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

.....
Signature of Witness

Prakash Jattan
Full name of Witness

APPENDIX 3
Mandalong Compliance Audit Of Consent Conditions

Condition No	Purpose	Trigger for Compliance	Status 31st December 2012
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 2012
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.
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 2012
100-101	Community Consultative Committee	Commencement of Construction	Three meetings in 2012
103	Community Information	Commencement of Construction	Completed in 2012
(One Month From Modification			

Condition No	Purpose	Trigger for Compliance	Status 31st December 2012
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 2012
52	Dust monitoring	During Construction	Complied for 2012
80	Lighting	During Construction	Completed
84	Heritage and Archaeology	During Construction	NT in 2012
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 2012
Mining Operations			
44	Noise	During operations	Complied in 2012
46B	Cooranbong Truck Loading Noise Mitigation	During operations	NYT
46C	Noise Audit	By 30 April 2013	NYT
46D	CHP Noise Mitigation	By 31 August 2013	NYT
52 - 53	Dust monitoring and mitigation	During operations	NYT
66	Minewater Discharge	Mining in ML1443	Completed
68-69	Erosion and Sediment Control	Commencement of Mining	Completed
85,	Hazards	During operations	Complied in 2012
		Operation of Gas Drainage Plant	NYT
85A	Hazards	Hazard assessment prior to commissioning VAMRAB	NYT
90	Local Roads	Mining	Complied in 2012
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 2012
SMP Applications			
13	Subsidence Management Measures	Offset costs of subsidence on third party no recoverable through MSB	Complied in 2012
18-19	End of Panel Report	End of Panel report and subsidence results in AEMR	Complied in 2012 – LW12 End Panel Report & AEMR

Condition No	Purpose	Trigger for Compliance	Status 31st December 2012
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 2012 – (MOP approved Dec 2013)
20	Subsidence Monitoring	Mining	Complied in 2012 - (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 2012
20	Subsidence Monitoring	Subsidence resulting from Mining	Complied in 2012 – (AEMR section 5.10)
65	Floodpath Monitoring	Monitoring of floodpath areas of Section 138 Approval	Complied in 2012 – (AEMR section 5.10)
Mining Act Obligations			
24	Bank Guarantee	Obligations under the Mining Act [Subsidence]	Complied in 2012 – (AEMR Appendix 2)
Commencement of Work/Mining In Particular Areas			
74	Wetland Management	Mining that may effect wetland hydrological regime	Complied in 2012–wetlands management plan and monitoring reported in AEMR section 5.8.4
108-110	Independent Environmental Audit	Prior to March 31 and every 3 yrs an independent audit of the consent.	Complied in 2010 – Letter (March 2010) to NSW DoP commission audit and submission of audit in May 2011.
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 construction

Condition No	Purpose	Trigger for Compliance	Status 31st December 2012
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 2012 – section 5.8.4 & 9.4
75	Mine Access Site Track	Throughout Development	Completed

Condition No	Purpose	Trigger for Compliance	Status 31st December 2012
	Upgrade		
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 2012
99	Dispute Resolution	Throughout Development	NYT
104	Community Support	Throughout Development	NYT

