised 1m at bed	none	none	70
45	3535444, 6334562	Mg11, 1hd	Stockton Creek (Ref No. 41)	08/12/11	Stockton Creek (Main Reach) Bank height 5 m, width 2-3 m	Pooled/visibly turbid/minor flow	none	pooled	incised 1m at bed	none	none	70
45	3535444, 6334562	Mg11, 1hd	Stockton Creek (Ref No. 41)	29/6/12	Stockton Creek (Main Reach) Bank height 5 m, width 2-3 m	Pooled/visibly turbid/minor flow	none	pooled	incised 1m at bed	none	none	90
45	3535444, 6334562	Mg11, 1hd	Stockton Creek (Ref No. 41)	18/12/12	Stockton Creek (Main Reach) Bank height 5 m,	Pooled/visibly turbid/ no flow	none	pooled	incised 1m at bed	none	none	80

					width 2-3 m							
45	3535444, 6334562	Mg11, 1hd	Stockton Creek (Ref No. 41)	19/06/13	Stockton Creek (Main Reach) Bank height 5 m, width 2-3 m	Slight turbid/ no flow	none	pooled	None	none	none	90
45	3535444, 6334562	Mg11, 1hd	Stockton Creek (Ref No. 41)	5/12/13	Stockton Creek (Main Reach) Bank height 5 m, width 2-3 m	Turbid/ low flow	none	pooled	None	none	none	80
46	353219, 6334787	Mg12, 1hd	Stockton Creek (Ref No. 41)	07/07/11	Stockton Creek (Main Reach) Bank height 2 m, width 15 m	Visibly turbid/minor flow	none	pooled	incised 1m at from top bank	none pre-mining	none pre-mining	70
46	353219, 6334787	Mg12, 1hd	Stockton Creek (Ref No. 41)	08/12/11	Stockton Creek (Main Reach) Bank height 2 m, width 15 m	Visibly turbid/minor flow	none	pooled	incised 1m at from top bank	none	none	70
46	353219, 6334787	Mg12, 1hd	Stockton Creek (Ref No. 41)	29/6/12	Stockton Creek (Main Reach) Bank height 2 m, width 15 m	Visibly turbid/minor flow	none	pooled	incised 1m at from top bank	none	none	90
46	353219, 6334787	Mg12, 1hd	Stockton Creek (Ref No. 41)	18/12/12	Stockton Creek (Main Reach) Bank height 2 m, width 15 m	Visibly turbid/minor flow	none	pooled	incised 1m at from top bank	none	none	80
46	353219, 6334787	Mg12, 1hd	Stockton Creek (Ref No. 41)	19/06/13	Stockton Creek (Main Reach) Bank height 2 m, width 15 m	No flow	none	pooled	None	none	none	80

46	353219, 6334787	Mg12, 1hd	Stockton Creek (Ref No. 41)	5/12/13	Stockton Creek (Main Reach) Bank height 2 m, width 15 m	Turbid / No flow	none	pooled	None	none	none	80
47	353207, 6334717	Mg12 2 hd	Stockton Creek (Ref No. 41)	07/07/11	Stockton Creek (Main Reach) Bank height 3 m, width 5 m	Visibly turbid/no flow	none	pooled	incised 1m from bank	none pre-mining	none pre-mining	70
47	353207, 6334717	Mg12 2 hd	Stockton Creek (Ref No. 41)	08/12/11	Stockton Creek (Main Reach) Bank height 3 m, width 5 m	Visibly turbid/minor flow	none	pooled	incised 1m at from top bank	none	none	70
47	353207, 6334717	Mg12 2 hd	Stockton Creek (Ref No. 41)	29/6/12	Stockton Creek (Main Reach) Bank height 3 m, width 5 m	Visibly turbid/minor flow	none	pooled	incised 1m at from top bank	none	none	80
47	353207, 6334717	Mg12 2 hd	Stockton Creek (Ref No. 41)	18/12/12	Stockton Creek (Main Reach) Bank height 3 m, width 5 m	Visibly turbid/minor flow	none	pooled	incised 1m at from top bank	none	none	80
47	353207, 6334717	Mg12 2 hd	Stockton Creek (Ref No. 41)	19/06/13	Stockton Creek (Main Reach) Bank height 3 m, width 5 m	Slightly turbid / no flow	none	pooled	Yes cattle crossing	none	none	80
47	353207, 6334717	Mg12 2 hd	Stockton Creek (Ref No. 41)	5/12/13	Stockton Creek (Main Reach) Bank height 3 m, width 5 m	Turbid / no flow	none	pooled	Yes	none	none	50
48	352983, 6334780	Mg13, 1hd	Stockton Creek (Ref No. 26)	08/12/11	Stockton Creek (Main Reach) Bank height 4 m,	Visibly turbid/moderate flow	none	pooled (run d/S)	some soil erosion exposed banks	none pre-mining	none pre-mining	50

					width 5.10m							
48	352983, 6334780	Mg13, 1hd	Stockton Creek (Ref No. 26)	28/6/12	Stockton Creek (Main Reach) Bank height 4 m, width 5.10m	Visibly turbid/low flow	none	pooled (run d/S)	some soil erosion exposed banks	none	none	80
48	352983, 6334780	Mg13, 1hd	Stockton Creek (Ref No. 26)	18/12/12	Stockton Creek (Main Reach) Bank height 4 m, width 5.10m	No flow	none	No	some soil erosion exposed banks	none	none	80
48	352983, 6334780	Mg13, 1hd	Stockton Creek (Ref No. 26)	19/06/13	Stockton Creek (Main Reach) Bank height 4 m, width 5.10m	Clear / slight flow	none	Pooled	some soil erosion exposed banks	none	none	80
48	352983, 6334780	Mg13, 1hd	Stockton Creek (Ref No. 26)	5/12/13	Stockton Creek (Main Reach) Bank height 4 m, width 5.10m	Slight turbidity / low flow	none	Pooled	Yes	none	none	50
49	352943, 6334714	Mg13, 2hd	Stockton Creek (Ref No. 39)	08/12/11	Stockton Creek (Main Reach) Bank height 3 m, width 11 m	Visibly turbid/moderate flow	none	pooled	some soil erosion exposed banks	none pre-mining	none pre-mining	50
49	352943, 6334714	Mg13, 2hd	Stockton Creek (Ref No. 39)	29/6/12	Stockton Creek (Main Reach) Bank height 3 m, width 11 m	Visibly turbid/moderate flow	none	pooled	some soil erosion exposed banks	none	none	80
49	352943, 6334714	Mg13, 2hd	Stockton Creek (Ref No. 39)	18/12/12	Stockton Creek (Main Reach) Bank height 3 m, width 11 m	Dry	none	none	some soil erosion exposed banks	none	none	80

49	352943, 6334714	Mg13, 2hd	Stockton Creek (Ref No. 39)	19/06/13	Stockton Creek (Main Reach) Bank height 3 m, width 11 m	Clear / Slight flow	none	Pooled	None	none	none	80
49	352943, 6334714	Mg13, 2hd	Stockton Creek (Ref No. 39)	5/12/13	Stockton Creek (Main Reach) Bank height 3 m, width 11 m	Slight Turbidity / low flow	none	Pooled	None	none	none	50
50	352594, 6335026	Mg14	Stockton Creek (Ref No. 22)	18/12/12	Stockton Creek (Main Reach) Bank height 3 m, width 5 m	Turbid / no flow	none	Pooled	none	none – pre mining	None – prep mining	80
50	352594, 6335026	Mg14	Stockton Creek (Ref No. 22)	19/06/13	Stockton Creek (Main Reach) Bank height 3 m, width 5 m	Turbid / no flow	none	Pooled	none	none – pre mining	None – prep mining	80
50	352594, 6335026	Mg14	Stockton Creek (Ref No. 22)	5/12/13	Stockton Creek (Main Reach) Bank height 3 m, width 5 m	Turbid / low flow	none	Pooled	none	none – pre mining	None – prep mining	50
51	352479, 6335079	Mg14	Stockton Creek (Ref No. 22)	18/12/12	Stockton Creek (Main Reach) Bank height 4 m, width 6 m	Dry	none	none	None	none – pre mining	none – pre mining	80
51	352479, 6335079	Mg14	Stockton Creek (Ref No. 22)	19/06/13	Stockton Creek (Main Reach) Bank height 4 m, width 6 m	Clear flow	none	Pooled	None	none – pre mining	none – pre mining	90
51	352479, 6335079	Mg14	Stockton Creek (Ref No. 22)	5/12/13	Stockton Creek (Main Reach) Bank height 4 m,	Slight turbidity / low flow	none	Pooled	None	none – pre mining	none – pre mining	90

					width 6 m							
52	352306, 63335120			19/06/13	Stockton Creek, Main reach	Clear flow / slow	None	Yes	None	None – pre mining	None - pre mining	80
52	352306, 63335120			5/12/13	Stockton Creek, Main reach	Slight Turbid / low flow	None	Yes	Yes	None – pre mining	None - pre mining	50
53	352040, 6335423			5/12/13	Stockton Creek, Main reach	Slight turbidity / Slight flow	None	Yes	None	None – pre mining	None – pre mining	50

Appendix 6

Floodpath Condition Photographic Monitoring Points

PT1 – MG6 1 HD Stock Creek April 2007

PT1 - MG6 1 HD Stockton Creek December 2007

PT1 - MG6 1 HD Stockton Creek June 2008

PT1 - MG6 1 HD Stockton Creek December 2008

PT1 - MG6 1 HD Stockton Creek June 2009

PT1 - MG6 1 HD Stockton Creek December 2009

PT1 - MG6 1 HD Stockton Creek December 2010

PT1 - MG6 1 HD Stockton Creek June 2011

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PT2 – MG6 2HD Stockton Creek June 2012

PT2 – MG6 2HD Stockton Creek December 2012

PT2 – MG6 2HD Stockton Creek June 2013

PT2 – MG6 2HD Stockton Creek December 2013

PT3 – MG5 1 HD Stockton Creek June 14th Flood Event 2007

PT3 – MG5 1HD Stock Creek April 2007

PT3 – MG5 1HD Stockton Creek December 2007

PT3 – MG5 1HD Stockton Creek June 2008

PT3 – MG5 1HD Stockton Creek December 2008

PT3 – MG5 1HD Stockton Creek June 2009

PT3 – MG5 1HD Stockton Creek December 2009

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PT3 – MG5 1HD Stockton Creek June 2013

PT3 – MG5 1HD Stockton Creek December 2013

PT4 – MG5 2HD Stockton Creek April 2007

PT4 –MG5 2HD Stockton Creek June 14th Flood Event

PT4 – MG5 2HD Stock Creek December 2007

PT4 – MG5 2HD Stock Creek June 2008

PT4 – MG5 2HD Stock Creek December 2008

PT4 – MG5 2HD Stock Creek June 2009

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PT5 – MG4 1HD Stockton Creek April 2007

PT5 – MG4 1HD Stockton Creek June 14th 2007 Flood Event

PT5 – MG4 1HD Stockton Creek December 2007

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PT8- MG3 2HD Stockton Creek June 2013

PT8- MG3 2HD Stockton Creek December 2013

PT9 – MG2 1HD Stockton Creek April 2007

PT9 – MG2 1HD Stock Creek June 14th 2007

PT9 – MG2 1HD Stockton Creek December 2007

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PT11 – MG1 1HD Stockton Creek December 2012

PT11 – MG1 1HD Stockton Creek June 2013

PT11 – MG1 1HD Stockton Creek December 2013

PT12 – Flank St Creek April 2007

PT12 – Flank St Creek June 14th 2007

PT12 – Flank St Creek December 2007

PT12 – Flank St Creek June 2008

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PT12 – Flank St Creek June 2013

PT12 – Flank St Creek December 2013

PT13 – MG6 2HD Stockton Creek Tributary April 2007

PT13 MG6 2HD Stockton Creek Tributary December 2007

PT13 MG6 2HD Stockton Creek Tributary June 2008

PT13 MG6 2HD Stockton Creek Tributary December 2008

PT13 MG6 2HD Stockton Creek Tributary June 2009

PT13 MG6 2HD Stockton Creek Tributary December 2009

PT13 MG6 2HD Stockton Creek Tributary June 2010

PT13 MG6 2HD Stockton Creek Tributary December 2010

PT13 MG6 2HD Stockton Creek Tributary June 2011

PT13 MG6 2HD Stockton Creek Tributary December 2011

PT13 MG6 2HD Stockton Creek Tributary June 2012

PT13 MG6 2HD Stockton Creek Tributary December 2012

PT13 MG6 2HD Stockton Creek Tributary June 2013

PT13 MG6 2HD Stockton Creek Tributary December 2013

PT14 – Stockton Creek Tributary April 2007

PT14 – Stock Creek June 14th 2007

PT14 – Stockton Creek December 2007

PT14 – Stockton Creek June 2008

PT14 – Stockton Creek December 2008

PT14 – Stockton Creek June 2009

PT14 – Stockton Creek December 2009

PT14 – Stockton Creek June 2010

PT14 – Stockton Creek December 2010

PT14- Stockton Creek June 2011

PT14 – Stockton Creek December 2011

PT14- Stockton Creek June 2012

PT14 – Stockton Creek December 2012

PT14- Stockton Creek June 2013

PT14 – Stockton Creek December 2013

PT15 – MG5 2HD St Creek April 2007

PT15 – MG5 2HD St Creek June 14 2007

PT15 – MG5 2HD St Creek December 2007

PT15 – MG5 2HD St Creek June 2008

PT15 – MG5 2HD St Creek December 2008

PT15 – MG5 2HD St Creek June 2009

PT15 – MG5 2HD St Creek December 2009

PT15 – MG5 2HD St Creek June 2010

PT15 – MG5 2HD St Creek December 2010

PT15- MG5 2HD St Creek June 2011

PT15 – MG5 2HD St Creek December 2011

PT15 – MG5 2HD St Creek June 2012

PT15 – MG5 2HD St Creek December 2012

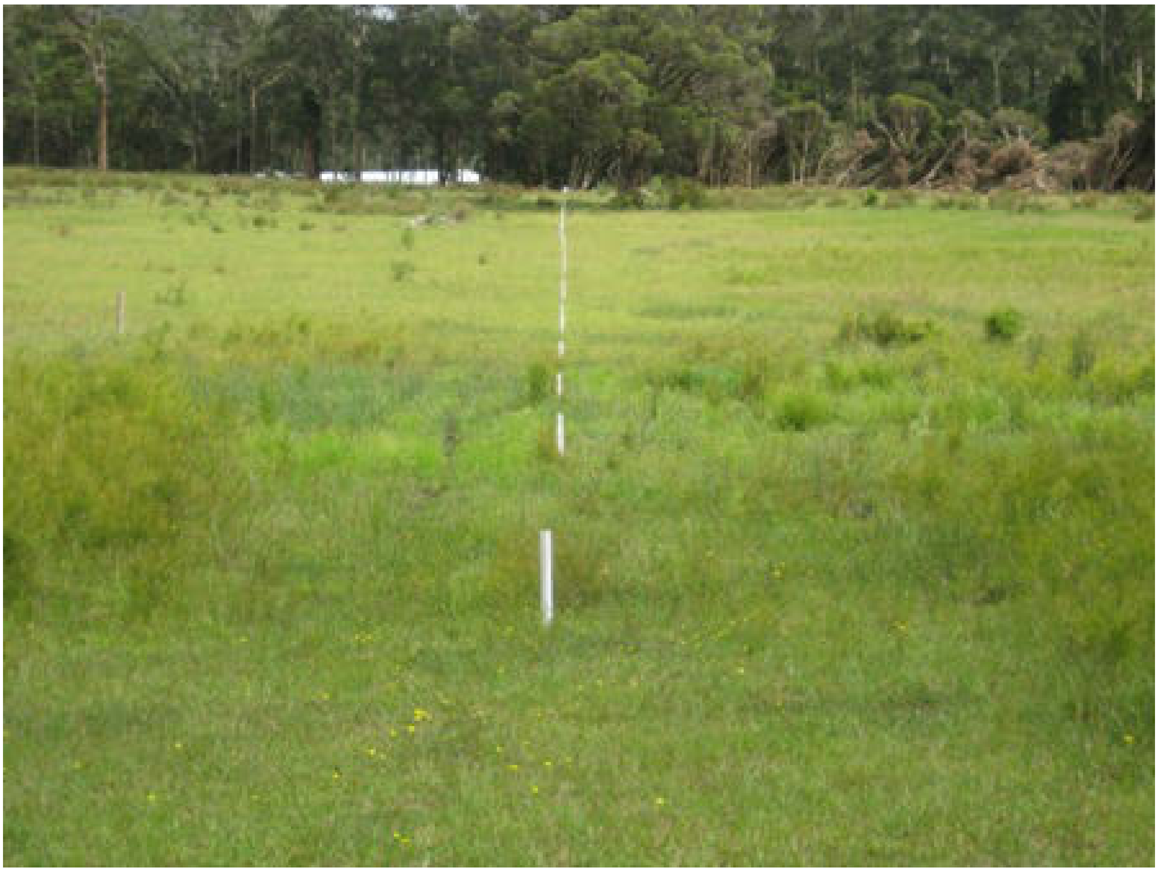
PT15 – MG5 2HD St Creek June 2013

PT15 – MG5 2HD St Creek December 2013

PT16 – Stockton Creek –CL April 2007

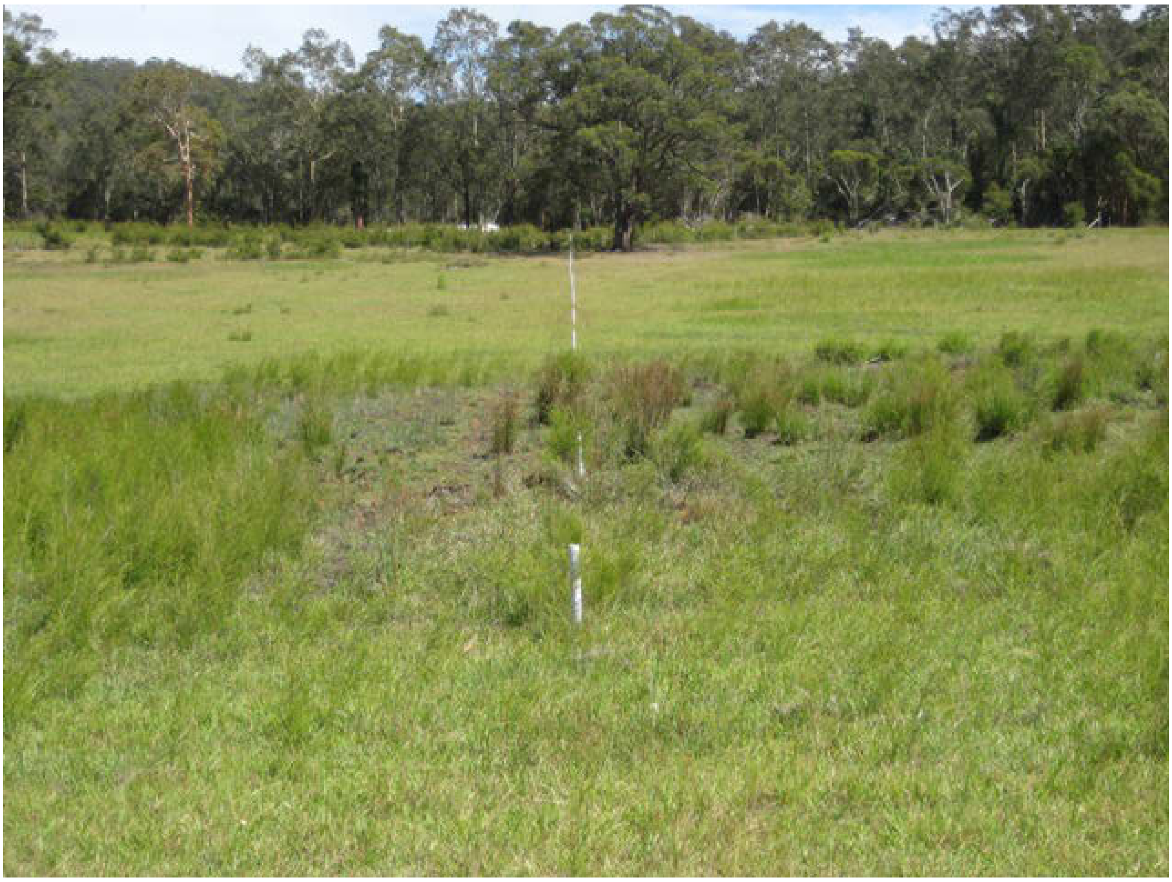
PT16 - St Creek CL December 2007

PT16 - St Creek CL June 2008



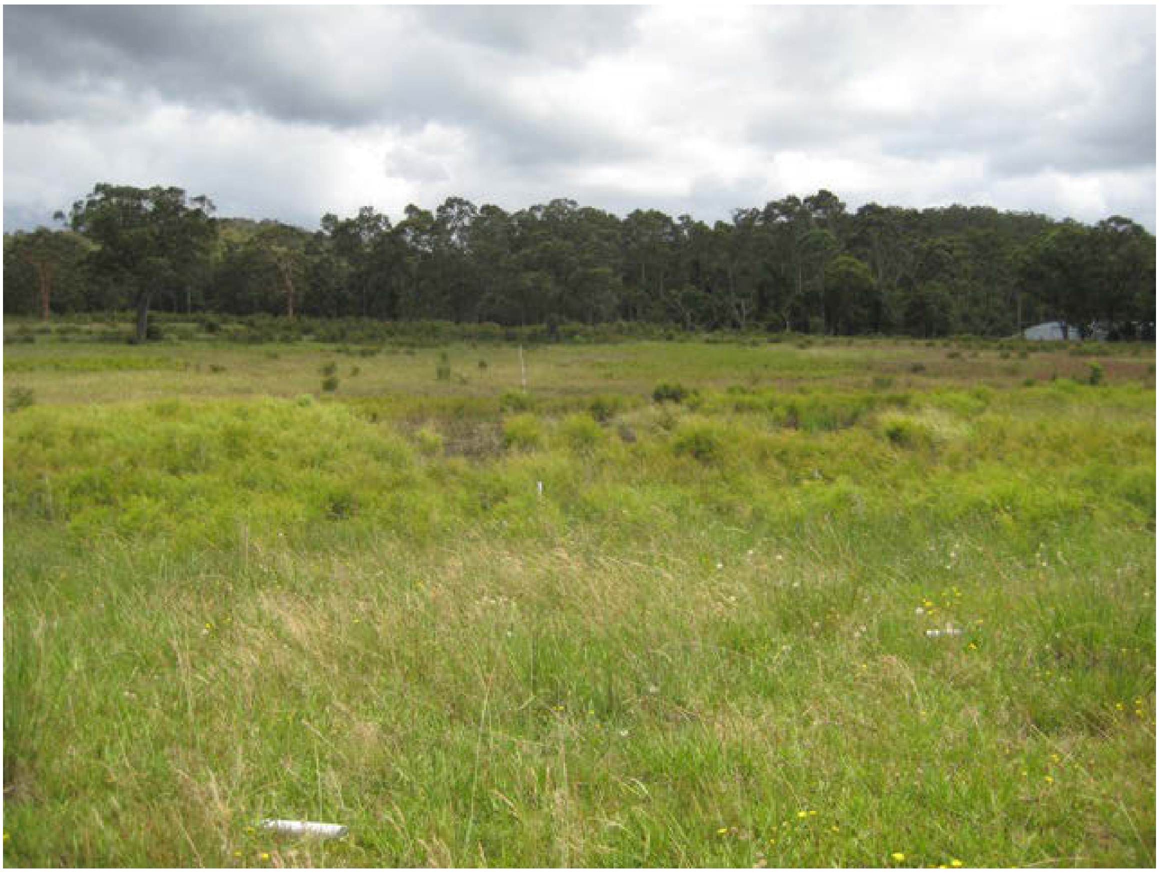
PT16 - St Creek CL December 2008

PT16 - St Creek CL June 2009

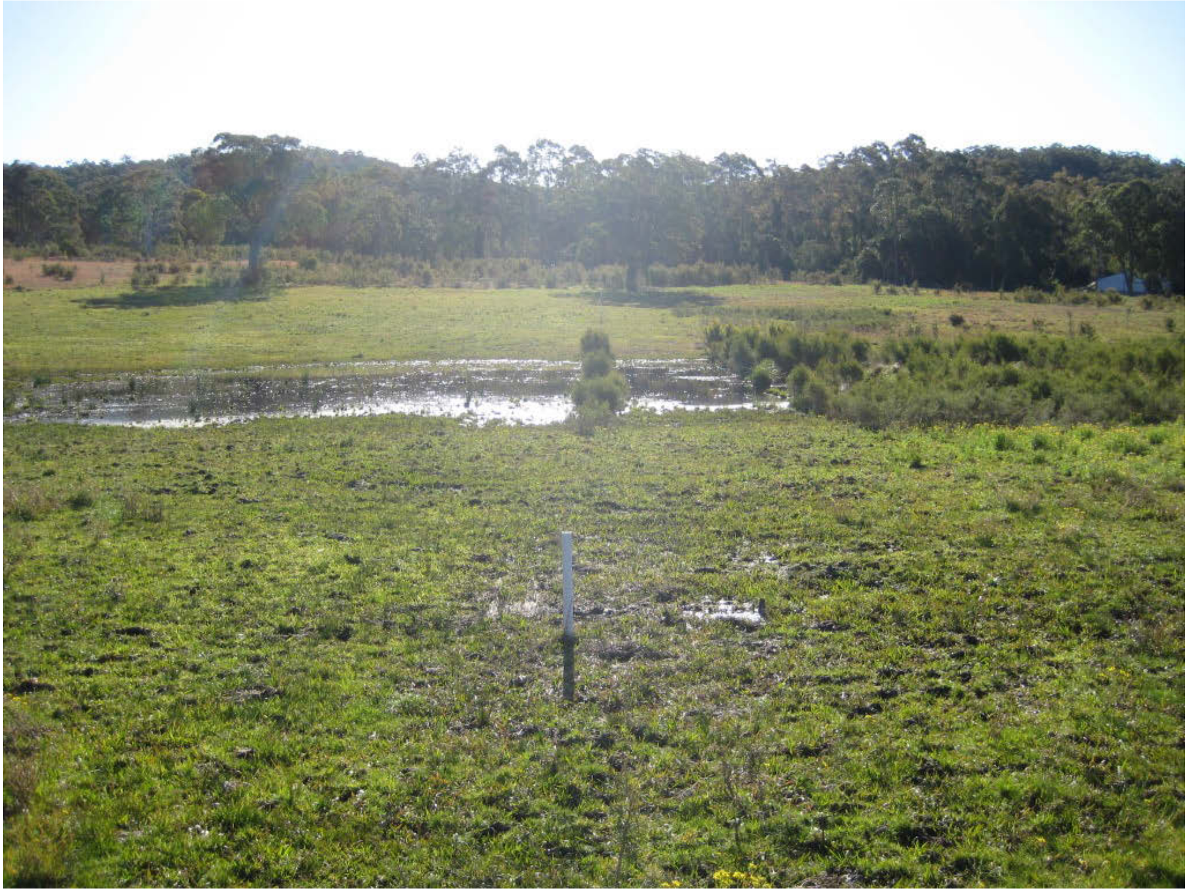


PT16 - St Creek CL December 2009

PT16 - St Creek CL June 2010



PT16 - St Creek CL December 2010



PT16 – St Creek CL June 2011

PT16 – St Creek CL December 2011

PT16 – St Creek CL June 2012

PT16 – St Creek CL December 2012

PT16 – St Creek CL June 2013

PT16 – St Creek CL December 2013

PT17 – MG4 2HD St Creek April 2007

PT17 MG4 2HD St Creek December 2007

PT17 MG4 2HD St Creek June 2008

PT17 MG4 2HD St Creek December 2008

PT17 MG4 2HD St Creek June 2009

PT17 MG4 2HD St Creek December 2009

PT17 MG4 2HD St Creek June 2010

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PT17 – MG4 2HD St Creek June 2011