Abbreviations

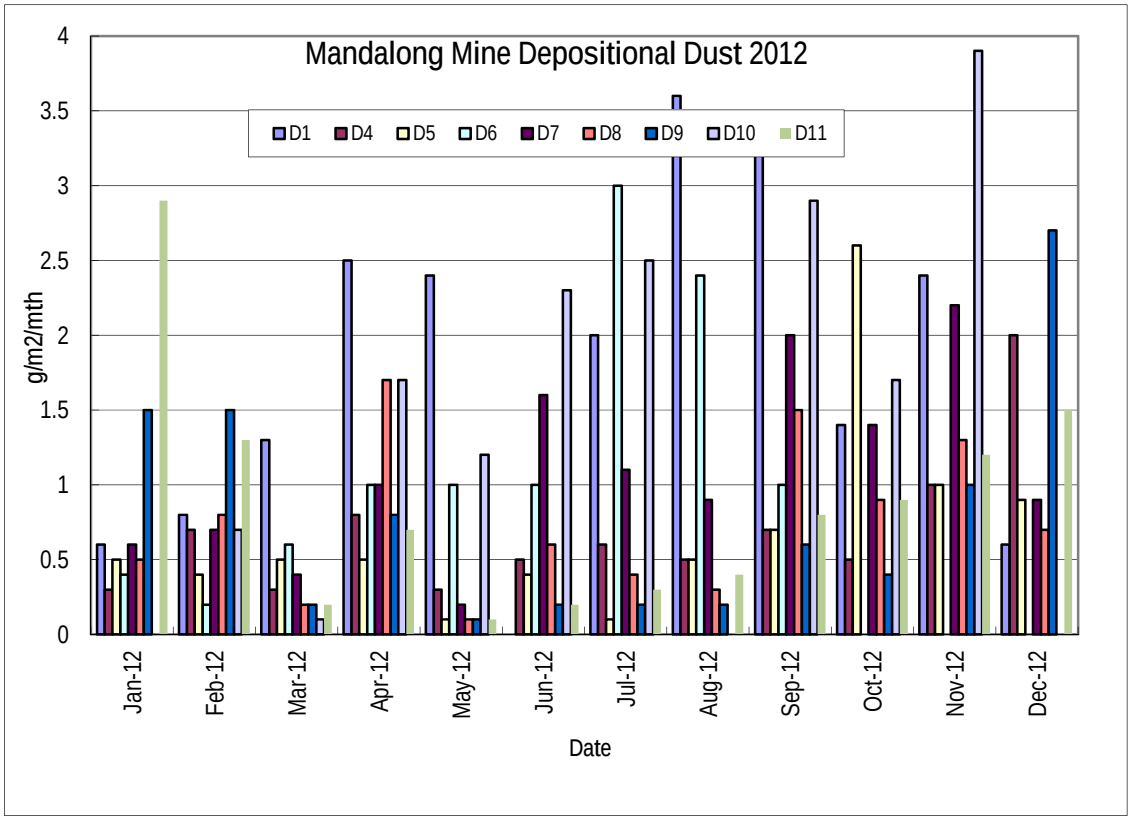
NT 2012	Not Triggered
NYT	Not Yet Triggered