PT17 MG4 2HD St Creek December 2011

PT17 – MG4 2HD St Creek June 2012

PT17 – MG4 2HD St Creek December 2012

PT17 – MG4 2HD St Creek June 2013

PT17 – MG4 2HD St Creek December 2013

PT18 MG3 1HD Stockton Creek Tributary April 2007

PT18 MG3 1HD Stockton Creek Tributary December 2007

PT19 – MG2 1HD St Creek April 2007

PT19 – MG2 1HD St Creek June 14th 2007

PT19 MG2 1HD St Creek December 2007

PT19 MG2 1HD St Creek June 2008

PT19 MG2 1HD St Creek December 2008

PT19 MG2 1HD St Creek June 2009

PT19 MG2 1HD St Creek December 2009

PT19 MG2 1HD St Creek December 2010

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PT19 MG2 1HD St Creek December 2012

PT19 MG2 1HD St Creek June 2012

PT19 MG2 1HD St Creek December 2013

PT20 – MG2 2HD Stockton Creek June 2007

PT20 MG2 2HD Stockton Creek June 14th 2007

PT20 MG2 2HD Stockton Creek December 2007

PT20 MG2 2HD Stockton Creek June 2008

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PT20 MG2 2HD Stockton Creek June 2012

PT20 MG2 2HD Stockton Creek December 2012

PT20 MG2 2HD Stockton Creek June 2013

PT20 MG2 2HD Stockton Creek December 2013

PT21 MG3 1HD Dam Wall Property Ref 108 – April 2007

PT21 MG3 1HD Dam Wall Property Ref 108 –June 2008

PT21 MG3 1HD Dam Wall Property Ref 108 –December 2008

PT22 - Dam Front Property Ref 108 – April 2007

PT22 Dam Front Property Ref 108 December 2007

PT22 Dam Front Property Ref 108 June 2008

PT22 Dam Front Property Ref 108 December 2008

PT23 Dam Property Reference No. 109 April 2007

PT23 Dam Property Reference No. 109 December 2007

PT23 Dam Property Reference No. 109 June 2008

PT23 Dam Property Reference No. 109 December 2008

PT24 MG4 1HD Property Ref No. 109 April 2007

PT24 MG4 1HD Property Ref 109 December 2007

PT24 MG4 1HD Property Ref 109 June 2008

PT24 MG4 1HD Property Ref 109 December 2008

PT25 –Drainage Line Property Ref 109 April 2007

PT25 Drainage line Property Ref 108 December 2007

PT26 MG4 1HD Drainage line Property Ref 109 April 2007

PT26 MG4 1HD Drainage line property ref 109 December 2007

PT26 MG4 1HD Drainage line property ref 109 June 2008

PT26 MG4 1HD Drainage line property ref 109 December 2008

PT 27 – MG7 2 HD Stockton Creek December 2008

PT 27 – MG7 2 HD Stockton Creek June 2009

PT 27 – MG7 2 HD Stockton Creek December 2009

PT 27 – MG7 2 HD Stockton Creek June 2010

PT 27 – MG7 2 HD Stockton Creek December 2010

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PT 28 – MG7 1HD (a) Stockton Creek December 2008

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PT 28 – MG7 1HD (a) Stockton Creek June 2013

PT 28 – MG7 1HD (a) Stockton Creek December 2013

PT29 – MG7 1HD (b) Tributary Stockton Creek December 2008

PT29 – MG7 1HD (b) Tributary Stockton Creek June 2009

PT29 – MG7 1HD (b) Tributary Stockton Creek December 2009

PT29 – MG7 1HD (b) Tributary Stockton Creek June 2010

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PT30 – MG8 2HD Stockton Creek December 2008

PT30 – MG8 2HD Stockton Creek June 2009

PT30 – MG8 2HD Stockton Creek December 2009

PT30 – MG8 2HD Stockton Creek June 2010

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PT31 – MG8 1HD Stockton Creek June 2012

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PT31 – MG8 1HD Stockton Creek June 2013

PT31 – MG8 1HD Stockton Creek December 2013

PT36 – LW9 Centre December 2009

PT36 – LW9 Centre December 2010

PT36 – LW9 Centre June 2011

PT36 – LW9 Centre December 2011

PT36 – LW9 Centre June 2012

PT36 – LW9 Centre December 2012

PT36 – LW9 Centre June 2013

PT36 – LW9 Centre December 2013

PT37 –LW8 Centre June 2009

PT37 –LW8 Centre December 2009

PT41 – MG9 1HD Stockton Creek December 2009

PT41 – MG9 1HD Stockton Creek June 2010

PT41 – MG9 1HD Stockton Creek December 2010

PT41 – MG9 1HD Stockton Creek June 2011

PT41 – MG9 1HD Stockton Creek December 2011

PT41 – MG9 1HD Stockton Creek June 2012

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PT43 – MG10 2HD Stockton Creek December 2009

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PT44 – MG11 1HD Stockton Creek December 2010

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PT47 MG12 2HD Stockton Creek June 2011

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PT50 – MG14 Stockton Creek December 2012

PT50 – MG14 Stockton Creek June 2013

PT50 – MG14 Stockton Creek December 2013

PT51 – MG14 Stockton Creek December 2012

PT51 – MG14 Stockton Creek June 2013

PT51 – MG14 Stockton Creek December 2013

PT52 Stockton Creek June 2013

PT52 Stockton Creek December 2013

PT53 Stockton Creek December 2013

APPENDIX 10
NOW Groundwater Licence Compliance Report

Condition No	Condition	Status 20BL168665	Status 20BL167117	Status 20BL167832	Status 20BL168663	Status 20BL169546	Status 20BL169547
1	The licence shall lapse if the works is not commence and completed within three years of the date of the issue of the licence.	Complied	Complied	Complied	Complied	Complied	Complied
2	The licensee shall within two months of completion or after the issue of the licence if the works is existing, furnish to the Department of Water and Energy :- a) Details of the work set out in the attached form "A" (must be completed by a driller); b) A plan showing accurately the location of the work, in relation to portion and property boundary; c) A one litre water sample for all licences other than those from stock, domestic, test bores and farming purpose; d) Details of any water analysis and/or pumping tests.	Complied	Complied	Complied	Complied	Complied	Complied
3	The licensee shall allow the department of water and energy or any person authorised by it, full and free access to the works, either during or after construction, for the purpose of carrying out inspection or test of the works and its fittings and shall carry out any work or alterations deemed necessary by the department for the protection and proper maintenance of the works, or the control of the water extracted and for the protection of the quality and the prevention from pollution or contamination of sub-surface water	NYT	NYT	NYT	NYT	NYT	NYT
4	If during the construction of the work, saline or polluted water is encountered above the producing aquifer, such water shall be sealed off by:- a) Inserting the appropriate length(s) of casing to a depth sufficient to exclude the saline or polluted water from the work. b) Cementing between the casing(s) and the walls of	Complied	Complied	Complied	Complied	Complied	Complied

Condition No	Condition	Status 20BL168665	Status 20BL167117	Status 20BL167832	Status 20BL168663	Status 20BL169546	Status 20BL169547
	the bore hole from the bottom of the casing to ground level. Any departure from these procedures must be approved by the department before undertaking the work.						
5	a) The licensee shall notify the department of water and energy if a flowing supply of water is obtained. The bore shall then be lined with casing and cemented and a suitable closing gear shall be attached to the borehead as specified by the department of water and energy. If a flowing supply of water is obtained from the work, the licensee shall only distribute water from the borehead by a system of pipelines and shall not be distributed it in drains, natural or artificial channels or depressions.	NYT	NYT	NYT	NYT	NYT	NYT
6	If a work is abandoned at any time the licensee shall notify the department of water and energy that the work has been approved and seal off the aquifer by:- a) Backfilling the work to ground levels with clay or cement after withdrawing the casing (lining): or b) Such methods as agreed to or directed by the department or water and energy.	NYT	NYT	NYT	NYT	NYT	NYT
7	The licensee shall not allow any tailwater/drainage to discharge into or onto:- ▪ Any adjoining public or crown road; ▪ Any other persons land; ▪ Any crown land; ▪ Any native vegetation as described under the	Complied	Complied	Complied	Complied	Complied	Complied

Condition No	Condition	Status 20BL168665	Status 20BL167117	Status 20BL167832	Status 20BL168663	Status 20BL169546	Status 20BL169547
	native vegetation conservation act 1997; ▪ Any wetland of environmental significance.						
8	Water shall not be pumped from the bore authorised by this licence for any purpose other than groundwater investigation.	Complied	Complied	Complied	Complied	Complied	Complied

Note: status as 31 December 2013

Abbreviations

NYT Not Yet Triggered

Condition No	Condition	Status 20BL169548	Status 20BL169549	Status 20BL168664	Status 20BL171706	Status 20BL171482	Status 20BL167832
1	The licence shall lapse if the works is not commence and completed within three years of the date of the issue of the licence.	Complied	Complied	Complied	Complied	Complied	Complied
2	The licensee shall within two months of completion or after the issue of the licence if the works is existing, furnish to the Department of Water and Energy :- e) Details of the work set out in the attached form "A" (must be completed by a driller); f) A plan showing accurately the location of the work, in relation to portion and property boundary; g) A one litre water sample for all licences other than those from stock, domestic, test bores and farming purpose; h) Details of any water analysis and/or pumping tests.	Complied	Complied	Complied	Complied	Complied	Complied
3	The licensee shall allow the department of water and energy or any person authorised by it, full and free access to the works, either during or after construction, for the purpose of carrying out inspection or test of the works and its fittings and shall carry out any work or alterations deemed necessary by the department for the protection and proper maintenance of the works, or the control of the water extracted and for the protection of the quality and the prevention from pollution or contamination of sub-surface water	NYT	NYT	NYT	NYT	NYT	NYT
4	If during the construction of the work, saline or polluted water is encountered above the producing aquifer, such water shall be sealed off by:- c) Inserting the appropriate length(s) of casing to a depth sufficient to exclude the saline or polluted water from the work. d) Cementing between the casing(s) and the walls of the bore hole from the bottom of the casing to ground level. Any departure from these procedures must be approved by the department before undertaking the work.	Complied	Complied	Complied	Complied	Complied	Complied

Condition No	Condition	Status 20BL169548	Status 20BL169549	Status 20BL168664	Status 20BL171706	Status 20BL171482	Status 20BL167832
5	b) The licensee shall notify the department of water and energy if a flowing supply of water is obtained. The bore shall then be lined with casing and cemented and a suitable closing gear shall be attached to the borehead as specified by the department of water and energy. c) If a flowing supply of water is obtained from the work, the licensee shall only distribute water from the borehead by a system of pipelines and shall not be distributed it in drains, natural or artificial channels or depressions.	NYT	NYT	NYT	NYT	NYT	NYT
6	If a work is abandoned at any time the licensee shall notify the department of water and energy that the work has been approved and seal off the aquifer by:- c) Backfilling the work to ground levels with clay or cement after withdrawing the casing (lining): or d) Such methods as agreed to or directed by the department or water and energy.	NYT	NYT	NYT	NYT	NYT	NYT
7	The licensee shall not allow any tailwater/drainage to discharge into or onto:- ▪ Any adjoining public or crown road; ▪ Any other persons land; ▪ Any crown land; ▪ Any native vegetation as described under the native vegetation conservation act 1997; ▪ Any wetland of environmental significance.	Complied	Complied	Complied	Complied	Complied	Complied
8	Water shall not be pumped from the bore authorised by this licence for any purpose other than groundwater investigation.	Complied	Complied	Complied	Complied	Complied	Complied

Note: status as 31 December 2013

Abbreviations
NYT Not Yet Triggered

Condition No	Condition	Status 20BL167117					
1	The licence shall lapse if the works is not commence and completed within three years of the date of the issue of the licence.	Complied					
2	The licensee shall within two months of completion or after the issue of the licence if the works is existing, furnish to the Department of Water and Energy :- i) Details of the work set out in the attached form "A" (must be completed by a driller); j) A plan showing accurately the location of the work, in relation to portion and property boundary; k) A one litre water sample for all licences other than those from stock, domestic, test bores and farming purpose; l) Details of any water analysis and/or pumping tests.	Complied					
3	The licensee shall allow the department of water and energy or any person authorised by it, full and free access to the works, either during or after construction, for the purpose of carrying out inspection or test of the works and its fittings and shall carry out any work or alterations deemed necessary by the department for the protection and proper maintenance of the works, or the control of the water extracted and for the protection of the quality and the prevention from pollution or contamination of sub-surface water	NYT					
4	If during the construction of the work, saline or polluted water is encountered above the producing aquifer, such water shall be sealed off by:- e) Inserting the appropriate length(s) of casing to a depth sufficient to exclude the saline or polluted water from the work. f) Cementing between the casing(s) and the walls of the bore hole from the bottom of the casing to ground level. Any departure from these procedures must be approved by the department before undertaking the work.	Complied					
5	c) The licensee shall notify the department of water and energy if a flowing supply of water is obtained. The bore shall then be lined with casing and cemented and a suitable closing gear shall be attached to the borehead as	NYT					

Condition No	Condition	Status 20BL167117					
	specified by the department of water and energy. d) If a flowing supply of water is obtained from the work, the licensee shall only distribute water from the borehead by a system of pipelines and shall not be distributed it in drains, natural or artificial channels or depressions.						
6	If a work is abandoned at any time the licensee shall notify the department of water and energy that the work has been approved and seal off the aquifer by:- d) Backfilling the work to ground levels with clay or cement after withdrawing the casing (lining): or e) Such methods as agreed to or directed by the department or water and energy.	NYT					
7	The licensee shall not allow any tailwater/drainage to discharge into or onto:- ▪ Any adjoining public or crown road; ▪ Any other persons land; ▪ Any crown land; ▪ Any native vegetation as described under the native vegetation conservation act 1997; ▪ Any wetland of environmental significance.	Complied					
8	Water shall not be pumped from the bore authorised by this licence for any purpose other than groundwater investigation.	Complied					

Note: status as 31 December 2013

Abbreviations NYT Not Yet Triggered

Condition No	Condition	Status 20BL173524					
1	The following definitions apply to this licence: - Alluvial water inflow means water contained within an alluvium which, if intercepted by mining activity, will give rise to an inflow of water into a mine work. - The Alluvium is defines as an extensive stream-laid deposit of unconsolidated material, including gravel, sand, silt and clay. - Mine work means any excavation relating to the construction and/or operation of underground mining by Centennial Mandalong Pty Ltd.	Noted					
2	All bores, other than bores used solely for monitoring purposes, located within the alluvial sediments of the Dora Creek water source must be cased to prevent alluvial groundwater from entering the bore.	Complied					
3	The licence holder must provide the Office of Water with a map of the Licenced Site showing areas of alluvial sediments likely to be impacted by operation of each bore.	Complied					
4	The licence holder must develop and implement a methodology to estimate the annual volume of alluvial groundwater intercepted and the impact of extraction from Cooranbong Underground storage on the alluvial and surface water systems (water budget), approved by the Office of Water, within six months of this licence being issued.	Complied					
5	The licence holder must develop and implement a Groundwater Monitoring & Contingency Plan, with its reporting schedule, and approved by the Office of Water. The Groundwater Monitoring and Contingency Plan is to be prepared and submitted to the Office of Water within six months of issuing the licence using the template provided by the Office of Water. This report should include the submission of salinity readings from all groundwater monitoring works.	Complied					
6	Bores are only to be constructed by a licenced driller, approved by the Office of Water.	Noted					
7	All bores must be constructed in accordance with the minimum construction requirements for water bores in Australia 2012.	Noted					

Condition No	Condition	Status 20BL173524					
8	Construction of the bores must prevent contamination between aquifers through proper bore construction.	Noted					
9	The licence holder must, within 2 months of completion of the construction of the bore, or after the issue of the licence if the bore exists, provide the Office of Water with; (a) Details of the bore on the prescribed form, (b) A plan showing accurately the location of the bore in relation to portion and property boundaries, and (c) Details of any water analyses and / or pumping tests.	Complied					
10	When a bore is abandoned, the licence holder must: (a) Notify the Office of Water that the work has been abandoned, and (b) Seal off the aquifer by backfilling the work to ground level after withdrawing the casing (lining), as specified by the Office of Water. (c) Follow decommissioning procedures that comply with minimum construction requirements for water bores in Australia or any alternative standards specified by the Office of Water.	Noted					
11	An extraction measurement device must be installed and maintained on each bore used for extraction of water under this licence. Each extraction measurement device must be of a type and standard, and must be maintained in a manner, which is acceptable to the Office of Water.	Complied					
12	In July of each year the licence holder must provide the Office of Water with an Annual Compliance Report, that reports on the results of the Groundwater Monitoring and Contingency Plan. The Annual Compliance report must: (a) Assess compliance with the licence terms and conditions (b) Provide information on the annual volume of alluvial water inflows (c) Provide a summary of the new bores or pits constructed during that year (d) Provide statistics for the monitoring data collated for each bore for the previous water year (e) Summarise contingency events that impacted on groundwater during the	NYT					

Condition No	Condition	Status 20BL173524					
	previous water year, including actions taken to remedy the situation and extra monitoring results (f) Any recommendations or measures to be taken for improvements for the new water year.						
13	The licence holder must submit an Independent Environmental (Water) Audit at the end of the twelve month licence period to the Office of Water as a comprehensive report (Environmental Audit Report). The Audit must: (a) Be carried out in accordance with guidelines and general principles for environmental auditing and procedures for environmental auditing approved by the Office of Water; (b) Assess compliance with the terms and conditions of this licence, including the Groundwater Monitoring and Contingency Plan; (c) Review actual impacts of the extractions on any aquifers, groundwater dependent ecosystems and any streams in the area; (d) Make comparisons between actual and predicted impacts (modelled results); (e) Provide recommendations as to works that ought to be performed or additional obligations that ought to be imposed in order to rectify any impacts on groundwater. (f) Be conducted by an independent certified auditor, nominated by the licence holder and approved in advance by the Office of Water; and (g) Be carried out at the cost of the licence holder.	NYT					
14	The volume of groundwater extracted from the works authorised by this licence shall not exceed 1825 megalitres in any 12 month period commencing 1st July.	NYT					
15	If, during the construction of the water supply work (bore), saline or contaminated water is encountered above the producing aquifer, such water is to be sealed off by: (a) Inserting the appropriate length (s) of casing to a depth sufficient to exclude the saline or contaminated water from the work, and (b) Placing an impermeable seal between the casing (s) and the walls of the bore hole from the bottom of the casing to ground level, as specified by the	Noted					

Condition No	Condition	Status 20BL173524					
	Office of Water.						

Note: status as 31 December 2013

Abbreviations: NYT Not Yet Triggered

APPENDIX 11
AEMR Photos 2013

Plate One: New Waste Bunker installed at the Mandalong Mine in 2013

Plate Two: Cooranbong Export Bin Sound Wall installed in May 2013.

Plate Three: Cooranbong Export Bin Sound Wall installed in May 2013.

Plate Four: Mandalong Haul Road Rehabilitation October 2013.

Plate Five: Cooranbong Truck Wheel Wash installed in October 2013.

Plate Six: Cooranbong Truck Wheel Wash installed in October 2013.

APPENDIX 12
Wetlands Monitoring Report

Centennial Coal

Mandalong Mine

Monitoring the Impact of Subsidence on Wetlands of the Mandalong Floodplain

Wetland Monitoring Report

November 2013

HUNTER ECO

Centennial Coal Environment Matters

Executive Summary

Conditions of Consent for the Centennial Mandalong Mine require monitoring and management of wetlands in the Mandalong subsidence area. In fulfilment of this condition, eight wetlands are monitored twice yearly (April and November) with baseline monitoring having been conducted in April 2009. Three wetlands (1, 2 and 3) are control sites unaffected by subsidence and five are within the subsidence area. This report presents the results from monitoring in November 2013 combined with all prior data.

Monitoring consists of collecting plant species abundance data in contiguous square metre quadrats along transects that start on dry land and continue into the aquatic habitat. Water is also analysed for the concentration of several nutrient and chemical components and properties.

Similarity analysis has shown that the monitoring transects include three habitat types: dry, margin and aquatic. A feature of the floristic content of the aquatic habitat has been a high level of variation between monitoring occasions.

Floristic data show a significant and positive increase in the total number of species recorded for each wetland since the start of monitoring with about 60% of that number actually present on any one occasion. Weed species are almost entirely confined to dry habitat and have remained at the same level throughout.

In April 2009 all wetlands contained water but during 2010 all but Wetland 3 became dry. Since then rainfall has continued to increase with water levels restored.

Wetland 6 is located over the pillars between longwalls 11 and 12 that were subsided in September 2011 and April 2012 respectively. Subsidence monitoring indicates that the land has tilted to the north west and this appears to have been expressed by the original dry habitat vegetation being replaced by margin habitat species due to increased inundation.

Wetland 7 is located over the pillars between longwalls 13 and 14. Longwall 13 was subsided in September 2012 with no detectable impact as at November 2013; there are no subsidence monitoring lines near this wetland.

Wetland 8 has been subject to subsidence for four years as of November 2013 and there is no detectable impact in the wetland itself. It does appear however that there is increased ponding immediately south of this wetland.

A two metre mesh fence around Wetland 2 will keep out feral deer and other herbivores. Fencing around Wetlands 4 and 5 is normal stock fencing that is proving ineffective against deer. Evidence is now accumulating pointing to a consistent reduction in diversity across all wetlands since monitoring commenced and the cause is tentatively suggested to be increased herbivory by both domestic and feral animals.

Centennial Coal

Mandalong Mine

Monitoring the Impact of Subsidence on Wetlands of the Mandalong Floodplain

Wetlands Monitoring Report November 2013

Report prepared for Centennial Mandalong

January 2014

HUNTER ECO

Colin Driscoll
Environmental Biologist

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Centennial Coal Mandalong Mine
Wetlands Monitoring Report November 2013

1 Introduction

Centennial Coal received development consent in 1998 to extend the life of the Cooranbong Colliery by mining coal under the Mandalong Valley with mining commencing in January 2005. Mandalong Mine utilises an innovative narrow longwall design that uses the strength and thickness properties of a massive conglomerate rock bed (beam) that lies within the overlying strata. The mine design aims to minimise subsidence impacts on property, floodplain and the environment. Surface subsidence occurs progressively as each longwall is extracted. The subsidence effect at the surface will occur as a bending movement progressively in the form of a shallow wave, which moves across the ground at approximately the same speed as the mining face progresses in the longwall panel, which is typically 100 metres per week.

There are 3 relevant outcomes of subsidence:

1. vertical subsidence – the lowering of the land surface;
2. tilt – a change of grade on the surface arising from differential lowering of the land surface; and
3. strain – the stretching or squeezing of the land surface as it lowers to the new level.

The level of subsidence is a combination of beam sag over the individual panels, compression of the remaining coal pillars, and compression of the immediate roof and floor strata, as each longwall is extracted. Surface subsidence results from the sag of overburden strata above the extracted longwall panels and also from compression of strata above, within and below the coal pillars.

The subsidence effect that will occur at a particular point on the surface depends on where the point is located relative to the longwall panels. The actual level of subsidence effects that occur on the surface is dependent on the final mine plan, geological conditions and depth of cover.

Amongst a variety of physical impacts caused by this surface movement, alteration of hydrology and flow regimes can result in changes to existing water-dependent ecosystems.

Conditions of Consent for the Mandalong mine require monitoring and management of wetlands in the Mandalong subsidence area. A wetlands management and monitoring plan (WMP) was prepared (Hunter Eco 2009a) which identified eight wetlands for monitoring (**Figure 1**). Wetlands 1, 2, and 3 are located outside of the subsidence impact area and are control sites while the remaining 5 wetlands are within the subsidence impact area.

In April 2009 a baseline report was prepared (Hunter Eco 2009b) which described the status of the wetlands prior to any subsidence having occurred. The current report provides data and analysis from the tenth 6-monthly monitoring of the 8 wetlands including baseline monitoring. Data for the baseline report were recorded prior to any subsidence having occurred at any of the five wetlands within the subsidence impact area. As of November 2013 subsidence had been completed for longwall panels 13 and 14 (**Figure 1**). Wetland 7, being located directly over a pillar between panels 13 and 14, now has the potential to be impacted by subsidence.

2 Baseline condition summary

The baseline report found that the 8 wetlands were essentially of the same floristic composition. The structure along the monitoring transects was divided into dry, margin and aquatic habitat as shown by Split Moving Window (SMW) and Multi-Dimensional Scaling (MDS) analysis (see Section 5.3). Dry habitat was made up almost entirely of introduced grasses, herbs and sedges whereas margin and aquatic habitats were mostly free from weeds.

Water analysis showed that both nitrogen and phosphorous levels were high to extremely high. These elevated levels were suggested to be a consequence of the rural agricultural landscape in which the wetlands are located. This was supported by there being a positive correlation between the amount of cleared land in a wetland catchment and the nutrient content of the water.

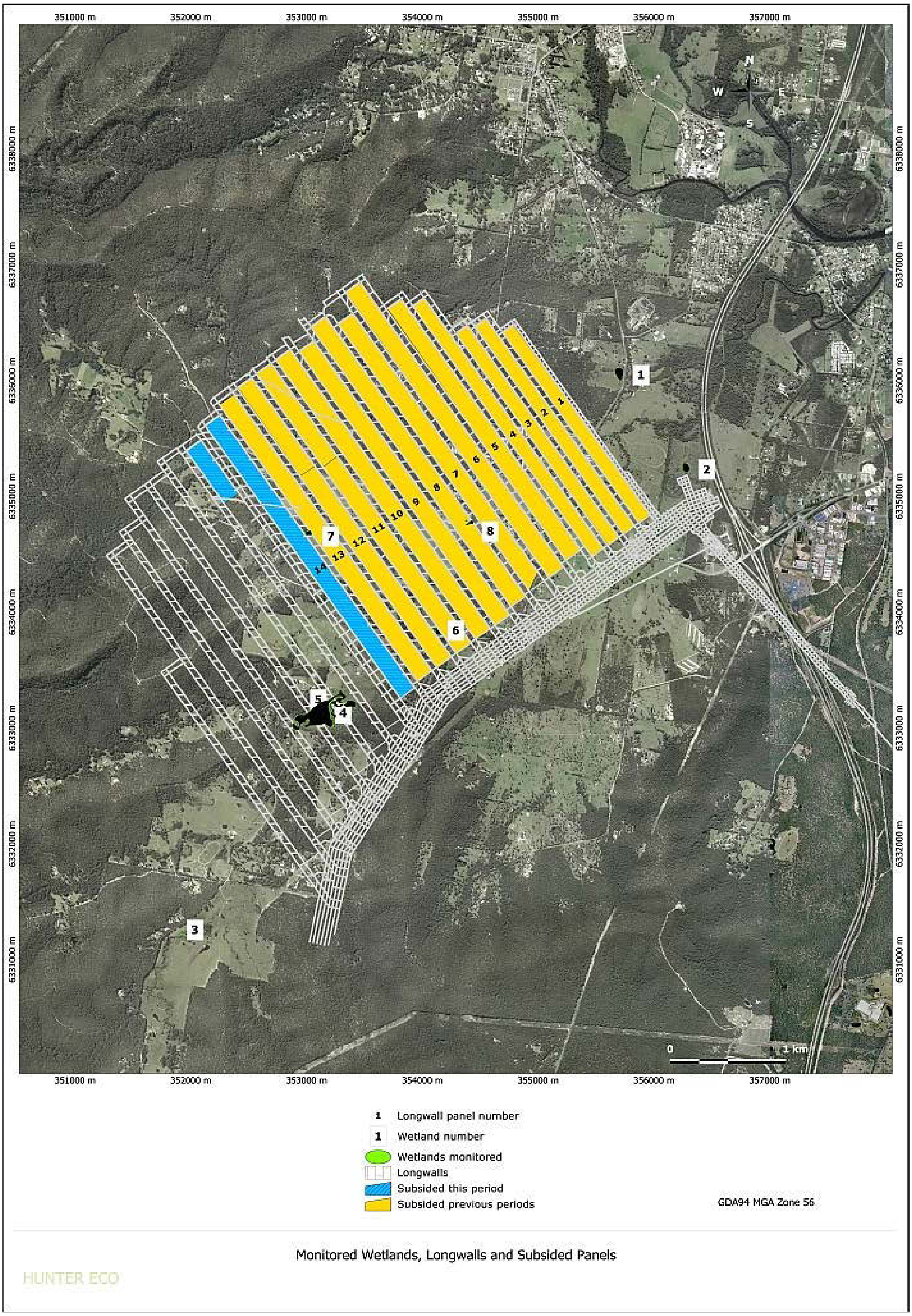


Figure 1 Monitored wetlands, longwalls and subsided panels

3 Field methods

The WMP specifies the indicators (**Table 1**) to be used in monitoring for any changes to wetlands over time.

Table 1 Summary of the wetland condition indicators to be used in the monitoring program.

Factor	**Data**
Wetland catchment	Monthly rainfall data Proportion of cleared to vegetated area
Physical form	Standardised photography
Hydrology	Local alterations to flow into and from the individual wetland
Water properties	Nitrogen, Phosphorous, pH, total suspended solids, salinity, temperature and dissolved Oxygen
Soils	Observations of the extent and nature of disturbance to the soil within the wetland and immediate surrounds
Biota	Floristic species, abundance and cover data collected from 1mx1m quadrats along a transect running from dryland vegetation to the deepest wadeable point or the approximate centre of the wetland.

General observations were made of the overall wetland condition in its immediate surroundings and a series of photographs were taken for each wetland.

Floristic monitoring was conducted using a transect of contiguous 1m x 1m quadrats (**Figure 2**) starting on dry land and continuing into the wetland, either to the centre or the deepest wadeable point. Permanent markers were placed at each wetland so that the same transect could be monitored on each subsequent monitoring occasion. A metric tape was tied between the markers as a guide and a 1m square light frame was flipped over along the line with floristic data being recorded in each quadrat. The side of the line (facing the wetland) on which the transect was located was also recorded so the same areas would be monitored on each occasion.

Data recorded in each quadrat was cover-abundance of all plant species scored using the modified Braun-Blanquet 1-6 scale (**Table 2**).

Table 2 The modified Braun-Blanquet scale for cover/abundance.

MBB:	1 = few individuals + <5% cover *	* Herbs, sedges & grasses	<5 individuals = 1
	2 = many individuals + <5% cover *		>= 5 individuals = 2
	3 = 5 - <25% cover	* Shrubs & small trees	< 5 individuals = 1
	4 = 25 - <50% cover		>= 5 individuals = 2
	5 = 50 - <75% cover		
	6 = 75 - 100% cover	* Medium-large overhanging tree	= 2

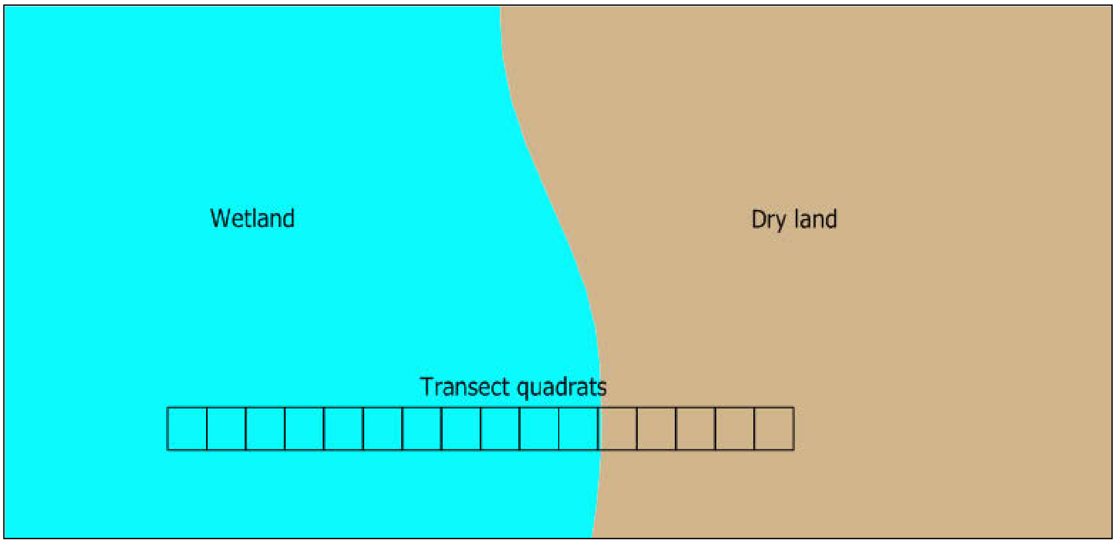


Figure 2 Schematic of a sampling transect.

4 Data analysis

4.1 Within wetland analysis

Data from the transect quadrats were analysed to determine attributes of each wetland individually. This involved determining whether there were plant species assemblages that were common to the position along the transect, and what the dominant species were for these assemblages. Also indices were computed for the various assemblages that described species diversity and richness. Primer 6 (Clarke & Gorley 2006) was used for similarity analysis and Minitab 16 for statistical analysis.

<u>Split Moving Window (SMW)</u>

This method has been used to detect boundaries for a variety of data (e.g. benthic communities, Panis & Verheyen (1995); vegetation patterns, Munoz-Reinoso & Garcia Novo (2000); vegetation ecotones, Boughton et al (2006)). In the case of the monitored Mandalong wetlands, SMW is applied to determine boundaries between similar vegetation groups. In principle an even number of quadrats is divided in half and the similarity distance between the two halves is determined. The most commonly used measure is the squared Euclidean distance (SED). The finest scale that can be used is two quadrats but in most cases this results in a lot of noise that can obscure real information. That was the case with the sampled Mandalong wetlands so a window of four quadrats was used (**Figure 3**) with raw abundance data being averaged for each pair and SED being calculated for the averages. SED was then plotted against window number.

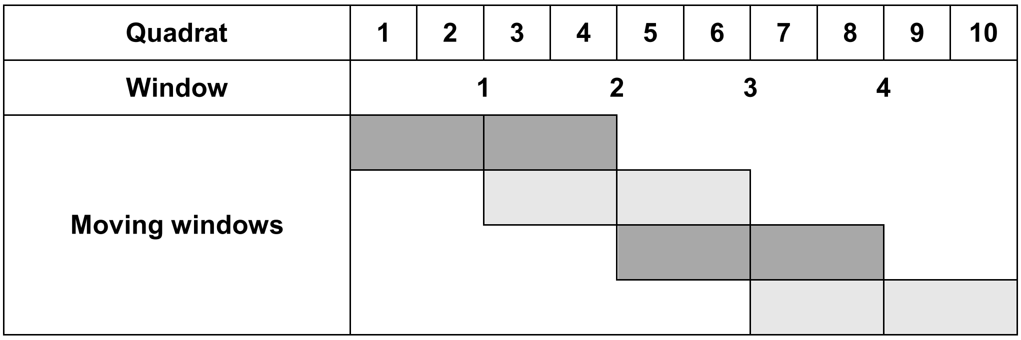


Figure 3 Schematic for SMW analysis using a window of four quadrats.

<u>Multi-dimensional Scaling (MDS)</u>

This is a procedure that compares species and abundance in all quadrats from a transect, and groups those quadrats that are similar. MDS can show finer detail than SMW but any changes detected using SMW should be close to the changes determined using MDS. The Bray-Curtis similarity measure was computed on standardised data. Several stages of data transformation are available (e.g. Square Root, 4th Root or Logarithmic) which increasingly down-weigh the contributions from the most common species. In the case of the Mandalong analysis the data were left untransformed.

<u>Biodiversity</u>

In addition to the SMW and MDS analysis, biodiversity indices were computed for the total number and abundance of species in each transect. The indices used were:

- Shannon Diversity Index (H')
  A measure of the diversity present in a set of samples. The highest diversity would be where all species were equally abundant and lower diversity values arise where one or some species are present in much greater amounts than the other species. This index was calculated using log(e).

- Pielou's Evenness Index (J')
  A measure of how evenly spread the numbers of all species are and is the proportion H'/H'_{max} where H'_{max} is the highest possible Shannon index where all species are equally abundant.

- Margaleff Richness Index (d)
  A measure of the number of species present for a given number of individuals.

These measures are only comparable between data sets having the same sampling structure and so are used to discern any changes in individual wetlands over time.

4.2 Between wetland analysis

For this analysis data from the eight transects were combined in order to determine similarity across all wetlands. Each quadrat was coded as to whether it was in dry, margin or aquatic habitat as determined using SMW/MDS analysis described above. For each wetland, species abundance scores in each quadrat were averaged for each of the three habitat types. The combined data matrix was standardised, and Bray-Curtis similarity was computed on untransformed data. A cluster analysis was then carried out combined with the SIMPROF routine that determines significant groupings. Finally a MDS plot was prepared showing the relative similarity of all samples.

The SIMPER routine of Primer 6 was used to determine the dominant species present in each identified habitat type. Basic statistics were computed using Minitab 16 (Minitab 2010).

Throughout this report, significance refers to the level of confidence that an outcome would not occur by chance. Levels of significance are commonly quoted as *p* (probability) values so a *p*-value of <0.05 means that there is greater than 95% probability that the outcome is not random (or less than 5% chance that it is random).

5 Results and discussion

Transect data were collected on 25th and 26th of April 2013. A photographic supplement to this report presents photographs of all wetlands for all monitoring occasions.

5.1 Floristics

The cumulative number of species recorded across all monitoring occasions and wetlands now totals 113 species (**Appendix 1)** from 42 families. **Figure 4** shows plots of the cumulative total species recorded for each wetland and each monitoring occasion. As expected, the lines are beginning to level out (approaching an asymptote) as there is a limit to the number of species likely to be present.

This increase in species over time can be considered to be a variation of the ecological 'law' that the number of species recorded increases with increasing sampling area (Holt *et al.* 1999). In this case increased area has been replaced by increased time observing the same area.

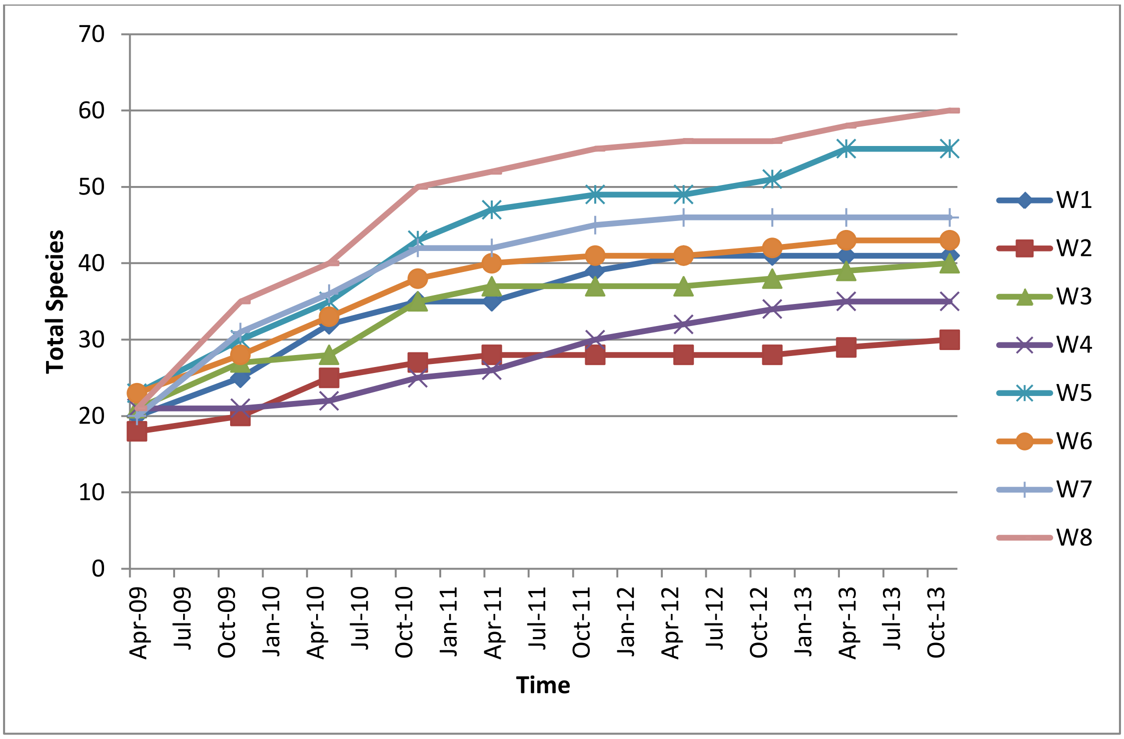


Figure 4 Cumulative species for each wetland transect over time

The total number of species recorded has close to, or more than, doubled for each wetland since the start of monitoring and is an indication of the size of the seedbank. Further analysis (data not shown) revealed that at any one monitoring occasion for any wetland, less than two thirds of the total possible species were present.

5.1.1 Weeds

Here the relationship between native species and weed species recorded at each monitoring occasion is investigated. The aim was to determine whether there was a trend over time in the proportion of weeds to native species. **Figure 5** shows plots, with trendlines, of the proportion of weed species to total species recorded on each monitoring occasion.

To determine whether the trendlines shown in **Figure 5** were significant, a least squares regression was conducted (**Table 3**). In April 2013 regression analysis showed that the trend was significant for Wetlands 6, 7 and 8 ($p < 0.05$). However in November 2013 the trend was only significant for Wetland 6, with a slight increase in weeds for Wetlands 7 and 8 negating the prior significant fall. For all other wetlands, even though the trendlines might rise or fall, there has been no significant change in the proportion of weeds to native species.

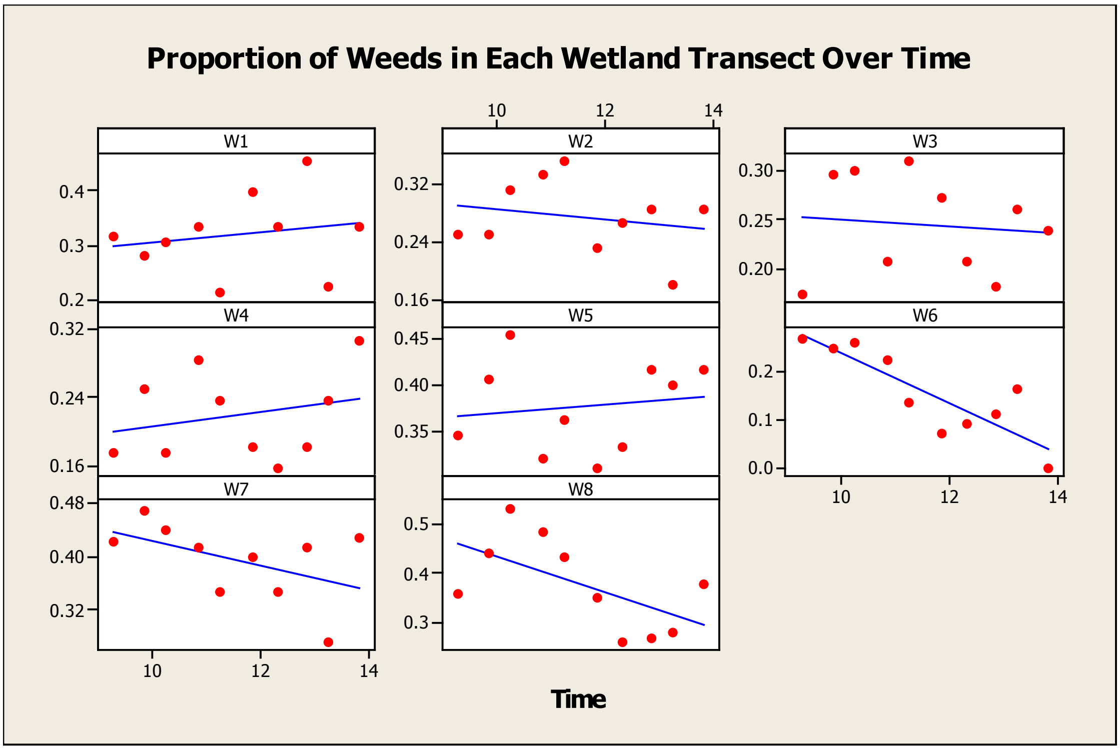


Figure 5 The proportion of weed species to total species in each wetland and each monitoring occasion

Table 3 Regression results for the ratio of weeds to total species versus time

Wetland	r^2	F-value	Significance (*p*-value)	Significant
W1	0.037	(1,7) 0.30	0.596	No
W2	0.048	(1,7) 0.41	0.542	No
W3	0.012	(1,7) 0.10	0.762	No
W4	0.061	(1,7) 0.52	0.492	No
W5	0.019	(1,7) 0.16	0.703	No
W6	0.724	(1,7) 20.97	**0.002**	**Yes**
W7	0.247	(1,7) 2.63	**0.144**	**No**
W8	0.354	(1,7) 4.38	**0.070**	**No**

This analysis has only dealt with diversity of weed species. For example, for five weed species, whether there was only one individual of each species or many more, there would still only be five weed species present. Section 6.3 below looks at the abundance of weed species along with native species in relation to habitat type.

5.2 Water levels and rainfall

In the November 2012 survey Wetlands 6 and 8 were dry, with low water levels in the remainder. In the current survey all wetlands were full. Water level in wetlands will primarily be a function of recent rainfall runoff from the immediate catchment. Monthly rainfall recorded at the Centennial Mandalong automatic weather station (AWS) since January 2009 (**Figure 6**) shows an overall pattern of increasing rainfall as indicated by the black trendline.