APPENDIX 4
Depositional Dust Monitoring

MANDALONG MINE & COORANBONG SERVICES SITE

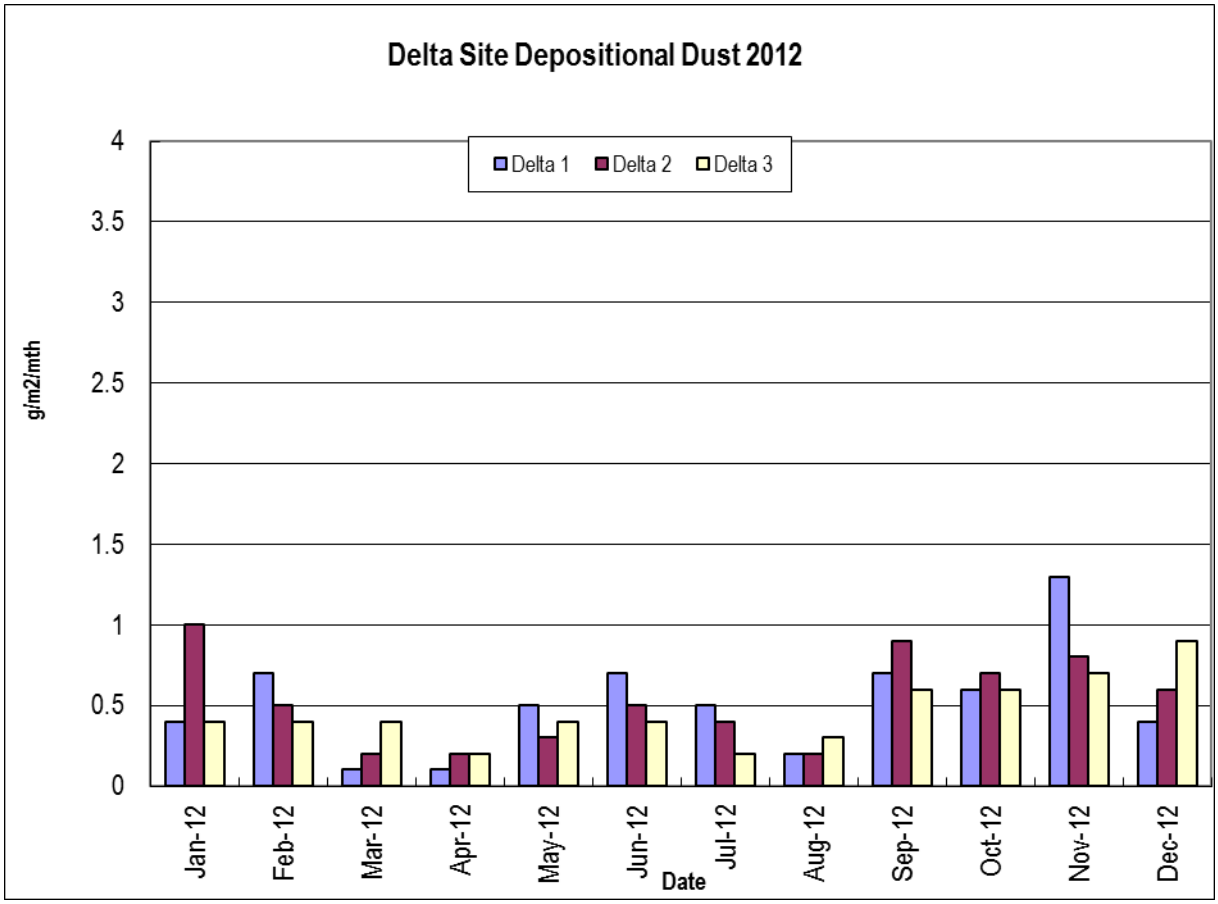
Date (Gauge Collected)	D1	Insoluble Solids g/m2/mth							
		D4	D5	D6	D7	D8	D9	D10	D11
19/01/12	0.6	0.3	0.5	0.4	0.6	0.5	1.5		2.9
20/02/12	0.8	0.7	0.4	0.2	0.7	0.8	1.5	0.7	1.3
20/03/12	1.3	0.3	0.5	0.6	0.4	0.2	0.2	0.1	0.2
19/04/12	2.5	0.8	0.5	1	1	1.7	0.8	1.7	0.7
21/05/12	2.4	0.3	0.1	1	0.2	0.1	0.1	1.2	0.1
21/06/12	*	0.5	0.4	1	1.6	0.6	0.2	2.3	0.2
23/07/12	2	0.6	0.1	3	1.1	0.4	0.2	2.5	0.3
22/08/12	3.6	0.5	0.5	2.4	0.9	0.3	0.2	*	0.4
19/09/12	3.5	0.7	0.7	1	2	1.5	0.6	2.9	0.8
18/10/12	1.4	0.5	2.6	*	1.4	0.9	0.4	1.7	0.9
19/11/12	2.4	1	1	*	2.2	1.3	1	3.9	1.2
18/12/12	0.6	2	0.9	*	0.9	0.7	2.7	*	1.5
Average Jan - Dec	1.9	0.7	0.7	1.2	1.1	0.8	0.8	1.9	0.9
LTA	1.6	0.9	0.9	1.3	1.1	0.8	1.3	1.3	1.2