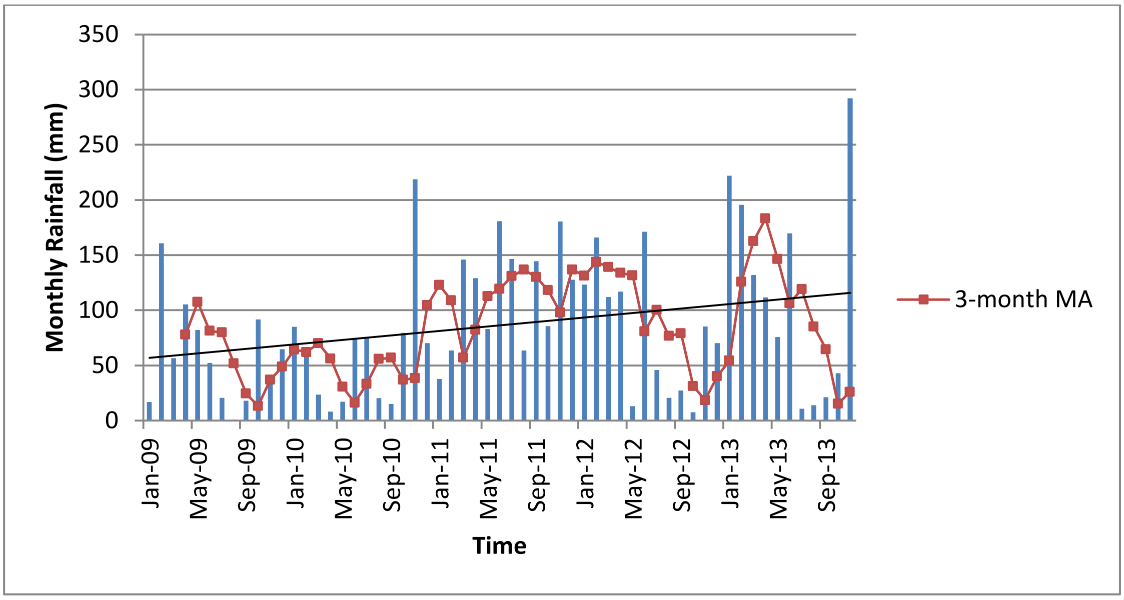
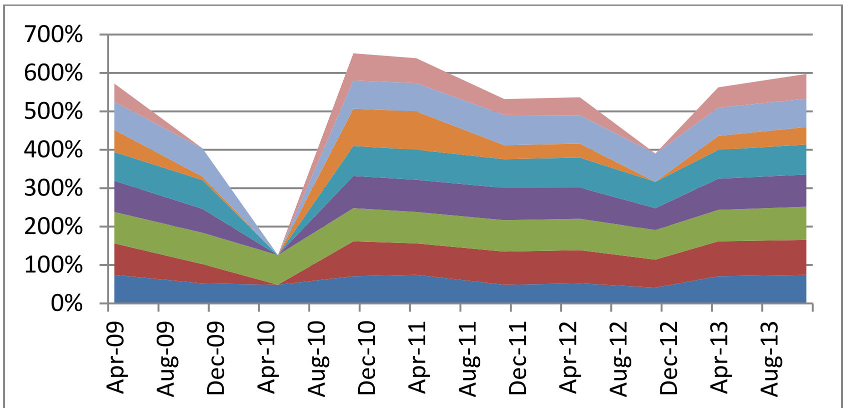


Figure 6 Monthly average rainfall at Mandalong for 2009 to November 2013
3-month MA is a 3-month moving average

The proportion of each transect containing water on each monitoring occasion is shown in **Figure 7**.



	Apr-09	Nov-09	May-10	Nov-10	Apr-11	Nov-11	May-12	Nov-12	Apr-13	Nov-13
W8	47%	0%	0%	71%	65%	41%	47%	0%	53%	65%
W7	74%	74%	0%	74%	74%	79%	74%	74%	74%	74%
W6	58%	9%	0%	97%	100%	36%	36%	0%	36%	45%
W5	75%	75%	0%	78%	78%	75%	78%	69%	75%	78%
W4	81%	62%	0%	84%	84%	84%	81%	57%	81%	84%
W3	82%	82%	77%	86%	82%	82%	82%	77%	82%	86%
W2	82%	50%	0%	91%	82%	86%	86%	73%	91%	91%
W1	74%	52%	48%	70%	74%	48%	52%	41%	70%	74%

Figure 7 The proportion of each transect containing water over time

5.3 Individual wetland detail

Results of similarity analysis of transect quadrats are provided in this section. Habitat classification was determined by the distinct grouping shown in the MDS plot, supported by cluster and SMW analysis. Each plot shows a trajectory line that follows the plots in numerical order from the dryland start. In each case the trajectory line confirms that quadrats in the three habitat groupings occur in order along the transect.

5.3.1 Wetland 1

Again this wetland (**Figure 8**) was full of water, with no aquatic vegetation present, as was the case in May and November 2012 and April 2013.

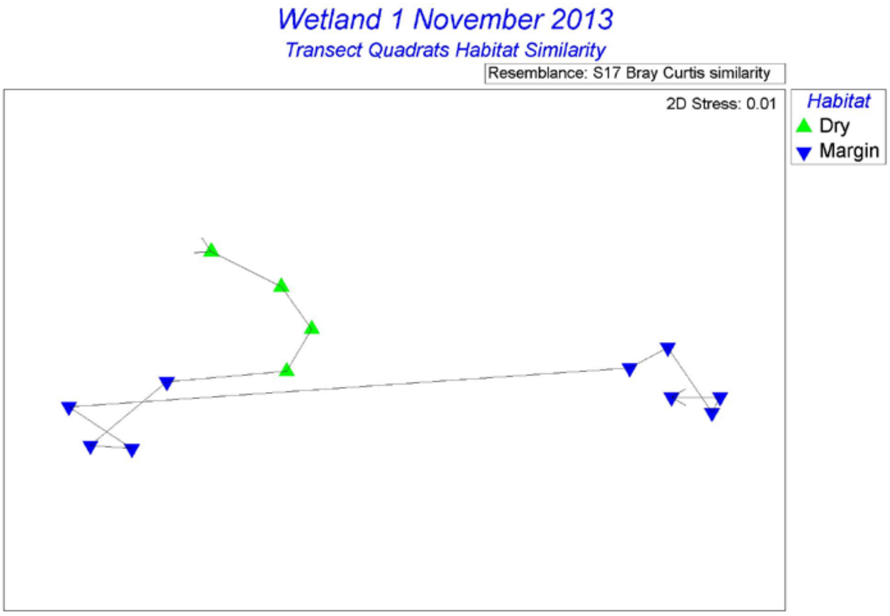


Figure 8 MDS showing Wetland 1 transect quadrats grouped according to habitat type

5.3.2 Wetland 2

This wetland (**Figure 9)** was again full of water. However, other than for two quadrats at the start of the aquatic habitat, there were no water plants present. As reported previously, feral deer were recorded grazing in this wetland and are likely to have contributed to the loss of aquatic vegetation. This wetland was fenced from domestic stock but the tenant on the property reports having seen many deer inside the fence.

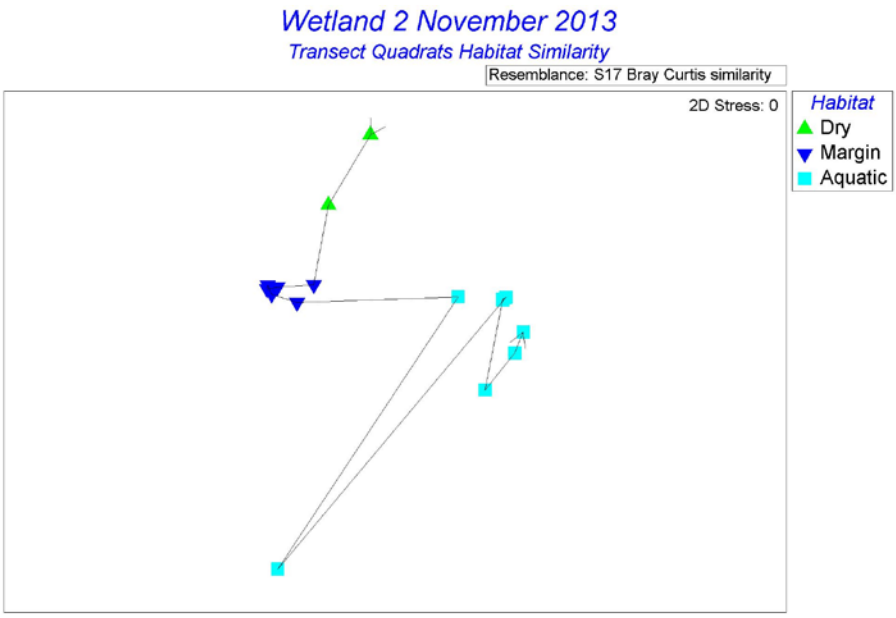


Figure 9 MDS showing Wetland 2 transect quadrats grouped according to habitat type

5.3.3 Wetland 3

Increased water levels since November 2012 have resulted in a clearer definition of the aquatic habitat (**Figure 10**) that had previously started to show mixed characteristics of all three habitat types.

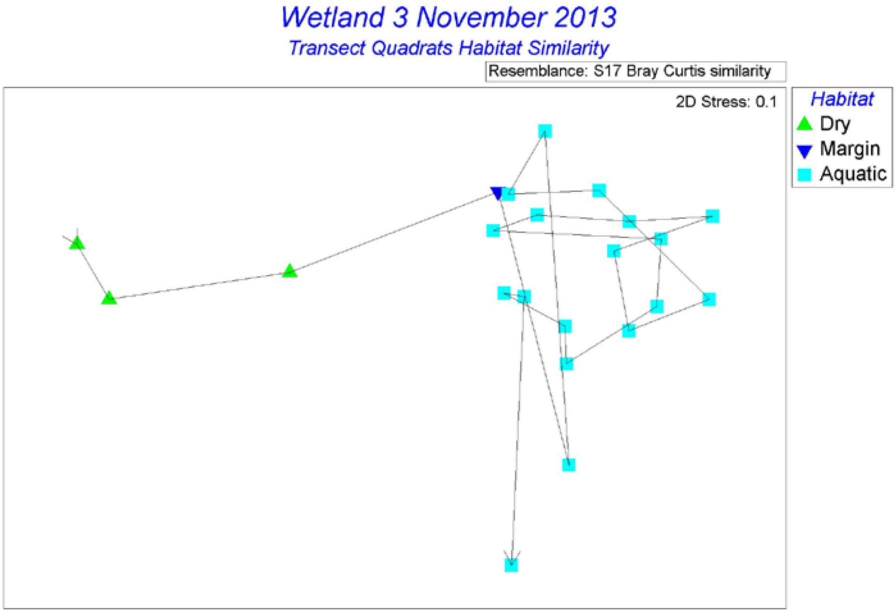


Figure 10 MDS showing Wetland 3 transect quadrats grouped according to habitat type

5.3.4 Wetlands 4 and 5

These transects are on opposite sides of the one large wetland. Water levels were high and there were clear habitat transitions (**Figures 11 and 12**).

In November 2012 the weed *Isolepis prolifera* showed signs of contracting since May 2012 and this continued markedly (**Table 4**) in April 2013 and remained static in November 2013. So far there is no obvious explanation for these changes.

Table 4 *Isolepis prolifera* abundance over time
The top row shows the quadrat number along the monitoring transect and the table cells show the abundance estimate within each quadrat.

Month	7	8	9	10	11	12	13
April 09			1				
Nov 09		2	4				
May 10			3	3	3		
Nov 10		3	3	1	1	1	
Apr 11		4	4	3	2	1	1
Nov 11		4	4	4	4	4	2
May 12		1	4	5	5	6	2
Nov 12	1	5	5	3	2	1	
April 13	1	3	3				
Nov 13	1	4	3				

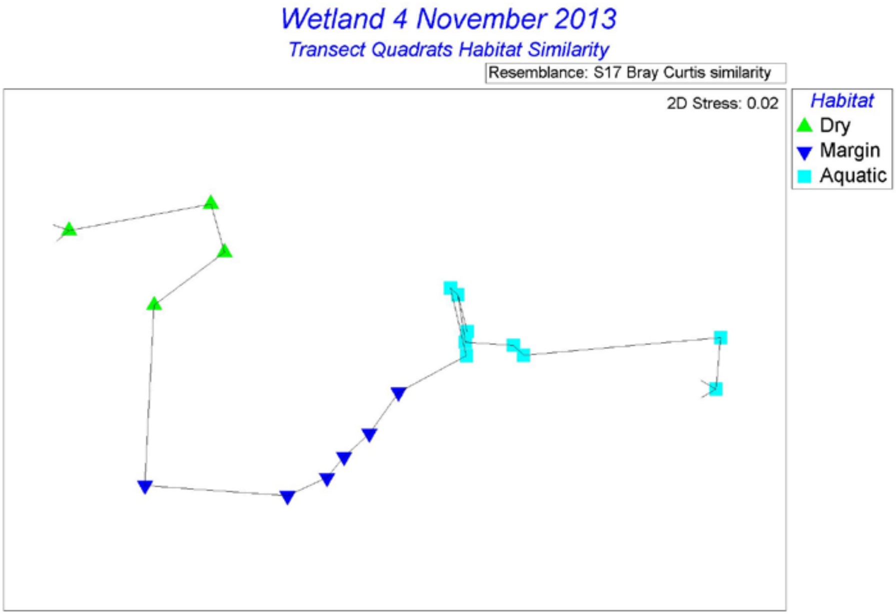


Figure 11 MDS showing Wetland 4 transect quadrats grouped according to habitat type

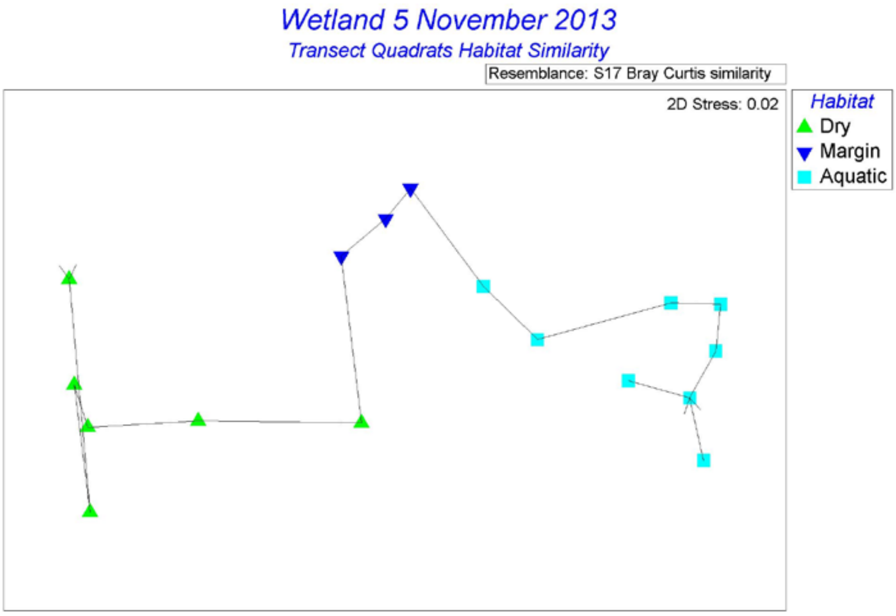


Figure 12 MDS showing Wetland 5 transect quadrats grouped according to habitat type

5.3.5 Wetland 6

This wetland was full of water and **Figure 13** shows a sharp distinction between margin and aquatic habitat. As previously, there was no longer any dry habitat present. The Aquatic habitat was dominated by dense *Cyperus exaltatus*.

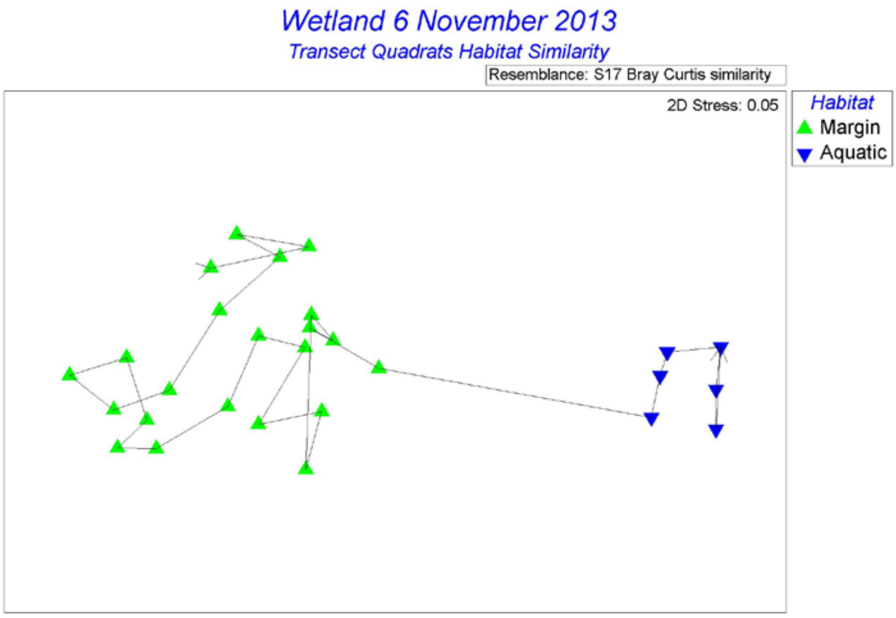


Figure 13 MDS showing Wetland 6 transect quadrats grouped according to habitat type

Figure 14 Wetland 6 aquatic habitat dominated by grazed Cyperus exaltatus

The dense patch of the threatened *Maundia triglochinoides* reported in November 2012 (**Figure 15**) was substantially reduced in April 2013 (**Figure 16**) and further reduced in November 2013 (**Figure 17**). It is not known what causes this change but the abundance of this species has also reduced since April 2009 in wetlands 1, 2 and 4.

Figure 15 Wetland 6 Maundia triglochinoides patch November 2012

Figure 16 Wetland 6 Maundia triglochinoides patch April 2013

Figure 17 Wetland 6 Maundia triglochinoides patch November 2013

5.3.6 Wetland 7

Again this wetland (**Figure 17**) shows a clear transition from Dry to Aquatic habitat with no Margin habitat. This is a consequence of a sharp physical transition from dry land to water along the monitoring transect. Other parts of this wetland have a more gradual transition that includes the more typical Margin habitat.

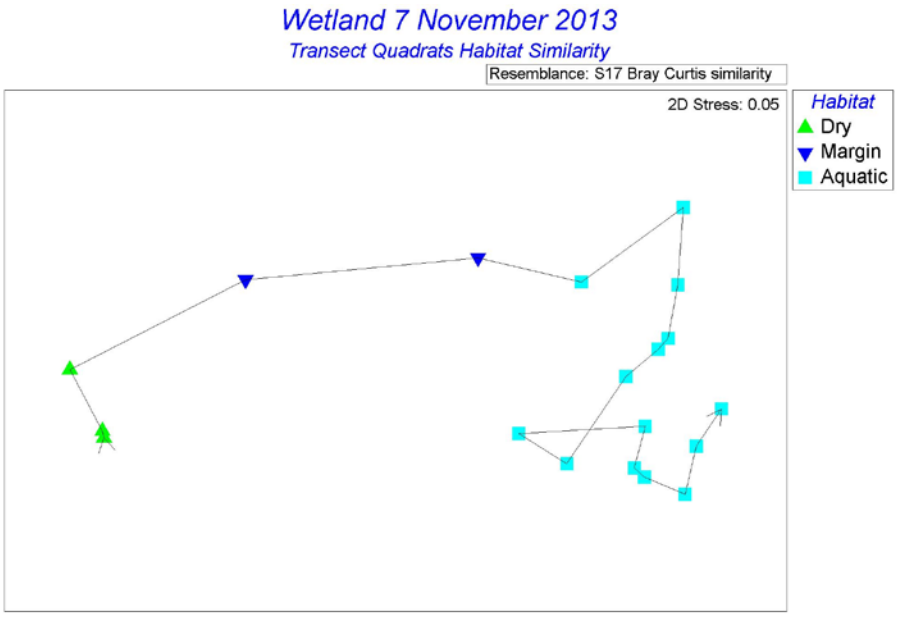


Figure 17 MDS showing Wetland 7 transect quadrats grouped according to habitat type

There is no indication of any impact from the recent subsidence.

5.3.1 Wetland 8

This wetland was again full of water and **Figure 18** shows the distinct habitat transitions. While there was no evidence of any change in this wetland that could be attributed to subsidence, it is apparent that water has ponded immediately to the south.

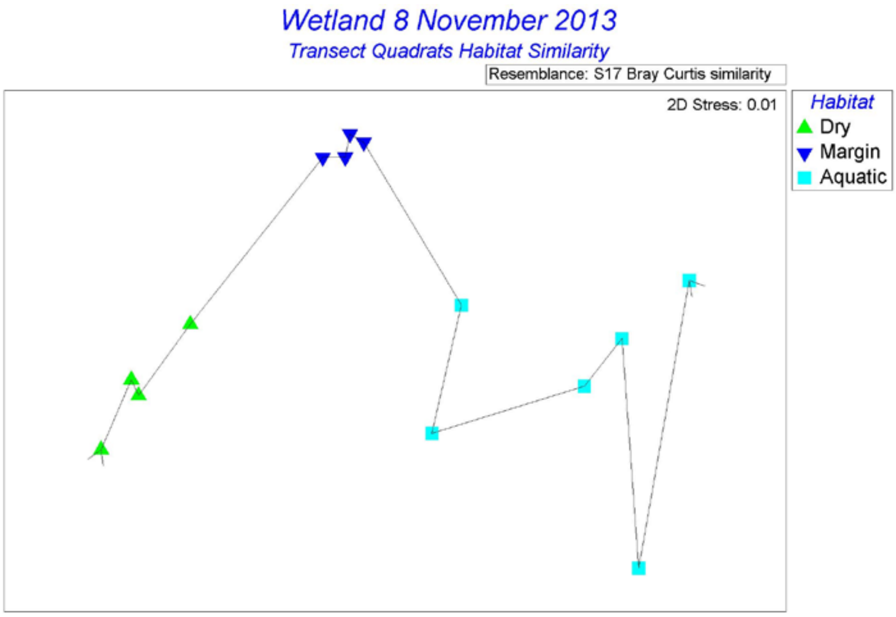


Figure 18 MDS showing Wetland 8 transect quadrats grouped according to habitat type

5.3.2 Combined Wetlands

To assess whether the pattern of habitat distribution was similar across all wetlands, transect quadrat abundance data from each wetland were averaged for each species and each habitat type. An MDS analysis (**Figure 19**) shows clear separation of dry from margin and aquatic habitats while there is some overlap between the latter two.

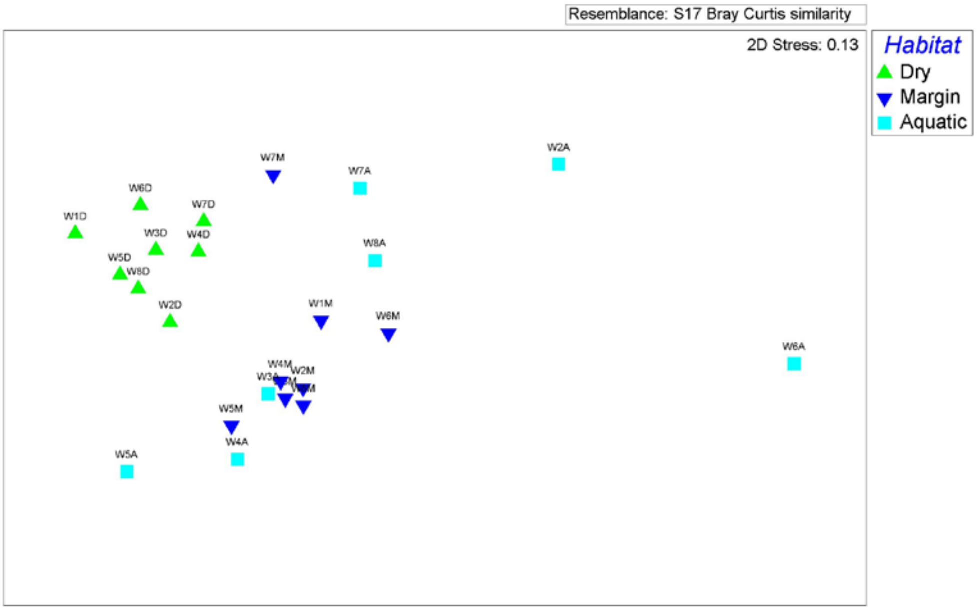


Figure 19 MDS showing habitat similarity across all wetlands

6 Aquatic Habitat

The quintessential character of a wetland is embodied in its aquatic habitat and this habitat is given particular attention in this program of monitoring wetlands for any subsidence impacts.

6.1 Extent of aquatic habitat

Figure 20 shows the metres of aquatic habitat in each transect over time. Previously regression analysis showed that in Wetland 6 aquatic habitat had been significantly reduced as margin habitat had extended. However, the extent has remained the same over the last four sampling periods including November 2013. For all other wetlands the variation has not been significant.

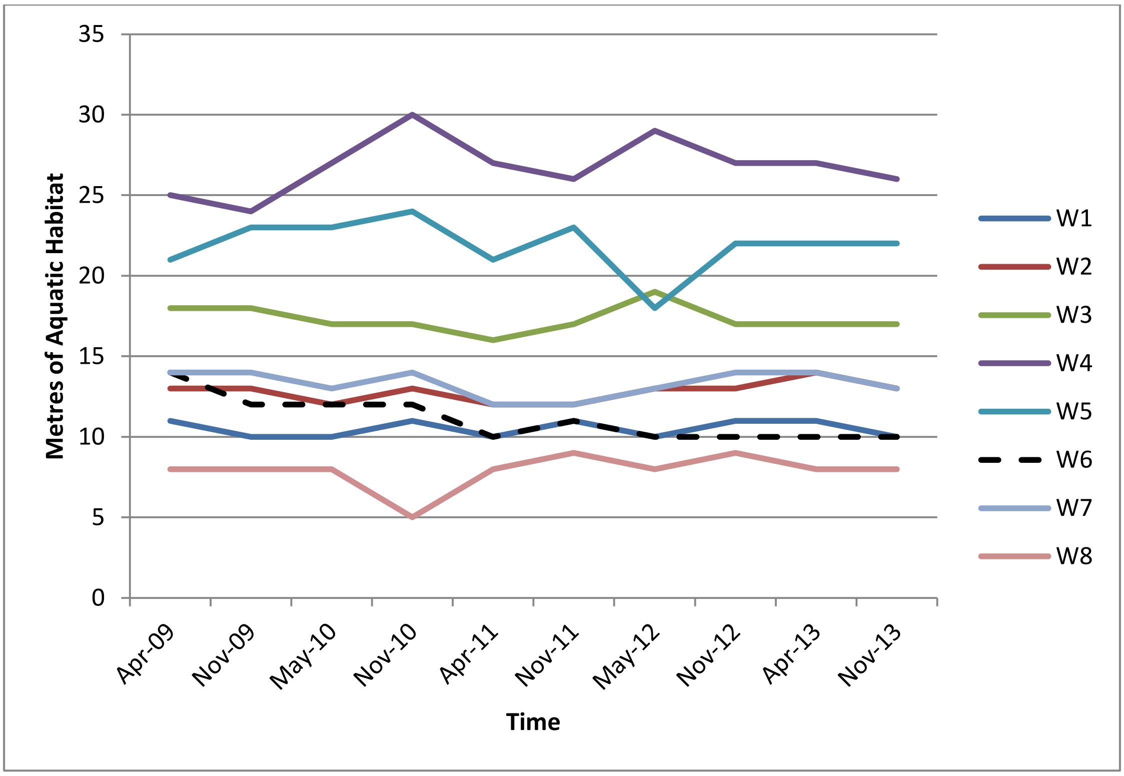


Figure 20 Metres of Aquatic habitat in each wetland transect over time

6.2 Aquatic habitat diversity indices

Three indices have been selected to describe the floristic content of Aquatic habitat: Margaleff richness; Shannon diversity; and Pielou's evenness. These measures are comparable between data sets having the same sampling structure and so have been compared over the nine sampling events since and including April 2009.

- **Margalef Richness Index** (d) is a measure of the number of species present for a given number of individuals.
- **Shannon Diversity Index** (H') is a measure of the diversity present in a set of samples. The highest diversity would be where all species were equally abundant and lower diversity values arise where one or some species are present in much greater amounts than the other species. This index was calculated using $\log_e$.
- **Pielou's Evenness Index** (J') is a measure of how evenly spread the numbers of all species are and is the proportion H'/H'_{max} where H'_{max} is the highest possible Shannon index where all species are equally abundant.

The aim of this analysis was to determine whether there were any trends over time in the three diversity indices for aquatic habitat. Of the three identified habitat types along each transect, the margin and aquatic habitats are particularly relevant to this monitoring program. In most wetlands the margin habitat is quite narrow so aquatic habitat is the focus of this analysis.

The analysis was made up of three parts: determining whether the data were normally distributed (dictates the subsequent analysis); plotting a least squares regression of each index against time to visualise any trend; and determining whether the variation between years was significant. The data were not normally distributed so the non-parametric Kruskal-Wallis test was first used to determine whether the variation in diversity over time was significant. This test was significant for all wetlands. However, this test is only reporting that changes in each diversity index between each monitoring occasion were significant.

A least squares regression was used to determine whether trends over time were significant. **Figures 21** to **26** show the plots with trendlines, and the regression results. Time is shown in abbreviated years 09, 10, 11 and 12. The analysis only includes wetlands with water and aquatic vegetation in that water.

Results are as follows:

- Wetlands 1 and 2 even with high water levels, there was no aquatic vegetation in either of these wetlands so no analysis was conducted.
- Wetland 3 showed no change in the Margaleff index but a significant increase in Pielou evenness and Shannon diversity.
- Wetland 4 shows a significant decrease in the three indices at a high level of certainty (99%) for Margaleff and Pielou and 95% for Shannon.
- Wetland 5 only Shannon diversity showed a significant fall over time with the other two indices remaining essentially unchanged.
- Wetland 6 all three indices have continued to fall significantly.
- Wetland 7 only Shannon diversity showed a significant rise over time with the other two indices remaining essentially unchanged.
- Wetland 8 both Margaleff and Shannon indices have continued to increase significantly.

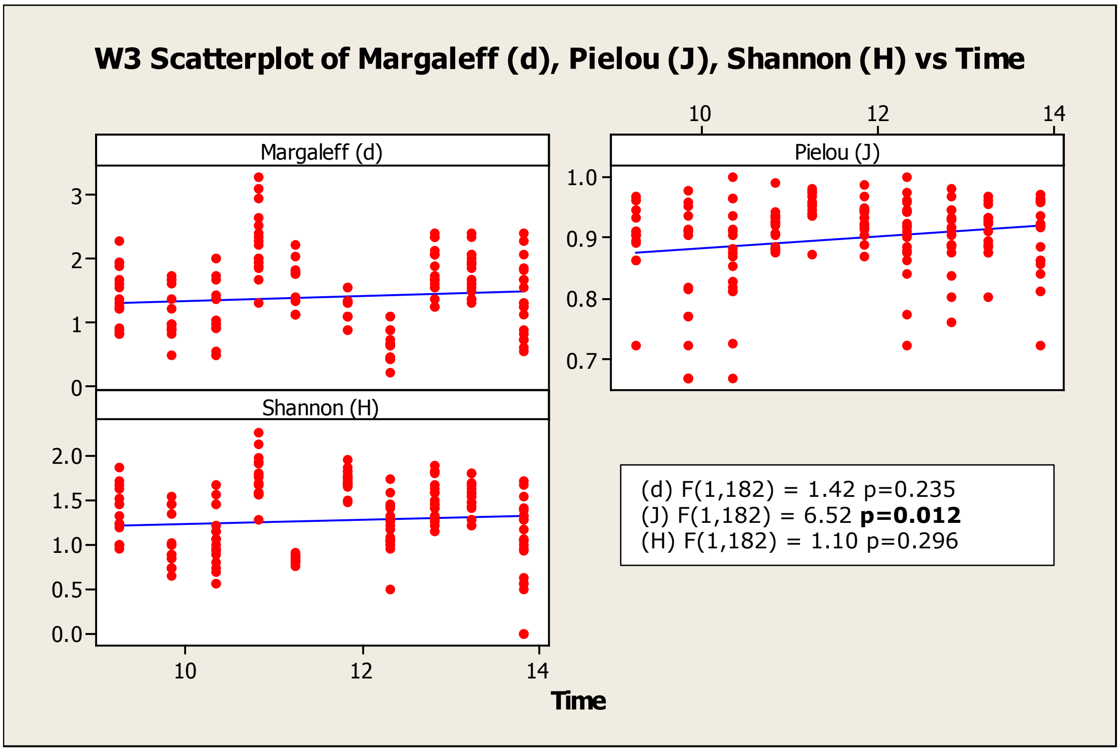


Figure 21 Wetland 3 plots showing the trend of the three diversity indices for aquatic habitat over the ten monitoring occasions

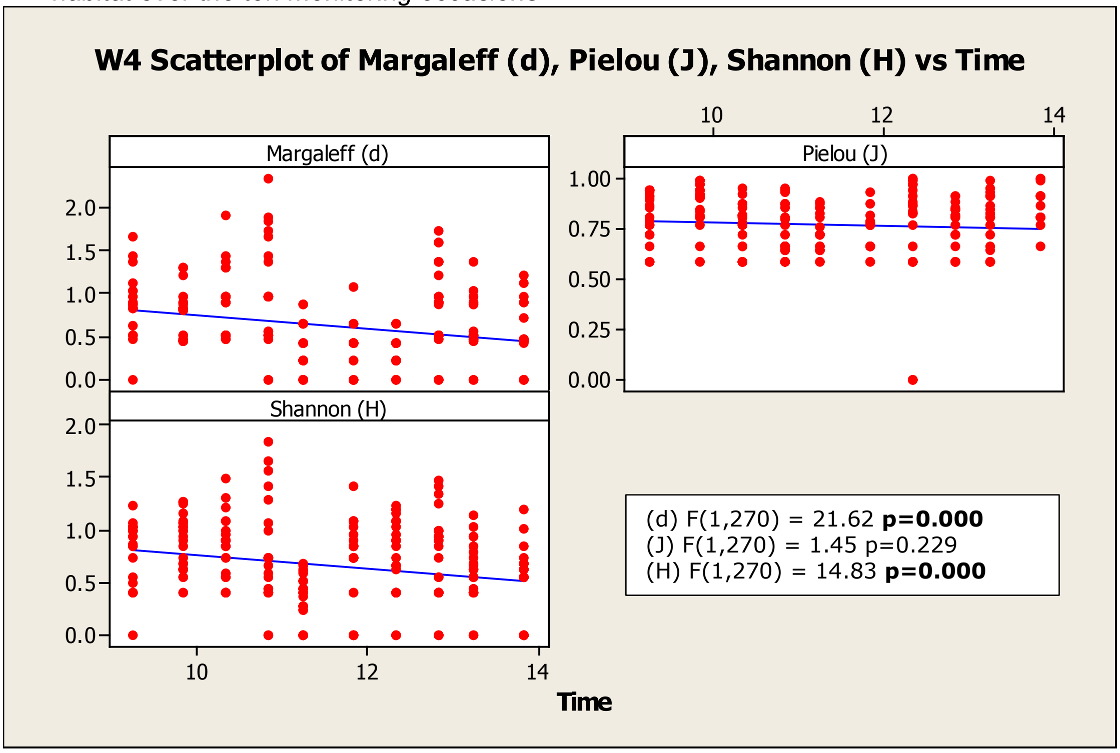


Figure 22 Wetland 4 plots showing the trend of the three diversity indices for aquatic habitat over the ten monitoring occasions

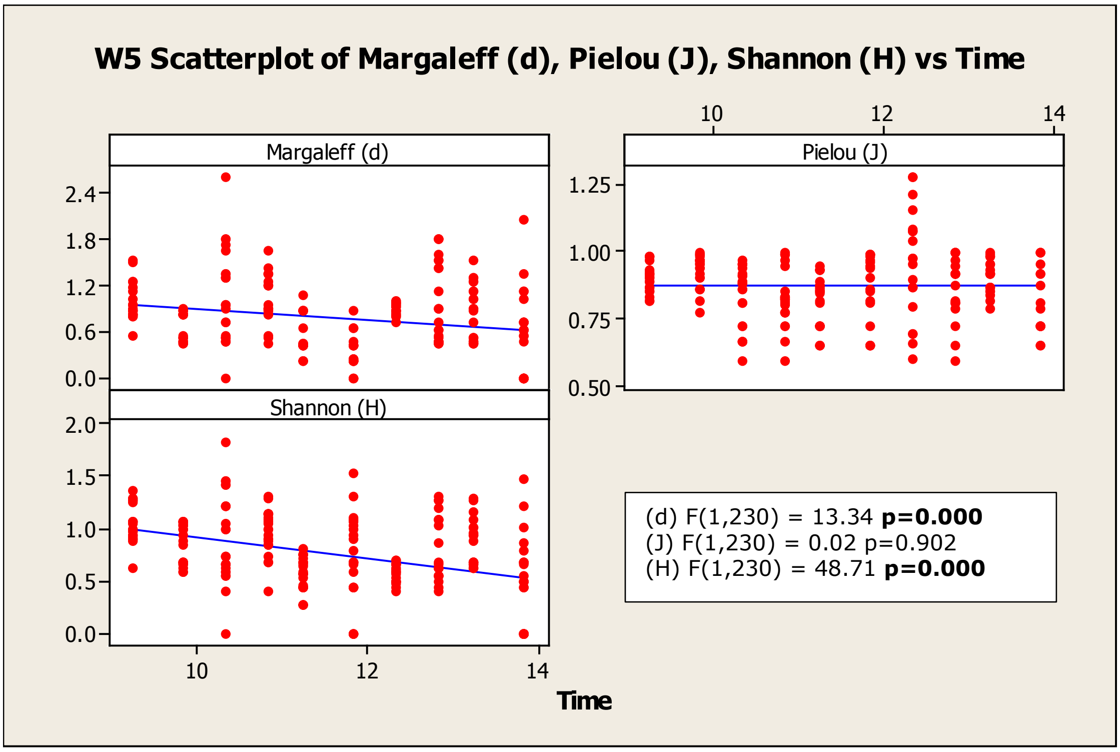


Figure 23 Wetland 5 plots showing the trend of the three diversity indices for aquatic habitat over the ten monitoring occasions

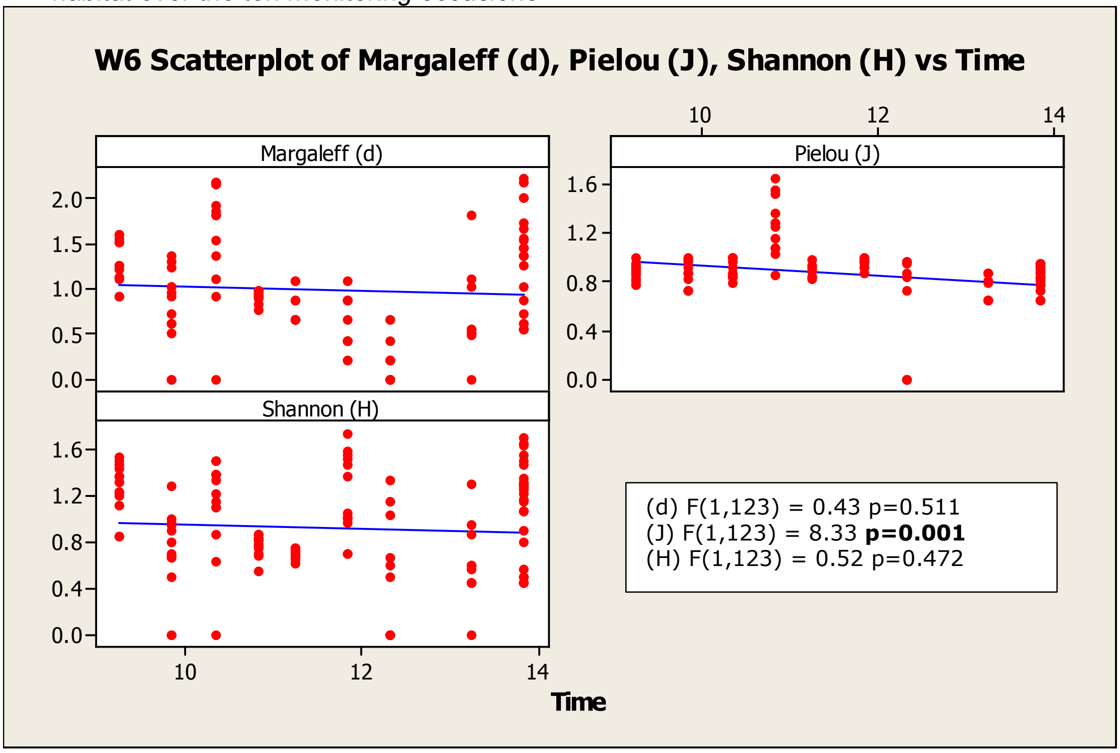


Figure 24 Wetland 6 plots showing the trend of the three diversity indices for aquatic habitat over the ten monitoring occasions

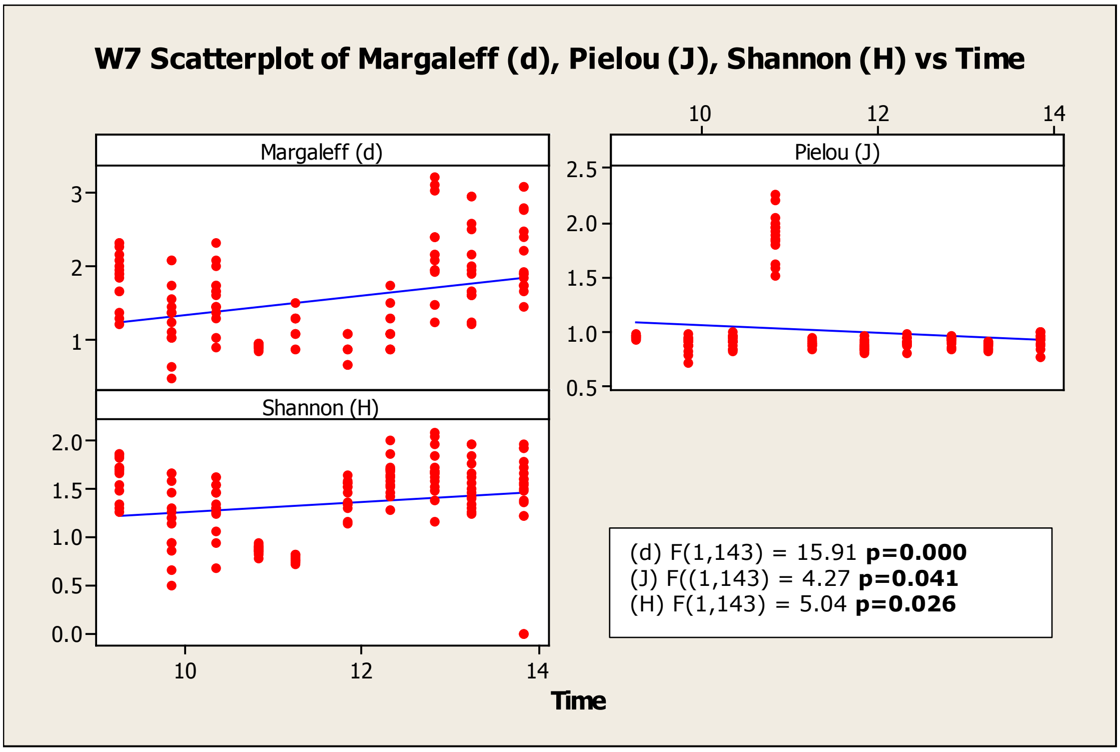


Figure 25 Wetland 7 plots showing the trend of the three diversity indices for aquatic habitat over the ten monitoring occasions

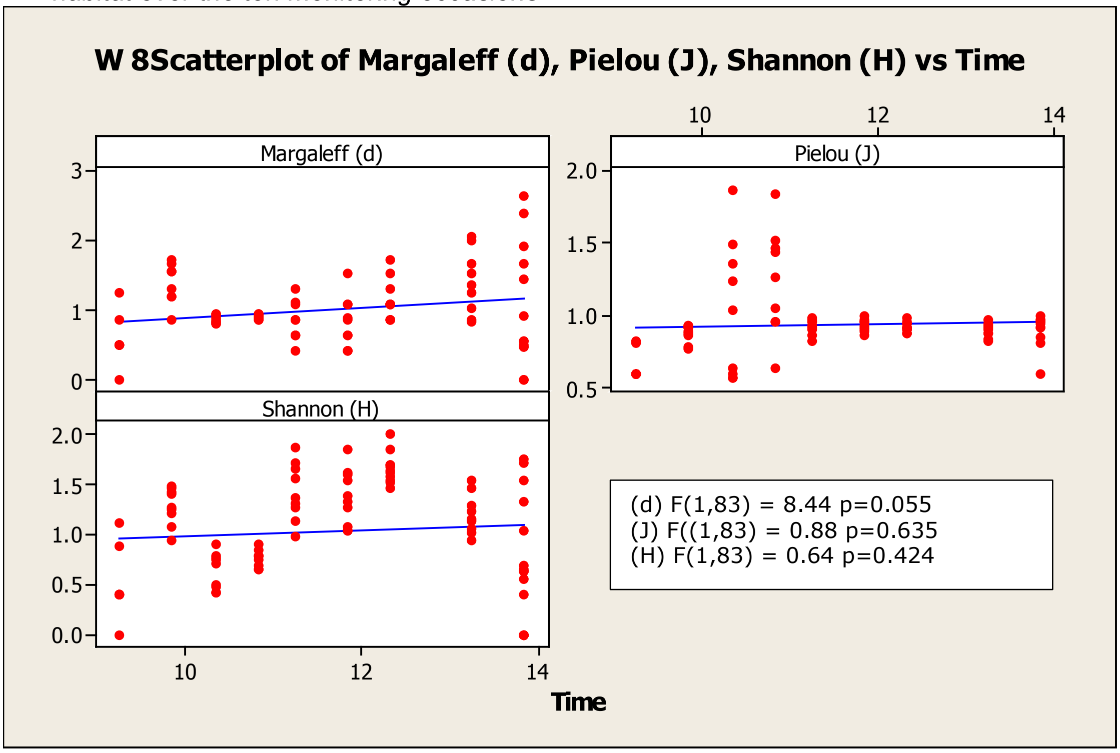


Figure 26 Wetland 8 plots showing the trend of the three diversity indices for aquatic habitat over the six monitoring occasions

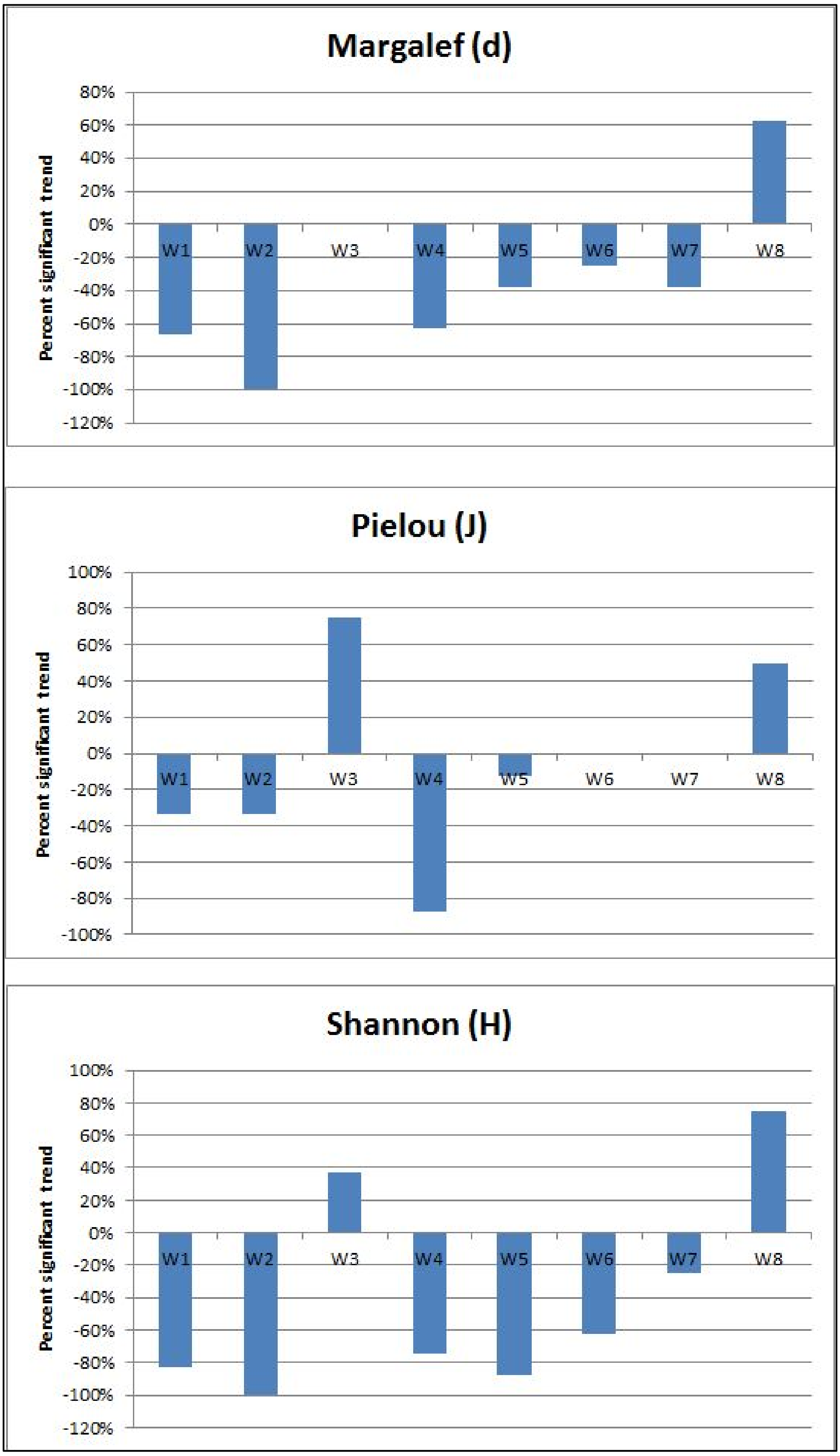


Figure 27 Summary of significance trends for diversity indices for each wetland

Trend is the net of positive and negative significant trends for each monitoring occasion starting November 2010.