* Data omitted due to contaminated sample



DELTA ENTRY SITE

Date (Gauge Collected)	Insoluble Solids g/m2/mth		
	Delta 1	Delta 2	Delta 3
19/01/12	0.4	1	0.4
20/02/12	0.7	0.5	0.4
20/03/12	0.1	0.2	0.4
19/04/12	0.1	0.2	0.2
21/05/12	0.5	0.3	0.4
21/06/12	0.7	0.5	0.4
23/07/12	0.5	0.4	0.2
22/08/12	0.2	0.2	0.3
19/09/12	0.7	0.9	0.6
18/10/12	0.6	0.7	0.6
19/11/12	1.3	0.8	0.7
18/12/12	0.4	0.6	0.9
AVERAGE	AVERAGE	0.5	0.5
LTA	**LTA**	0.694203	0.747143



APPENDIX 5

Groundwater Monitoring Data & AGE Consulting Pty Ltd "Groundwater Monitoring Review For 2012 AEMR"

APPENDIX 5 - GROUNDWATER MONITORING

pH	BH001	BH002	BH02A	BH02B	BH02C	BH003	BH003A	BH003B	BH004	BH005	BH006	BH006A	BH006B	BH007	BH007A	BH007B	BH008	BH009	BH009A	BH009B	BH010	BH010A	BH010B	BH011	BH012
Jan-12	6.60	5.56	7.01	6.26	5.85	6.33	6.02	6.44	5.91	6.96	6.37	6.37		6.30		7.43	6.57	6.31	12.17	12.03	5.98	7.58	11.99	5.63	6.63
Feb-12	6.53	5.93	7.36	6.41	5.68	6.23	6.30	6.50	6.01	-	6.34	7.35		6.31		7.80	6.37	6.45	11.61	11.91	6.15	7.62	11.71	5.86	6.66
Mar-12	6.30	6.11	7.40	6.45	6.26	6.17	6.04	6.82	6.25	6.81	6.28	7.39		6.03		6.83	6.47	5.67	11.27	11.62	6.51	7.31	11.48	5.64	6.47
Apr-12	6.41	5.70	7.23	6.29	5.52	5.99	6.05	6.85	-	-	6.23	6.99		5.93		6.98	6.37	-	-	-	6.07	7.54	11.68	5.67	6.44
May-12	6.33	5.65	7.21	6.33	5.56	6.00	5.82	6.53	6.17	6.92	6.28	7.32		5.88		6.95	6.32	-	-	-	6.13	7.80	11.55	5.02	6.56
Jun-12	6.08	-	-	-	-	6.10	6.10	6.88	-	-	6.52	7.68		6.36		7.30	6.84	-	-	-	6.41	7.74	11.91	6.03	6.98
Jul-12	-	-	-	-	-	6.11	6.29	6.90	-	-	-	-		5.80		6.98	6.57	-	-	-	6.13	7.98	11.24	5.81	6.63
Aug-12	6.53	6.18	7.22	6.20	5.36	6.26	6.46	7.15	6.20	6.87	6.12	7.48		6.15		7.25	6.84	6.21	11.54	11.97	6.12	7.73	11.39	5.96	6.61
Sep-12	6.38	6.11	7.34	6.20	5.50	6.28	6.28	6.76	6.00	6.69	6.34	7.43		6.00		6.94	6.73	6.03	11.47	11.85	5.97	7.65	11.21	5.86	6.58
Oct-12	6.17	6.03	7.36	6.39	5.39	6.24	6.32	6.96	6.04	6.44	6.33	7.59		5.97		6.95	6.68	6.71	11.61	12.17	6.02	7.61	11.12	5.83	6.59
Nov-12	6.78	5.92	7.25	6.18	5.11	6.07	6.22	6.71	6.44	6.32	6.30	7.30		6.04		7.14	6.63	6.29	11.38	11.74	6.03	7.43	11.01	5.68	6.56
Dec-12	6.04	5.63	7.11	6.20	5.03	6.09	6.13	6.70	5.92	6.14	6.39	7.30		5.94		6.95	6.47	6.17	11.45	11.79	6.00	7.46	10.69	5.49	6.32
Average	6.38	5.88	7.25	6.29	5.53	6.16	6.17	6.77	6.10	6.64	6.32	7.29		6.06	#DIV/0!	7.13	6.57	6.23	11.56	11.89	6.13	7.62	11.42	5.71	6.59