As the scatterplots (**Figures 21 – 26**) indicate, there is a high level of variance in each diversity index with the result that a significant trend on one occasion might not be significant on the next occasion. **Figure 27** provides a summary of the significant trends in the three diversity indices over eight monitoring occasions starting with November 2010. The indices shown are the net of positive, negative or non-significant trends. These trends show that diversity in wetlands W3 and W8 has been increasing over time while diversity in the remaining six wetlands has been decreasing.

Changes in diversity vary independently of the occurrence of subsidence. However these changes could relate to changes in land-use practices (increased stock loads) and increase in feral deer numbers resulting in increased herbivory in wetlands. Monitoring following the recent fencing of wetland W2 from all major herbivores may provide some insight.

6.3 Dominant species

The Simper module in Primer 6 was used to determine the dominant species in the abundance data and comparison was made using mean contribution values of all species over all survey periods for each habitat type combined for all wetlands. The current period, November 13, was compared with the long term average (LTA) of contributions. The cutoff used in the analysis was 90% of the total species contributions.

Figure 28 shows that there are two clearly dominant species in Dry habitat. These are the weedy grasses *Axonopus fissifolius* (Carpet Grass) and *Cynodon dactylon* (Couch). It is expected that dry grassland that has been cleared and then grazed for many years would be dominated by weed species.

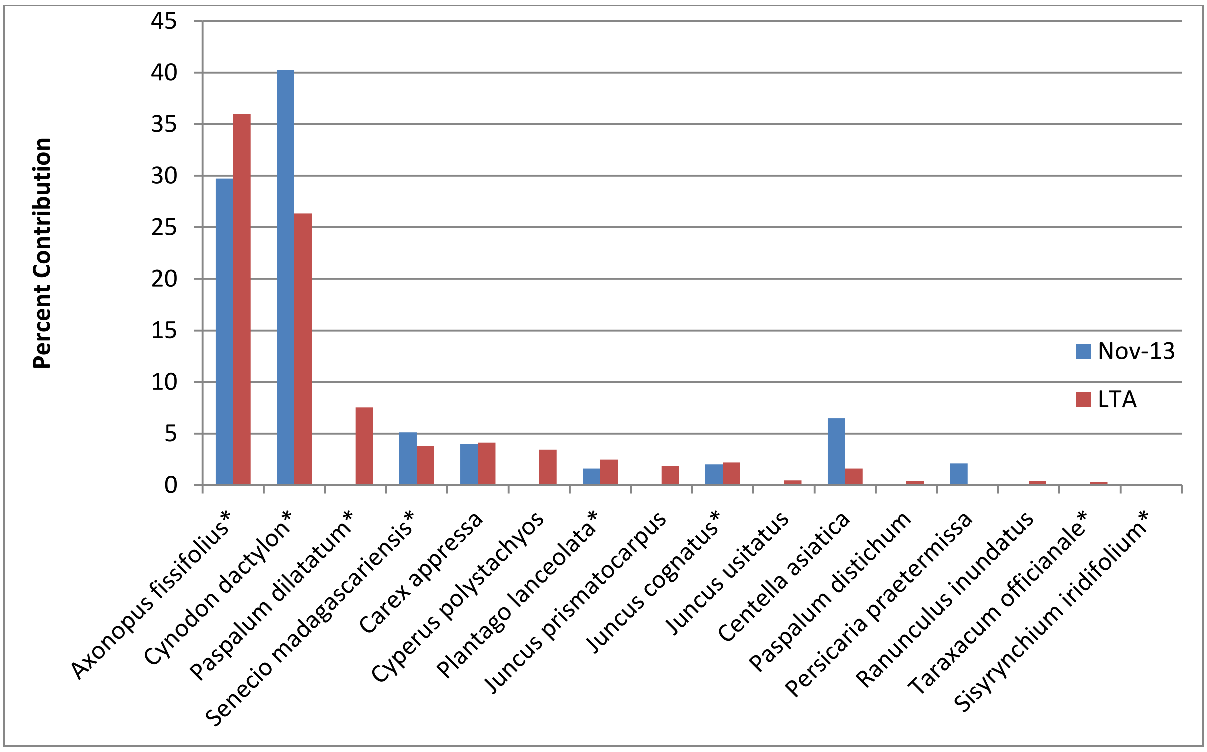


Figure 28 Simper analysis of dominant species in Dry habitat for all wetlands

* Indicates weed species

Figure 29 shows that the dominant species in Margin habitat was *Carex appressa* followed by *Persicaria praetermissa*. Weeds persist into the margin habitat but in small quantities. In total, weeds only contribute 7% of Margin habitat species.

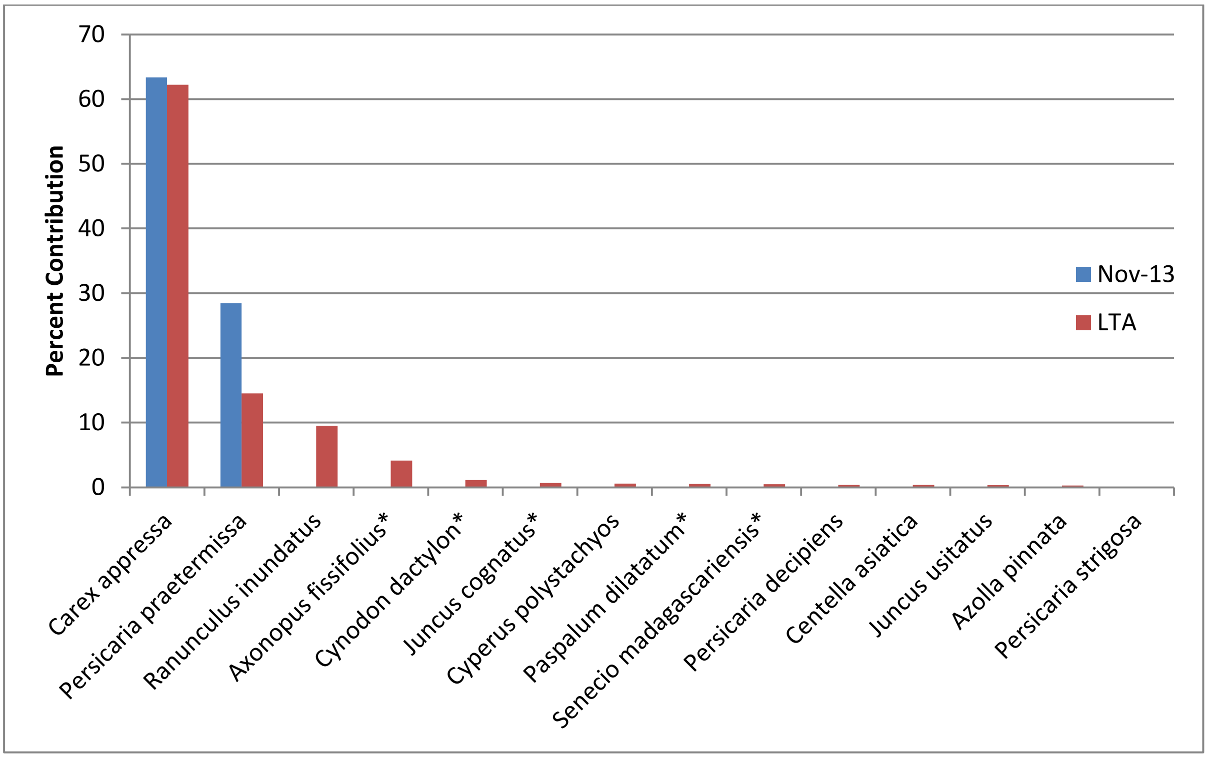


Figure 29 Simper analysis of dominant species in margin habitat for all wetlands

* Indicates weed species

Figure 30 shows that several species contribute to Aquatic habitat diversity. Weeds are negligible and have only been recorded when water levels are very low to dry.

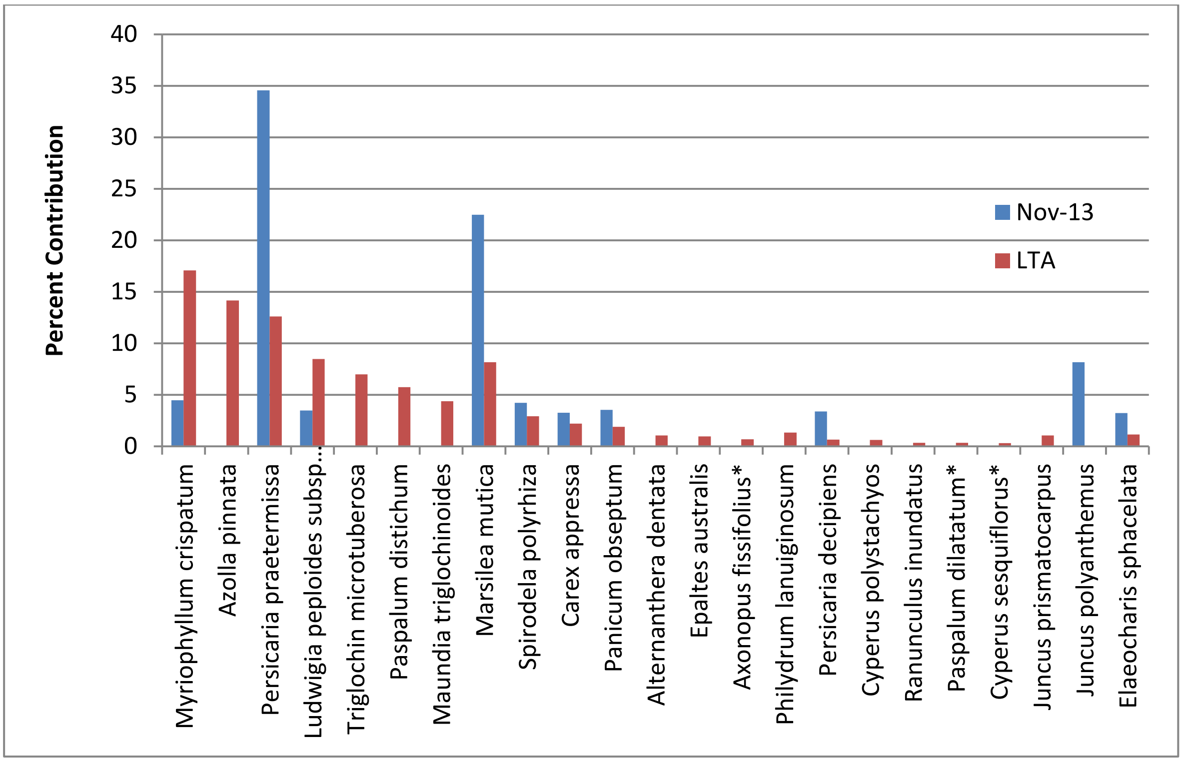


Figure 30 Simper analysis of dominant species in aquatic habitat for all wetlands

* Indicates weed species

In summary, these data show clearly that weeds are primarily restricted to Dry habitat with over 75% of all species in that habitat being weeds. Margin habitat shows 7% weed species and Aquatic habitat 2.52%. However, weeds in these two habitats were only recorded in May 2010 when all wetlands (other than W3) were dry.

6.4 Water analysis

Appendix 3 provides a detailed table of water analysis results to date.

Nitrogen

The nitrogen content of all wetlands is almost entirely contained in organic matter as opposed to being freely dissolved in the water. The nitrogen values vary widely both between wetlands and between years.

Phosphorus

Phosphorus levels have been variable but within a narrow range.

pH

All monitored wetlands are located in soils of the Wyong Alluvial Landscape (Murphy 1993) which have a pH range of from 4.0 – 6.0. The pH values from the wetland water show a similar range.

Total Suspended Solids

These values show a wide range and a number of factors can influence this such as recent animal activity, rainfall, drying or light penetration through floating vegetation.

Salinity

Salinity levels have generally remained well below levels that would be detrimental to aquatic ecosystems. The exception being values for Wetlands 1 and 3 in May 2010 when the other wetlands were dry. In Wetland 3 the high salinity did appear to have resulted in the mass loss of the previously dense *Panicum obseptum* and even though levels have now returned to normal, that vegetation was still recovering in November 2011. In May 2012 it appeared that the large amount of subsurface organic matter was resulting in a substantial change in the aquatic vegetation. This effect continued in November 2012 but had diminished at April 2013 and November 2013, probably because of persistent increased water levels.

Similarity analysis using all water analytes was conducted to determine whether any patterns existed between wetlands, year or season. MDS plots in **Figure 31** show no groupings. From this analysis it can be concluded that there is no effect of wetland, or season on the measured water variables. Up until 2012 there was no effect of year on the variables. However, in 2013 data for all wetlands in both April and November were very similar as can be seen by the close grouping of the 2013 symbols.

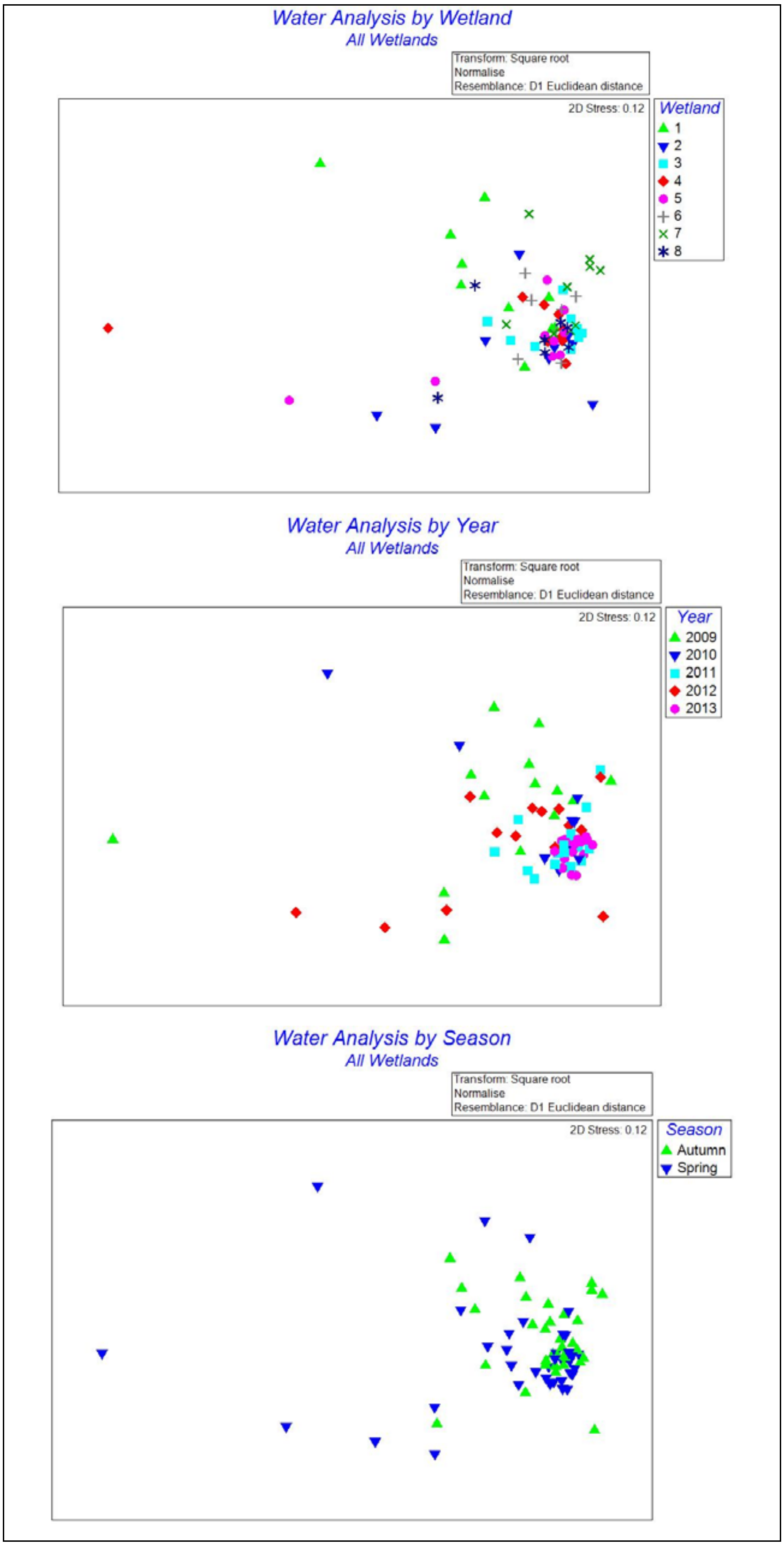


Figure 31 MDS similarity plots of water analysis by wetland, year and season

Oxygen saturation

There are several factors that influence wetland oxygen saturation levels: time of day (plants consume oxygen at night and release it during the day); recent windiness and orientation/exposure of the wetland to prevailing wind; recent rain or water inflow; amount of drying taking place; depth from which samples were taken; amount of organic matter present; and, quantity and type of plants present.

Previous analyses have shown a general downward trend in oxygen saturation for individual wetlands, although not all trends were statistically significant. **Figure 32** shows the combined trend for all wetlands for the ten monitoring occasions.

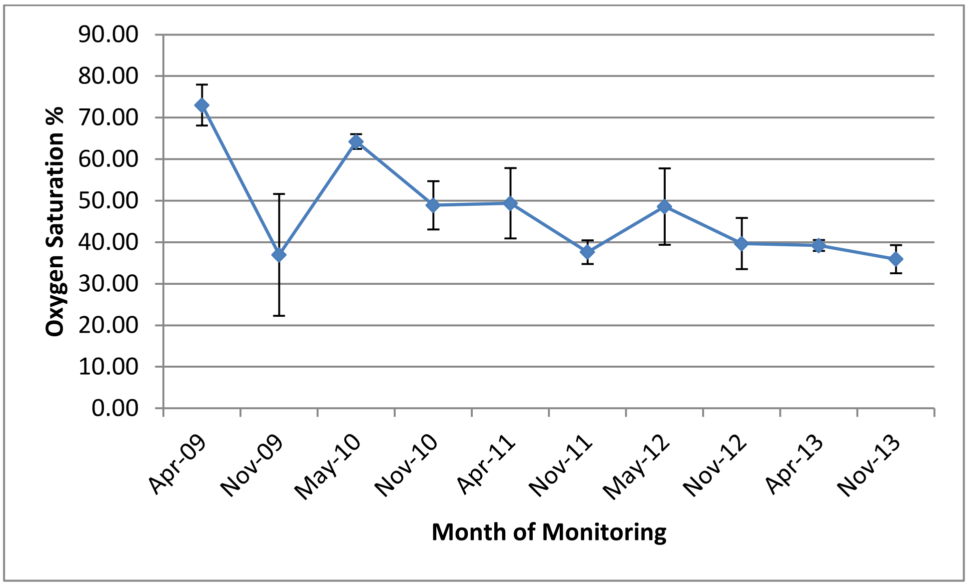


Figure 32 Oxygen saturation levels over time for each wetland (bars are standard error)

Simple linear regression shows a significant downward trend with $F_{(1, 68)} = 11.37$, $p = 0.001$.

There is little information available regarding acceptable oxygen saturation levels in the water of wetlands in SE Australia. ANZECC (2000) guidelines generally regard 80% as a lower level for wetlands in other parts of Australia. This would currently place the Mandalong monitored wetlands at half of the acceptable levels. Section 6.2 has shown generally consistent declines in diversity across all wetlands over the same time period which might be connected with the decline in Oxygen saturation. This decline is unlikely to be related to mine subsidence but could be related to increased stocking levels and feral deer numbers, all contributing to increased herbivory in the aquatic habitat.

7 Subsidence impact

7.1 Wetland 6

Figure 33 shows the location of the vegetation monitoring transect and subsidence monitoring lines at Wetland 6. Subsidence monitoring lines are: 11MG2 aligned along the maingate between panels 11 and 12, and running through the centre of Wetland 6; and 1CS5 that crosses panels 11 and 12 at right angles to 11MG2. The section of Panel 11 adjacent Wetland 6 was subsided in March/April 2011 and Panel 12 was subsided in September 2012.

Data from line 11MG2 show that the land has tilted to the north west with the fall across Wetland 6 being from 0.156 to 0.216 m as of June 2013. This has been reflected in the loss of any dry habitat at the start if the monitoring transect (see Section 5.3.2 above).

Data from line 1CS5 show that Wetland 6 is perched over maingate 11 with a slight tilt to the east into panel 11. The differential between maingate 11 and the centre of panels 11 and 12 is approximately -0.5 m.

Looking at **Figure 33** the pattern of subsidence suggests that water could spread to the left and right of the transect as well as along the transect to the north west. The change in landform resulting from subsidence has the potential, during lengthy periods of low rainfall, for Wetland 6 to dry out earlier than previously due to the perched position. Subsidence data from September 2013 indicates no significant change across this wetland.

7.2 Wetland 7

Referring back to Figure 1, this wetland is located over the maingate between longwalls 13 and 14. Longwall 13 was subsided on September 2012 and longwall 14 on May 2013. There are no subsidence monitoring lines in or near Wetland 7 so changes in water levels and/or vegetation patterns will be the only potential indicator of subsidence impact. At November 2013 there were no changes that could potentially be attributed to subsidence. Given the location over a maingate substantial subsidence impacts are unlikely for this wetland.

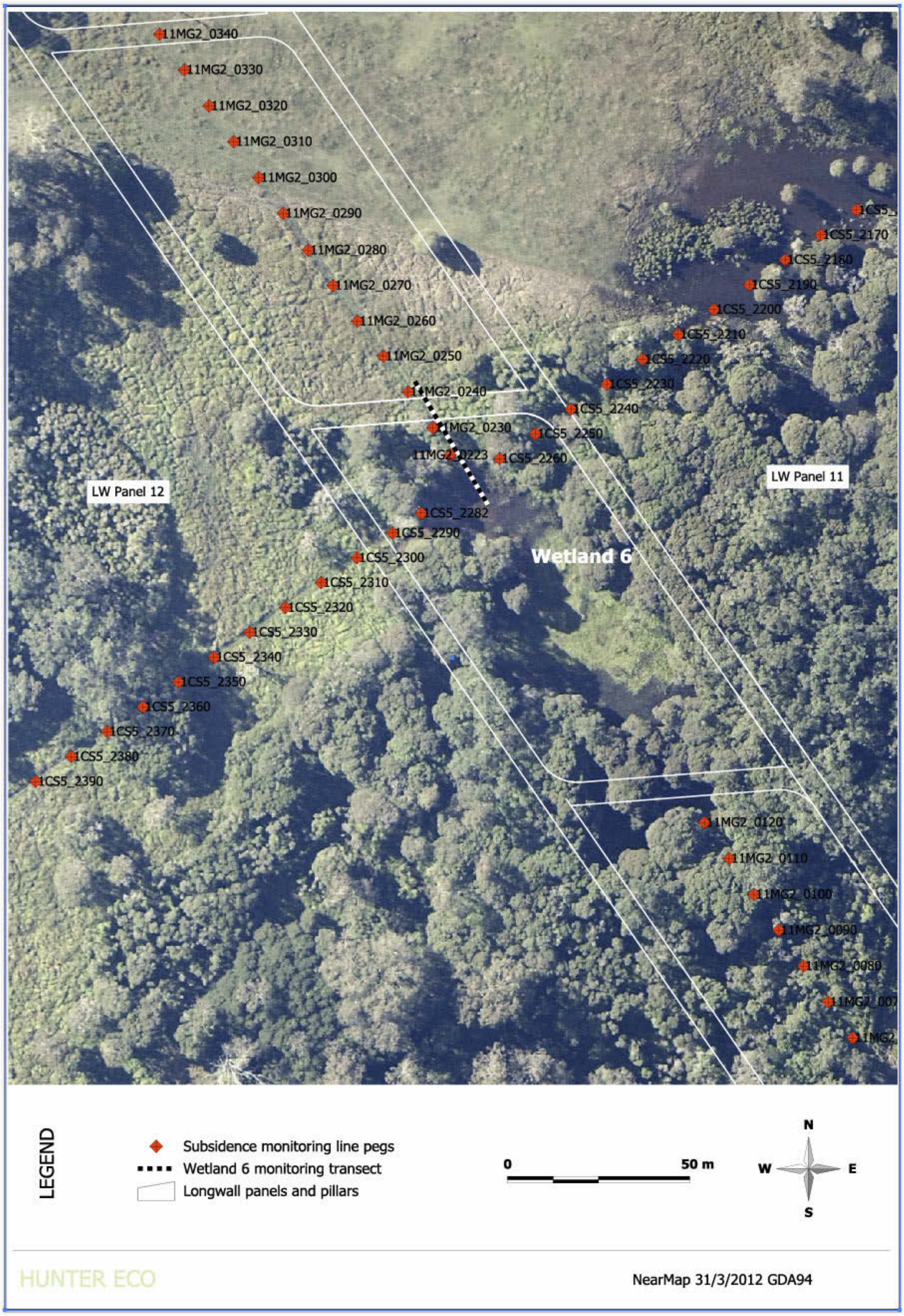


Figure 33 Wetland 6 subsidence monitoring lines and wetland monitoring transect

7.1 Wetland 8

This wetland is located at the north western edge of longwall 8 that was subsided in October 2009. There is a subsidence monitoring survey line running through a section of the overall wetland complex of which Wetland 8 is a part (**Figure 34**).

Survey data collected on 7 July 2013 shows that subsidence has stabilised around 2011 levels i.e. about one metre of subsidence. There are no detectable subsidence impacts on the monitored wetland and subsidence is now expected to have stabilised after four years.

Figure 34 Wetland 8 subsidence monitoring line and wetland monitoring transect

8 Management actions

The Mandalong mine Wetland Management Plan (Hunter Eco 2009a) provides a table describing monitoring results that would trigger further investigation and possible remedial action. The following **Table 5** is an assessment of the current monitoring results and the triggers for action. All changes recorded between the April 2009 and April 2013 can be explained as being from causes other than mining subsidence. Even though Wetland 8 has experienced subsidence for 3.5 years there is no clear evidence of change that could be attributed to subsidence.

Table 5 Responses to the WMP triggers

Trigger	Result at November 2013	Response
A steady trend in the decline of water level observed in more than one round for monitoring at monitored wetlands that cannot be explained by rainfall data or upstream agricultural activity.	Water was present in all wetlands.	No further action needed.
A significant increase in the trend of EC levels observed over greater than one monitoring round. AGEC (2008) describe the alluvial aquifer as having substantially elevated EC levels. Any increase in EC in a wetland could be the result of the alluvial aquifer coming into contact with surface water.	EC levels were all within an acceptable range.	No further action needed.
Substantial physical erosion or damage to the wetland soil that cannot be explained by natural or man-made erosion process and is caused subsidence cracking (>200 mm in width).	No erosion or cracking was found	No further action needed
A significant increase in water nutrient levels, particularly N and P that cannot be explained by natural variations in nutrient levels or manmade influences.	Nutrient levels were acceptable.	No further action needed
A steady trend in declining biodiversity observed over a period greater than one monitoring round.	Six wetlands have shown statistically significant declining diversity indices.	Not related to subsidence (see discussion in Section 6.2)
A landholder submits a complaint that a wetland has changed as a result of subsidence.	No landholder reports had been received.	No further action needed

9 Final summary

The purpose of this monitoring program, as prescribed in the Conditions of Consent, is to determine what, if any, changes in the monitored wetlands in the Mandalong floodplain can be attributed to subsidence.

Monitoring of these eight wetlands commenced in April 2009 so as at November 2013 the total monitoring period has been over four years, ten monitoring occasions. All wetlands started out with water then began to dry until May 2010 when only Wetlands 1 and 3 had water. Section 5.2 shows increasing rainfall trend up to May 2012, falling to November 2012 after which it has risen to the highest level since the start of monitoring.

Clearly these wetlands are dynamic ecosystems with species composition and diversity varying with the amount of available water and seasons. Variable land-use activities also have an influence on the state of the wetlands. Water analysis results continue to be highly variable, showing no trends over time or within or among wetlands.

Wetland 6 is located over a pillar between panels 11 and 12, both panels having been subsided. The most noticeable change at this wetland is the change from dry to margin habitat at the beginning of the transect. This change appears to now be a feature of this transect. Wetland 8 has been subject to subsidence for over three years and there is no change in the wetland vegetation and water levels that can clearly be assigned to being an impact of subsidence. Around the middle of 2012 panel 13 was subsided beside Wetland 7 which is located over a pillar between panels 13 and 14. There is no subsidence monitoring through this wetland and it is too soon to detect any impact on the structure of this wetland.

When reading this report regarding the plant species it is important to be aware of the distinction between occurrence and abundance. The species lists, as in Section 5.1, only provide occurrence information and say nothing about how many of any one species is present. Abundance information is contained in Section 6.3. The data show that species composition across all wetlands is relatively consistent over time. Few new species were added on this monitoring occasion suggesting that the majority of likely species have been recorded. Weeds are primarily confined to the surrounding dry grassland with no invasion into the aquatic ecosystem (except *Isolepis prolifera* in Wetland 5 which declined in the period from November 2012 to November 2013). Section 5.1 shows that the proportion of weeds to native species over time has reduced significantly for Wetlands 6, 7 and 8 but has remained unchanged for the others.

Changes in the amount of the threatened *Maundia triglochinoides* are interesting with whole local populations disappearing by April 2011 (Wetlands 2 & 6) or substantially reducing in numbers (Wetlands 1 & 4). Since November 2011 a large area of the species at the south eastern end of Wetland 6 had recovered by November 2012 but had declined in April 2013 and November 2013.

Wetlands 4 and 5 had been fenced from stock since November 2012 however the property tenant reported seeing deer inside the fence and deer droppings were present on a track near Wetland 5 on the day of monitoring. Game cameras were positioned at the beginning of the wetland 5 and 6 transects and left for one month from late May to late June 2013 and no deer were recorded.

Herbivory and environmental degradation caused by feral deer is listed as a Key Threatening Process in the NSW *Threatened Species Conservation Act 1955.* (http://www.environment.nsw.gov.au/determinations/FeralDeerKtp.htm)

The impact of deer on wetlands could arise from direct grazing of wetland plants and indirectly by destroying underwater regrowth with continual trampling. Depending on severity, this type of disturbance will add a confounding factor to comparison between wetlands.

While there have been some significant reductions in diversity (Section 6.2) and oxygen saturation (Section 6.4) none can be directly attributed to mining subsidence.

10 References

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Appendix 1 Cumulative floristics at November 2013

✓ = new in November 2013

Family and Species	1	2	3	4	5	6	7	8
Amaranthaceae								
Alternanthera denticulata		✓			✓	✓		✓
Apiaceae								
Centella asiatica	✓	✓	✓	✓	✓	✓	✓	✓
*Cyclospermum leptophyllum**								✓
Daucus glochidiatus								✓
*Hydrocotyle bonariensis**						✓		
Hydrocotyle laxiflora		✓		✓	✓			✓
Hydrocotyle tripartita		✓		✓	✓			
Hydrocotyle verticillata						✓		
Apocynaceae								
Parsonsia straminea					✓		✓	✓
Asteraceae								
*Aster subulatus**	✓			✓	✓	✓	✓	✓
*Cirsium vulgare**								✓
Epaltes australis	✓	✓			✓	✓		✓
Euchiton sphaericus						✓		✓
*Senecio madagascariensis**	✓	**✓**	✓	✓	✓	✓	✓	✓
*Taraxacum officinale**	✓	✓	✓		✓		✓	
Caryophyllaceae								
*Stellaria media**								✓
Casuarinaceae								
Casuarina glauca								✓
Chenopodiaceae								
Einadia hastata								✓
Clusiaceae								
Hypericum gramineum							✓	
Commelinaceae								
Commelina cyanea								✓
Convolvulaceae								
Dichondra repens					✓	✓		✓
Cyperaceae								
Baumea articulata		✓						
Carex appressa	✓	✓	✓	✓	✓	✓		✓
Carex gaudichaudiana			✓			✓		
Cyperus difformis	✓						✓	
Cyperus exaltatus			✓			✓	✓	
Cyperus flavidus				✓		✓		✓
Cyperus haspan subsp. haspan							✓	
Cyperus polystachyos	✓		✓	✓	✓	✓	✓	✓
*Cyperus sesquiflorus**	✓		✓		✓	✓	✓	✓

Eleocharis cylindrostachys								✓
*Eleocharis minuta**	✓						✓	✓
Eleocharis sphacelata	✓	✓	✓	✓			✓	
Fimbristylis dichotoma			✓	✓	✓			
Fimbristylis velata		✓						
Isolepis cernua	✓				✓			
Isolepis inundata	✓							✓
*Isolepis prolifera**					✓			
Schoenoplectus mucronatus			✓					
Schoenus apogon					✓			
Tetraria capillaris	✓		✓		✓		✓	
Dennstaedtiaceae								
Pteridium esculentum			✓					
Fabaceae (Faboideae)								
Glycine microphylla					✓			
*Lotus corniculatus**							✓	✓
*Lotus suaveolens**								✓
*Trifolium repens**	✓	✓					✓	✓
Goodeniaceae								
Goodenia bellidifolia subsp. bellidifolia	✓							
Goodenia stelligera				✓	✓			
Haloragaceae								
Myriophyllum crispatum			✓	✓	✓	✓	✓	
Hydrocharitaceae								
Ottelia ovalifolia subsp. ovalifolia		✓	✓	✓		✓	✓	✓
Iridaceae								
*Sisyrinchium iridifolium**			✓		✓		✓	✓
Juncaceae								
*Juncus articulatus**	✓				✓		✓	
*Juncus cognatus**	✓		✓	✓	✓	✓	✓	✓
Juncus planifolius	✓							
Juncus polyanthemus	✓	✓	✓	✓	✓	✓	✓	✓
Juncus prismatocarpus	✓	✓	✓	✓	✓	✓	✓	✓
Juncus usitatus	✓		✓	✓	✓	✓	✓	✓
Juncaginaceae								
Maundia triglochinoides	✓	✓		✓		✓		
Triglochin microtuberosa		✓	✓		✓	✓	✓	✓
Triglochin procera						✓		
Lauraceae								
Cassytha glabella						✓		
Lemnaceae								
Lemna disperma								✓
Spirodela polyrhiza	✓	✓			✓		✓	✓
Lentibulariaceae								

Utricularia gibba	✓		✓					
Linaceae								
*Linum trigynum**					✓			
Lobeliaceae								
Pratia purpurascens		✓	✓		✓			✓
Lythraceae								
Lythrum hyssopifolia	✓						✓	
Malvaceae								
*Sida rhombifolia**								✓
*Modiola caroliniana**								✓
Marsileaceae								
Marsilea mutica	✓			✓	✓			
Myrsinaceae								
*Anagallis arvensis**								✓
Onagraceae								
Ludwigia peploides subsp. montevidensis	✓	✓	✓	✓	✓	✓	✓	✓
Oxalidaceae								
Oxalis sp.			✓					✓
Philydraceae								
Philydrum lanuginosum	✓		✓	✓	✓		✓	
Plantaginaceae								
*Plantago lanceolata**		✓		✓	✓		✓	✓
Poaceae								
*Andropogon virginicus**			✓		✓			
*Axonopus fissifolius**	✓	✓	✓	✓	✓	✓	✓	✓
*Briza minor**					✓		✓	✓
*Cynodon dactylon**	✓	✓	✓	✓	✓		✓	✓
Dichelachne rara				✓				
Echinochloa colona						✓		
Eragrostis alveiformis				✓				
Hemarthria uncinata						✓		✓
Isachne globosa						✓		
Lachnagrostis filiformis						✓		
*Lolium perenne**								✓
Microlaena stipoides					✓			
Panicum bisulcatum	✓			✓	✓	✓		✓
Panicum obseptum		✓	✓	✓	✓	✓	✓	
*Paspalum dilatatum**	✓	✓	✓	✓	✓	✓	✓	✓
Paspalum distichum	✓		✓	✓	✓	✓	✓	✓
*Paspalum urvillei**					✓			
*Pennisetum clandestinum**							✓	✓
Sacciolepis indica			✓		✓			
*Setaria gracilis**								✓
Setaria parviflora	✓							

*Setaria sphacelata**							✓	
*Sporobolus africanus**			✓		✓		✓	
Themeda australis					✓			
*Vulpia bromoides**	✓							
Polygonaceae								
Persicaria decipiens	✓		✓	✓	✓	✓	✓	✓
Persicaria praetermissa		✓	✓	✓	✓		✓	✓
Persicaria strigosa	✓		✓			✓		
Rumex sp.						✓	✓	
Rumex brownii								✓
Potamogetonaceae								
Potamogeton octandrus	✓		✓	✓		✓	✓	
Potamogeton tricarinatus						✓		
Ranunculaceae								
Ranunculus inundatus	✓	✓	✓	✓	✓	✓	✓	✓
Ranunculus lappaceus					✓	✓		
Ricciaceae								
Ricciocarpus natans		✓					✓	✓
Rosaceae								
*Rubus discolor**		✓			✓			
Scrophulariaceae								
Veronica sp.								✓
Solanaceae								
*Solanum nigrum**					✓			
Verbenaceae								
*Verbena bonariensis**								✓
Salviniaceae								
Azolla pinnata	✓	✓	✓	✓	✓	✓	✓	✓
Total Species	**41**	**30**	**40**	**35**	**55**	**43**	**46**	**60**

Appendix 2 Wetland Transect Detail

Wetland 1

Wetland 1	Transect quadrat number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
Family	Species	Abundance Scores																										
Poaceae	*Axonopus fissifolius**	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyperaceae	*Carex appressa*	0	0	0	0	0	0	0	0	0	0	0	5	5	6	4	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Cynodon dactylon**	6	6	6	6	6	6	6	4	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyperaceae	*Cyperus polystachyos*	1	2	2	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncaceae	*Juncus polyanthemus*	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncaceae	*Juncus usitatus*	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Paspalum distichum*	0	0	0	0	0	0	0	4	5	6	6	3	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polygonaceae	*Persicaria decipiens*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Setaria parviflora*	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		DRY							MARGIN								AQUATIC											

Wetland 2

Wetland 2	Transect quadrat number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Family	Species	Abundance Scores																					
Azollaceae	*Azolla pinnata*	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyperaceae	*Carex appressa*	0	0	4	6	6	6	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Cynodon dactylon**	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Apiaceae	*Hydrocotyle laxiflora*	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Onagraceae	*Ludwigia peploides subsp. montevidensis*	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Panicum obseptum*	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polygonaceae	*Persicaria praetermissa*	0	1	1	3	3	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lobeliaceae	*Pratia purpurascens*	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rosaceae	*Rubus discolor**	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lemnaceae	*Spirodela polyrhiza*	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncaginaceae	*Triglochin microtuberosa*	0	0	0	0	0	0	1	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0
		DRY		MARGIN					AQUATIC														

Wetland 3

Wetland 3	Transect quadrat number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Family	Species	Abundance Scores																					
Poaceae	*Axonopus fissifolius**	6	4	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Azollaceae	*Azolla pinnata*	0	0	0	0	0	1	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	1
Cyperaceae	*Carex appressa*	0	0	2	4	1	3	5	0	0	0	0	0	0	3	3	0	0	0	0	0	0	0
Apiaceae	*Centella asiatica*	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Cynodon dactylon**	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyperaceae	*Cyperus polystachyos*	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyperaceae	*Cyperus sesquiflorus**	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyperaceae	*Eleocharis sphacelata*	0	0	0	0	0	0	0	1	1	1	0	1	2	1	2	0	0	0	1	0	0	0
Juncaceae	*Juncus cognatus**	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Onagraceae	*Ludwigia peploides subsp. montevidensis*	0	0	0	0	1	0	0	2	1	1	2	1	1	0	0	0	2	1	1	0	0	0
Hydrocharitaceae	*Ottelia ovalifolia subsp. ovalifolia*	0	0	0	2	5	4	3	3	1	3	3	3	4	2	0	1	2	1	1	1	2	2
Poaceae	*Panicum obseptum*	0	0	0	0	1	2	1	5	3	1	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Paspalum dilatatum**	0	3	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Paspalum distichum*	0	0	0	0	0	0	0	0	1	3	4	5	3	1	1	3	2	2	3	2	3	4
Polygonaceae	*Persicaria decipiens*	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polygonaceae	*Persicaria strigosa*	0	1	1	2	3	2	3	4	3	3	0	0	1	3	4	4	1	3	4	6	3	3
Philydraceae	*Philydrum lanuginosum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
Dennstaedtiaceae	*Pteridium esculentum*	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ranunculaceae	*Ranunculus inundatus*	0	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Sacciolepis indica*	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyperaceae	*Schoenoplectus mucronatus*	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0
Asteraceae	*Senecio madagascariensis**	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncaginaceae	*Triglochin microtuberosa*	0	0	0	0	2	3	1	2	2	1	1	2	1	1	0	1	2	1	1	1	2	2
		DRY				AQUATIC																	

Wetland 4

Wetland 4	Transect quadrat number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
Family	Species	Abundance Scores																																				
Asteraceae	*Aster subulatus*	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Axonopus fissifolius**	3	2	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyperaceae	*Carex appressa*	0	0	1	1	3	6	6	5	5	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Apiaceae	*Centella asiatica*	0	0	0	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Cynodon dactylon**	4	5	5	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyperaceae	*Cyperus polystachyos*	1	1	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyperaceae	*Fimbristylis dichotoma*	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Goodeniaceae	*Goodenia stelligera*	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Apiaceae	*Hydrocotyle laxiflora*	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncaceae	*Juncus cognatus**	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncaceae	*Juncus polyanthemus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncaceae	*Juncus prismatocarpus*	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncaceae	*Juncus usitatus*	0	1	2	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Marsileaceae	*Marsilea mutica*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	5	6	6	5	5	5	6	6	6	4	5	6
Haloragaceae	*Myriophyllum crispatum*	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3	3	3	3	3	3	2	1	1
Poaceae	*Panicum obseptum*	0	0	0	0	0	0	0	0	0	2	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Paspalum distichum*	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	2	2	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polygonaceae	*Persicaria praetermissa*	0	0	0	0	0	0	1	2	4	5	6	6	6	5	6	6	6	6	6	6	6	6	6	6	6	4	2	2	2	1	0	0	0	0	0	0	0
Potamogetonaceae	*Potamogeton octandrus*	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ranunculaceae	*Ranunculus inundatus*	0	0	0	0	1	0	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Asteraceae	*Senecio madagascariensis**	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		DRY				MARGIN					AQUATIC																											

Wetland 5

Wetland 5	Transect quadrat number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Family	Species	Abundance scores																															
Poaceae	*Andropogon virginicus**	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Axonopus fissifolius**	3	4	4	4	4	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Azollaceae	*Azolla pinnata*	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyperaceae	*Carex appressa*	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Cynodon dactylon**	2	3	3	3	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyperaceae	*Cyperus polystachyos*	0	0	2	2	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Goodeniaceae	*Goodenia stelligera*	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Apiaceae	*Hydrocotyle laxiflora*	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyperaceae	*Isolepis prolifera**	0	0	0	0	0	0	1	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncaceae	*Juncus cognatus**	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncaceae	*Juncus usitatus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0
Marsileaceae	*Marsilea mutica*	0	0	0	0	0	0	0	0	0	1	3	3	5	5	3	3	4	6	6	6	5	5	5	5	5	4	4	3	3	3	3	2
Poaceae	*Microlaena stipoides*	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Haloragaceae	*Myriophyllum crispatum*	0	0	0	0	0	0	0	0	0	2	4	4	3	3	4	6	3	3	3	3	3	3	4	3	3	2	1	1	1	1	1	2
Apocynaceae	*Parsonsia straminea*	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Paspalum dilatatum**	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Paspalum distichum*	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Paspalum urvillei**	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polygonaceae	*Persicaria decipiens*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	2	2	0	0
Polygonaceae	*Persicaria praetermissa*	0	0	0	0	1	3	5	6	6	6	3	0	0	0	0	0	0	0	0	1	1	0	0	1	1	0	0	0	0	0	0	0
Lobeliaceae	*Pratia purpurascens*	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ranunculaceae	*Ranunculus inundatus*	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rosaceae	*Rubus discolor* *	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Asteraceae	*Senecio madagascariensis**	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Asteraceae	*Taraxacum officinale**	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		DRY						MARGIN			AQUATIC																						

Wetland 6

Wetland 6	Transect quadrat number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
Family	Species	Abundance Scores																																
Asteraceae	*Aster subulatus**	0	0	1	0	0	0	0	0	1	0	1	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Axonopus fissifolius**	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyperaceae	*Carex appressa*	0	0	0	0	1	1	1	1	0	1	0	0	1	1	1	1	1	4	3	2	4	1	0	0	0	0	0	0	0	0	0	0	0
Cyperaceae	*Carex gaudichaudiana*	6	6	6	6	6	6	5	5	6	6	6	6	6	5	5	6	6	4	5	5	4	5	0	0	0	0	0	0	0	0	0	0	0
Apiaceae	*Centella asiatica*	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyperaceae	*Cyperus exaltatus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5	6	5	5	4	4	5	6	5	5	5
Asteraceae	*Euchiton sphaericus*	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Hemarthria uncinata*	1	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Apiaceae	*Hydrocotyle verticillata*	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Isachne globosa*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncaceae	*Juncus polyanthemus*	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Panicum bisulcatum*	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polygonaceae	*Persicaria decipiens*	1	3	1	1	2	2	3	3	1	1	1	2	2	2	2	2	1	0	0	0	0	1	2	2	2	2	2	1	1	0	1	1	1
Polygonaceae	*Persicaria strigosa*	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	2	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Potamogetonaceae	*Potamogeton octandrus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Ranunculaceae	*Ranunculus inundatus*	0	0	0	0	1	0	0	0	0	1	0	0	0	1	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Asteraceae	*Senecio madagascariensis**	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncaginaceae	*Triglochin microtuberosa*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
		MARGIN																						AQUATIC										

Wetland 7

Wetland 7		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Family	Species	Abundance Scores																		
Asteraceae	*Aster subulatus**	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Axonopus fissifolius**	6	6	6	3	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Azollaceae	*Azolla pinnata*	0	0	0	0	0	0	0	1	1	0	1	1	1	1	1	0	1	0	0
Apiaceae	*Centella asiatica*	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyperaceae	*Cyperus polystachyos*	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyperaceae	*Eleocharis sphacelata*	0	0	0	0	0	0	0	0	0	0	0	2	2	2	4	4	5	3	2
Juncaceae	*Juncus polyanthemus*	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0
Juncaceae	*Juncus prismatocarpus*	0	0	0	0	1	0	0	0	0	0	1	1	1	1	0	0	1	0	0
Onagraceae	*Ludwigia peploides subsp. montevidensis*	0	0	0	0	0	1	0	1	0	1	1	0	0	1	1	1	0	0	0
Haloragaceae	*Myriophyllum crispatum*	0	0	0	0	3	4	5	6	5	4	3	1	2	0	0	0	0	1	2
Hydrocharitaceae	*Ottelia ovalifolia subsp. ovalifolia*	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0
Poaceae	*Paspalum dilatatum**	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Paspalum distichum*	0	0	0	0	4	5	3	3	3	2	2	2	1	1	3	5	5	5	5
Polygonaceae	*Persicaria praetermissa*	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Philydraceae	*Philydrum lanuginosum*	0	0	0	0	0	1	3	1	2	5	5	5	5	4	2	1	2	2	1
Potamogetonaceae	*Potamogeton octandrus*	0	0	0	0	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Polygonaceae	*Rumex sp.**	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Asteraceae	*Senecio madagascariensis**	1	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Setaria sphacelata**	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lemnaceae	*Spirodela polyrhiza*	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0
Juncaginaceae	*Triglochin microtuberosa*	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	1	1	1	1
Polygonaceae	*Persicaria decipiens*	1	1	2	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
		DRY				AQUATIC														

Wetland 8

Wetland 8	Transect quadrat number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Family	*Species*	Abundance Scores																
Amaranthaceae	*Alternanthera denticulata*	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Myrsinaceae	*Anagallis arvensis**	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Asteraceae	*Aster subulatus**	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Axonopus fissifolius**	3	1	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyperaceae	*Carex appressa*	0	1	1	3	6	6	6	5	3	0	0	0	0	0	0	0	0
Casuarinaceae	*Casuarina glauca*	1	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Apiaceae	*Centella asiatica*	0	2	1	2	0	0	0	1	0	0	0	0	0	0	0	0	0
Commelinaceae	*Commelina cyanea*	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyperaceae	*Cyperus polystachyos*	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Apiaceae	*Hydrocotyle laxiflora*	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncaceae	*Juncus polyanthemus*	0	0	0	0	0	0	0	0	0	3	4	0	4	1	0	0	0
Juncaginaceae	*Juncus usitatus*	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fabaceae (Faboideae)	*Lotus corniculatus**	0	0	0	0	1	2	2	2	1	0	0	0	0	0	0	0	0
Onagraceae	*Ludwigia peploides subsp. montevidensis*	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
Poaceae	*Paspalum dilatatum**	1	0	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0
Poaceae	*Paspalum distichum*	0	0	0	0	0	0	0	0	5	5	3	1	0	0	0	0	0
Polygonaceae	*Persicaria decipiens*	0	0	1	0	1	2	0	1	2	3	3	4	4	4	5	3	3
Polygonaceae	*Persicaria praetermissa*	0	0	0	0	0	2	2	1	0	0	0	0	0	0	0	0	0
Lobeliaceae	*Pratia purpurascens*	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0
Ranunculaceae	*Ranunculus inundatus*	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Ricciaceae	*Ricciocarpus natans*	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1
Asteraceae	*Senecio madagascariensis**	2	3	3	2	0	0	0	0	0	0	1	0	0	0	0	0	0
Poaceae	*Setaria gracilis**	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Lemnaceae	*Spirodela polyrhiza*	0	0	0	0	0	0	0	0	0	0	1	2	1	1	1	1	1
Juncaginaceae	*Triglochin microtuberosa*	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	1	1
		DRY				MARGIN				AQUATIC								

Appendix 3 Water analysis tables

	Wetland	Total N (mg/L)	N Organic TKN (mg/L)	Total P (mg/L)	pH	TSS (mg/L)	EC (uS/cm)	Nox (mg/L)	DO (mg/L) (field)	Temp (field)	O sat (%)
Apr-09	W1	17.50	17.50	2.08	5.74	426.00	467.00	0.01	7.17	0.00	74
Nov-09	W1	2.00	1.90	0.09	4.89	228.00	686.00	0.03	5.38	0.00	67
May-10	W1	4.00	3.90	0.22	5.73	684.00	1060.00	0.05	6.14	14.60	62
Nov-10	W1	18.20	18.20	1.35	5.66	2550.00	1900.00	0.02	6.35	15.50	70
Apr-11	W1	2.60	2.50	0.55	5.92	10.00	465.00	0.06	2.44	17.10	26
Nov-11	W1	7.90	7.90	0.74	6.58	724.00	252.00	0.01	4.16	24.60	53
May-12	W1	4.80	4.80	0.48	6.23	50.00	199.00	0.01	6.91	13.50	68
Nov-12	W1	9.5	9.5	0.67	6.25	96	812		3.67	26.2	49
Apr-13	W1	2.0	2.0	0.22	6.4	25	246	0.03	3.5	20.8	41
Nov-13	W1	2	2	0.68	6.36	15	234	0.05	3.49	22.8	43
Apr-09	W2	9.70	9.60	0.95	5.75	1160.00	126.00	0.02	8.11	0.00	83
Nov-09	W2	4.30	4.20	0.32	5.34	3710.00	267.00	0.03	0.60	0.00	10
May-10	W2	-	-	-	-	-	-	-	-	-	
Nov-10	W2	3.90	3.90	0.35	5.82	14.00	123.00	0.00	2.24	20.10	26
Apr-11	W2	14.40	14.40	2.18	5.55	74.00	135.00	0.04	3.44	15.00	35
Nov-11	W2	2.6	2.6	0.26	6.34	22	100	0.01	3.33	23.1	41
May-12	W2	1.6	1.6	0.11	6.87	28	78	0.01	1.72	10	16
Nov-12	W2	14.6	14.6	1.04	6.20	7180	179		1.80	19.3	20
Apr-13	W2	4.7	4.7	0.37	6.06	12	96	0	3.04	16.7	32
Nov-13	W2	1.8	1.8	0.19	6.22	12	80	0	3.09	20.2	36
Apr-09	W3	3.90	3.90	0.45	5.58	148.00	77.00	0.02	5.91	0.00	61
Nov-09	W3	8.20	8.10	0.72	5.84	480.00	153.00	0.08	2.54	0.00	31
May-10	W3	18.2	18.2	1.35	5.66	2550	1900	0.02	6.35	14.6	66
Nov-10	W3	7.00	7.00	0.68	6.25	256.00	60.00	0.02	2.98	21.70	36
Apr-11	W3	1.50	1.40	0.07	5.84	6.00	77.00	0.07	3.66	15.40	38
Nov-11	W3	1.9	1.9	0.16	6.42	49	100	0.01	2.79	23	34
May-12	W3	1.8	1.8	0.2	6.04	200	69	0.01	5.76	9.5	52
Nov-12	W3	15.6	15.6	1.40	5.95	370	221		3.59	22.4	44
Apr-13	W3	1.3	1.3	0.00	6.02	7	55		4	16.8	43
Nov-13	W3	1.4	1.4	0.09	5.95	15	76	0.02	3.59	24.3	46
Apr-09	W4	2.10	2.10	0.11	5.92	140.00	298.00	0.02	5.50	0.00	56
Nov-09	W4	46.50	46.30	3.82	3.76	2270.00	594.00	0.14	0.69	0.00	9

May-10	W4	-	-	-	-	-	-	-	-	-	
Nov-10	W4	3.00	3.00	0.10	6.15	48.00	88.00	0.02	3.20	22.00	39
Apr-11	W4	2.00	1.90	0.26	5.96	16.00	134.00	0.05	4.23	12.50	41
Nov-11	W4	2.6	2.6	0.31	6.45	192	174	0.01	2.89	23.4	36
May-12	W4	2.2	2.2	0.23	6.03	112	141	0.01	6	10.3	55
Nov-12	W4	5.3	5.3	0.78	6.49	117	396	0.01	5.04	21.6	60
Apr-13	W4	2.1	2.1	0.13	5.71	46	128	0	3.32	17.7	36
Nov-13	W4	1.3	1.2	0.24	5.85	33	133	0.08	1.92	22.6	23
Apr-09	W5	2.20	2.20	0.14	5.64	25.00	331.00	0.00	6.43	0.00	66
Nov-09	W5	12.70	12.70	1.10	5.65	1310.00	374.00	0.02	0.78	0.00	10
May-10	W5	-	-	-	-	-	-	-	-	-	
Nov-10	W5	2.50	2.50	0.20	6.36	61.00	146.00	0.02	5.09	21.80	61
Apr-11	W5	1.70	1.70	0.12	5.80	18.00	231.00	0.04	3.35	15.90	35
Nov-11	W5	2.1	2.1	0.17	6.47	49	183	0.01	2.42	23.7	30
May-12	W5	4.1	4.1	0.49	6.01	120	137	0.01	3.78	10.5	35
Nov-12	W5	26.6	26.6	6.08	6.21	9570	560	0.01	2.05	20.8	24
Apr-13	W5	1.6	1.6	0.16	6.13	9	154	0	3.72	17.6	41
Nov-13	W5	2.6	2.3	0.37	5.89	36	166	0.35	2.13	21.9	26
Apr-09	W6	5.00	5.00	0.80	5.74	680.00	277.00	0.00	7.54	0.00	77
Nov-09	W6	-	-	-	-	-	-	-	-	-	
May-10	W6	-	-	-	-	-	-	-	-	-	
Nov-10	W6	2.30	2.30	0.29	6.33	42.00	184.00	0.02	5.19	20.90	61
Apr-11	W6	1.30	1.30	0.06	6.16	36.00	178.00	0.02	7.19	15.00	74
Nov-11	W6	2.3	2.3	0.39	6.71	592	353	0.01	3.14	23.7	39
May-12	W6	3.2	3.2	0.6	6.26	530	300	0.01	6.42	12.4	62
Nov-12	W6	-	-	-	-	-	-		-	-	
Apr-13	W6	1.5	1.5	0.25	6.38	68	218	0	3.6	19.5	41
Nov-13	W6	1.5	1.4	0.15	5.73	16	177	0.06	2.22	20.2	26
Apr-09	W7	1.40	1.40	0.00	6.20	83.00	107.00	0.00	9.88	0.00	100
Nov-09	W7	5.20	5.20	0.44	6.10	3360.00	151.00	0.05	6.24	0.00	94
May-10	W7	-	-	-	-	-	-	-	-	-	
Nov-10	W7	6.90	6.90	0.55	5.76	118.00	45.00	0.03	5.35	20.60	63
Apr-11	W7	2.90	2.80	0.20	5.66	9.00	94.00	0.08	8.87	17.70	97
Nov-11	W7	3	3	0.26	6.04	200	90	0.01	3.23	23.2	40
May-12	W7	2.3	2.3	0.14	5.6	108	62	0.01	9.33	11.6	88

Nov-12	W7	11.4	11.4	0.93	6.03	162	246	0.01	3.41	21.6	41
Apr-13	W7	2.1	2.1	0.1	5.75	28	77	0	4	16.7	43
Nov-13	W7	1.5	1.5	0.1	6.05	27	98	0.04	3.38	24.4	43
Apr-09	W8	17.30	17.30	1.86	5.91	688.00	279.00	0.01	6.47	0.00	66
Nov-09	W8	-	-	-	-	-	-	-	-	-	
May-10	W8	-	-	-	-	-	-	-	-	-	
Nov-10	W8	1.70	1.70	0.12	6.46	15.00	167.00	0.00	3.13	20.20	36
Apr-11	W8	1.5	1.5	0.22	6.22	58	180	0.02	4.47	17.3	48
Nov-11	W8	2.7	2.7	0.62	6.13	146	196	0.01	2.10	23.4	26
May-12	W8	14.5	14.5	3.14	6.08	2720	193	0.01	1.4	10.9	13
Nov-12	W8	-	-	-	-	-	-		-	-	
Apr-13	W8	4.7	4.7	0.79	6.42	28	151	0	3.2	19.2	36
Nov-13	W8	1.4	1.4	0.4	6.14	<5	150	0	3.76	21.7	45

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Monitoring the Impact of Subsidence on Wetlands of the Mandalong Floodplain

Wetland Monitoring Photographic Supplement

April 2009 – November 2013

HUNTER ECO

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APPENDIX 13
2013 INDEPENDENT ENVIRONMENTAL AUDIT ACTION PLAN

Condition Number	Recommendation	Condition Owner	Action Description	Action Due Date
DA97/800-1A	**Non Compliant** - Limits of Approval Recommendation: Ensure coal production limits as stated are met. Continue to progress application for a modification to this Development Consent CoA with the DoP.	Environmental Coordinator / Commercial Manager	Consent tonnage limits have been added to the Mandalong Site Business Risk Assessment. Scheduled actions have also been included within the compliance database to review production tonnages at the business planning and marketing stage with regular auditing to be undertaken to ensure limits are not exceeded.	Complete
DA97/800-24	**Non-compliant** - Compensation and Bank Guarantee Recommendation: Discuss the relevance of this condition with DP&I with a view to removing Compensation and Bank Guarantee it in future Project Approval Modifications	Environmental Coordinator	Bank Guarantee was established with DRE in June 2013 to address Consent Condition 24.	Complete
DA97/800-38	**Non-compliant** - DP&I Responsibility Independent Panel Recommendation: That Mandalong discuss with DP&I the details of the condition and consider the ongoing relevance of including LMCC and government agencies on the independent panel. This review may consider the set up of the panel overall given the nature of current operations, and the maturity of mining in the area now as compared to when the condition was drafted.	Environmental Coordinator	Send letter to DoPI regarding LMCC inclusion on Independent Panel.	Complete
DA97/800-44	**Non-compliant** - Noise and Vibration Recommendation: Conduct a noise assessment in accordance with this condition, at the noise receiver locations specified, to demonstrate compliance with the noise limits imposed by this condition. Update the Noise Monitoring Program to reflect the changes made to CoA 44 and re-submit to DoP for approval. (An Updated Noise Monitoring Program was submitted to DP&I in March 2013).	Environmental Coordinator	The annual noise assessment was conducted in August 2013 in accordance with consent condition 44 and the Noise Monitoring & Management Plan (NMMP). The NMMP was updated in March 2013 to reflect the changes to consent condition 44 and approved by the Department on 2 July 2013.	Complete

DA97/800-45	**Non-compliant** - Noise and Vibration Recommendation: Conduct a noise assessment in accordance with this condition, at the noise receiver locations specified, to demonstrate compliance with the noise limits imposed by this condition.	Environmental Coordinator	The annual noise assessment was conducted in August 2013 in accordance with consent condition 44 and the Noise Monitoring & Management Plan (NMMP). The results will be included in the 2013 AEMR.	Complete
DA97/800-45	**Non-compliant** - Noise and Vibration Recommendation: Update the Noise Monitoring Program to reflect the changes made to CoA 44 and re-submit to DoP for approval. (An Updated Noise Monitoring Program was submitted to DP&I in March 2013).	Environmental Coordinator	The NMMP was updated in March 2013 to reflect the changes to consent condition 44 and approved by the Department on 2 July 2013	Complete
DA97/800-52	**Indeterminate** - Air Quality Implement actions to meet the requirements of this condition and the equivalent condition in EPL 365 Variation dated 14 February 2013.	Environmental Coordinator	Real-time PM10 and TSP monitors were installed at Cooranbong in June 2013.	Complete
DA97/800-61	**Non-compliant** - Water Recommendation: Expedite the development of an updated EMS and related plans, sub-plans and procedures.	Environmental Coordinator	Review and update the Centennial Mandalong EMS.	30/06/2014
DA97/800-61	**Non-compliant** - Water Recommendation: Expedite the review and update of the overarching Water Management Plan and related sub plans, and ensure that its content covers the related aspects of the plans it supersedes. The WMP should be developed in accordance with outcomes/actions as defined in the WMO and Water Balance and be relevant for current activities and operations.	Environmental Coordinator	Review and update the Mandalong Water Management Plan.	30/06/2014
DA97/800-62	**Non-Compliant** -Surface water Recommendation: As above for Condition 61. It is recommended that a strategy for decommissioning of the various measures in the dirty water system (e.g. dams, drains, etc) is developed prior to planned end of mining.	Environmental Coordinator	Review and update the Mandalong Water Management Plan. Include strategy for decommissioning water management structures in update.	30/06/2014

DA97/800-63	**Non-compliant** - Surface water Recommendations: As per Condition 61. Additionally, revise the methodology of surface water monitoring of all unlicensed surface water discharges at Mandalong pit-top area to be able to demonstrate that discharges are not causing "pollution to waters" under section 120 of the POEO Act.	Environmental Coordinator	Monthly sampling of discharge from the Mandalong pit-top area commenced in June 2012. Note – The discharge from the Mandalong pit top has been included in the Mandalong South Project Environmental Impact Statement (EIS) with a proposal to licence the discharge point.	Complete
DA97/800-63	**Non-compliant** - Surface water Recommendations: Include in the revised Water Management Plan a guide to the revised methodology for monitoring of unlicensed discharge from the site.	Environmental Coordinator	Review and update the Mandalong Water Management Plan. Include guide to the revised methodology of unlicensed discharge from site.	30/06/2014
DA97/800-66	**Indeterminate** - Surface water Recommendation: Investigate whether approval/licencing from relevant agencies (i.e. NOW and EPA) is required with respect of directing mine water and runoff waters underground. If required, obtain approval from the authorities as soon as possible. Mandalong to further consider if they have met the requirements of this condition to investigate opportunities to reduce mine water discharge through other means.	Environmental Coordinator	Mandalong to undertake consultation with NOW regarding need to licence injection of surface water into existing underground workings.	30/04/2014
DA97/800-66A	**Indeterminate** - Water Recommendation: Expedite finalisation of the GHD report titled Review of the Draft Stormwater Assessment – Water Management Options Report (GHD) and implement recommendations identified therein	Environmental Coordinator	Finalise GHD Cooranbong Water Management Options Report	Complete
DA97/800-66A	**Indeterminate** - Water Recommendation: Review water management and monitoring in the Mandalong Pit Top area to demonstrate water discharged from the Mandalong Dam complies with Section 120 of the POEO Act.	Environmental Coordinator	Monthly sampling of discharge from the Mandalong pit-top area commenced in June 2012. Note – The discharge from the Mandalong pit top has been included in the Mandalong	Complete

			South Project Environmental Impact Statement (EIS) with a proposal to licence the discharge point.	
DA97/800-68	**Non-compliant** (Delta Link site) Erosion and Sediment Control Indeterminate (rest of site). Recommendation: Erosion and Sediment Control Plans should be updated as part of the update of the WMP. The ESCPs need to updated to be relevant to current site activities.	Environmental Coordinator	Review and update the Erosion and Sediment Control Plan.	30/06/2014
DA97/800-68	**Non-compliant** (Delta Link site) Erosion and Sediment Control **Indeterminate** (rest of site). Recommendation: Assess options to improve sedimentation and the management of coal fines at the Delta Link site. These may include sealing the unsealed access track to reduce sediment load, and/or replacing the existing sump with a drive-in sump, which can be regularly cleaned out. See other recommendations in the main body of the report.	Environmental Coordinator	Concrete drive-in sump to be installed to replace existing earthen sump.	30/04/2014
DA97/800-85	**Indeterminate** (ii) Hazards, Risks and Safety Conduct an audit of Dangerous Goods / Hazardous Substances used and stored at the site to assess compliance with Australian Standards and relevant legislation.	Environmental Coordinator	Conduct an audit of Dangerous Goods / Hazardous Substances used and stored at the site to assess compliance with Australian Standards and relevant legislation.	30/05/2014
DA97/800-110	**Non-compliant** - Independent Environmental Audit Recommendation: It is recommended that Management Plans are reviewed by Mandalong in response to recommendations made throughout this audit report.	Environmental Coordinator	As per above management plan updates as required by DA97/800 conditions 44, 45, 61, 62, 63 and 68.	30/06/2014
DA97/800-Appendix 1 Statement of Commitments (MOD 4) #11	**Non-compliant** - Statement of Commitments See other recommendations regarding the need to update the EMS and Management Plans.	Environmental Coordinator	As per above management plan updates as required by DA97/800 conditions 44, 45, 61, 62, 63 and 68.	30/06/2014
Cooranbong Distribution Project Environmental	**Indeterminate** - Cooranbong Distribution Project Environmental Assessment (MOD 8) Air Quality	Environmental Coordinator	A wheel wash unit was installed at Cooranbong on 26/10/2013.	Complete

Assessment (MOD 8) Air Quality	Recommendation: Install wheel wash within timeframes as agreed with relevant agencies.			
Development Consent Delta Link Project DA35-2-2004 #1	**Non Compliant** - Water It is recommended that alternative practices are sought to better manage coal fines collected from pits in the Delta area. It was noted that Mandalong had identified this issue and were in the process of improving the management of the fines at the time of the inspection. These were still to be completed. Confirm arrangements with Delta for the use of the dam and the discharge of water to the dam that have the potential to be contaminated with coal fines and sediment. This should also include arrangements for storage of fines and sediment at the edge of the dam.	Environmental Coordinator	Remove coal fines from Delta 9ML Dam	28/02/2014 Delayed due to wet weather. Works are scheduled to be completed in March 2014
Development Consent Delta Link Project DA35-2-2004 #1	**Non Compliant** - Water URS recommends that Mandalong reviews its sedimentation and erosion controls at the Delta Link site to prevent migration of contaminated water and sediment to the 9ML dam.	Environmental Coordinator	Concrete drive-in sump to be installed to replace existing earthen sump.	30/04/2014
EPL365 L1.1, EPL365-L2.4.	**Non-compliant** - Stormwater Recommendation: Expedite finalisation of the GHD report titled Review of the Draft Stormwater Assessment – Water Management Options Report (GHD) and implement recommendations identified therein.	Environmental Coordinator	Finalise GHD Cooranbong Water Management Options Report	Complete
EPL365 L1.1	**Non-compliant** - Stormwater Recommendation: Review water management and monitoring in the Mandalong Pit Top area to demonstrate water discharged from the Mandalong Dam complies with Section 120 of the POEO Act.	Environmental Coordinator	Monthly sampling of discharge from the Mandalong pit-top area commenced in June 2012. Note – The discharge from the Mandalong pit top has been included in the Mandalong South Project Environmental Impact Statement (EIS) with a	Complete

			proposal to licence the discharge point.	
EPL365-M2.1	**Non-compliant** - Sampling Procedure Recommendation: Confirm that the AECOM SWMS has been updated and that personnel conducting sampling are aware of the licence requirements.	Environmental Coordinator	Confirm that the AECOM SWMS has been updated and that personnel conducting sampling are aware of the licence requirements.	Complete
EPL365-M2.4	**Indeterminate** - Discharge procedure Recommendation: Develop a documented procedure covering the requirements for monitoring under a special frequency condition, in the event of a handover or absence of the Environmental Coordinator. Records for monitoring need to include the time of discharge commencing to ensure sampling is completed within 8 hours of commencement of discharge.	Environmental Coordinator	Develop procedure for special frequency monitoring and record in spreadsheet time when discharge occurred. Records for monitoring need to include the time of discharged commencing to ensure sampling is completed within 8 hours of commencement of discharge.	Complete
EPL365 R2	**Indeterminate** - Pollution incident reporting Recommendation: Clarify in system documents whether only Category 3 incidents or higher are to be reported to the EPA. Ensure that environmental incident forms are updated to contain the requirement for "immediate" notification to the EPA of environmental harm. (Mandalong indicated this had been completed prior to finalising this report) Inform staff of changes to the requirement to report material environmental harm "immediately" upon becoming aware of it. (Mandalong indicated this had been completed prior to finalising this report)	Environmental Coordinator	Category 4 incidents and higher to be reported to EPA as per Centennial standard and as per Mandalong PIRMP. Presentation provided to Mandalong staff in 2012 regarding requirement to report immediately.	Complete

EPL365 R2.1	**Indeterminate** – Pollution incident reporting. Recommendation: Ensure that all Category 3 incidents are reported "immediately" to the EPA's Pollution Line Service.	Environmental Coordinator	Category 4 incidents and higher to be reported to EPA as per Centennial standard and as per Mandalong PIRMP.	Complete
EPL365 R2.2	**Non- compliant** - Pollution Incident Reporting Recommendation: Ensure all incidents are reported within timeframes specified in the EPL. Record the date of submission of all written reports to EPA in the Mandalong incident report so that compliance with this condition can be demonstrated.	Environmental Coordinator	Centennial Environment & Community Database (ECD) is now used for recording the reporting of incidents as per Mandalong PIRMP.	Complete
CCL762 #18	**Non-compliant** Recommendation: Consolidate Mandalong's various surface water management plans into one overarching, site-wide Water Management Plan. Include in the new Water Management Plan a summary of procedures for surface water monitoring and recording of data. Address recommendations from the Phase 1 Assessments at Cooranbong, Delta and Mandalong as appropriate	Environmental Coordinator	Review and update the Mandalong Water Management Plan to include this recommendation.	30/06/2014
ML1443 #55	**Indeterminate** - Consultation NSW Fisheries Recommendation: It is recommended that consultation is conducted with NSW Fisheries as required.	SMP Coordinator	DPI – NSW Fisheries are a member of the SMP Interagency panel. Mandalong undertakes consultation with the Interagency panel for all SMP approvals.	Complete