pH	BH013	BH014	BH015	BH17A1	BH20A	BH20B	BH21	BH21A	BH22A	BH22B	BH23	BH23A	BH23B	BH24A	BH24B	BH24C	BH25A	BH25B	BH25C	BH26A	BH26B	BH26C	BH27A	BH27B	BH27C
Jan-12	6.94	6.47	6.58	6.43	6.21	6.28	7.68	0.00	7.41	7.41	7.43	7.56	6.40	6.64	9.48	7.18	6.47	6.94	8.34	6.38	7.27	8.00	0.00	7.33	8.08
Feb-12	0.00	6.31	6.84	6.49	6.16	6.29	7.67	5.68	-	-	7.45	7.52	6.45	6.52	8.98	7.83	6.52	6.99	8.17	6.40	7.00	7.83	6.89	7.62	7.44
Mar-12	0.00	-	6.19	6.21	6.11	6.20	0.00	5.67	-	-	7.20	7.17	6.52	7.40	8.86	7.90	6.48	7.12	7.26	6.54	7.17	8.18	0.00	7.36	7.78
Apr-12	0.00	-	6.83	6.19	6.07	6.20	6.29	5.77	-	-	7.19	7.41	7.54	6.39	9.27	6.88	6.42	6..94	8.17	5.92	7.13	7.94	0.00	7.68	8.04
May-12	6.52	-	6.88	6.12	6.14	6.25	8.13	5.70	6.15	7.49	7.34	6.28	6.04	6.31	8.99	6.93	6.54	7.01	8.40	6.16	7.23	7.96	0.00	7.48	8.00
Jun-12	-	-	6.79	6.21	5.66	5.98	7.83	6.15	-	-	7.06	7.18	6.41	6.87	9.10	7.03	6.53	7.47	8.50	6.28	7.51	8.22	0.00	7.52	7.77
Jul-12	-	-	6.79	6.25	6.04	6.20	7.85	5.55	-	-	7.05	7.29	6.28	6.62	8.52	6.83	6.51	7.26	8.19	6.16	7.18	8.00	0.00	7.58	8.09
Aug-12	0.00	6.35	6.66	6.43	6.12	6.40	-	6.26	6.40	7.42	7.30	7.53	6.31	6.73	8.36	7.13	6.61	7.32	8.36	6.30	7.30	8.08	0.00	-	8.05
Sep-12	6.65	6.36	6.58	6.39	6.13	6.37	7.95	5.88	6.27	7.55	7.27	7.54	6.33	6.77	8.15	7.10	6.54	7.24	8.21	6.39	7.25	8.13	0.00	7.70	7.94
Oct-12	6.70	6.39	6.56	6.09	6.06	6.38	8.03	5.70	6.25	7.50	7.33	7.49	6.33	6.61	8.26	7.16	6.51	6.95	8.13	6.36	7.10	8.12	0.00	7.74	7.96
Nov-12	6.68	6.27	6.56	6.04	6.16	6.16	8.36	5.66	6.32	7.27	7.22	7.48	6.26	6.27	8.00	7.28	6.72	6.95	6.61	6.51	7.16	8.23	0.00	7.69	7.89
Dec-12	6.38	6.03	6.66	5.91	5.97	6.11	7.71	5.43	6.21	7.39	7.17	7.28	0.00	6.45	7.91	7.34	6.51	7.06	7.92	6.17	6.86	8.02	0.00	7.62	7.77
Average	3.99	6.31	6.66	6.23	6.07	6.24	7.05	5.29	6.43	7.43	7.25	7.31	5.91	6.63	8.66	7.22	6.53	7.12	8.02	6.30	7.18	8.06	0.57	7.57	7.90

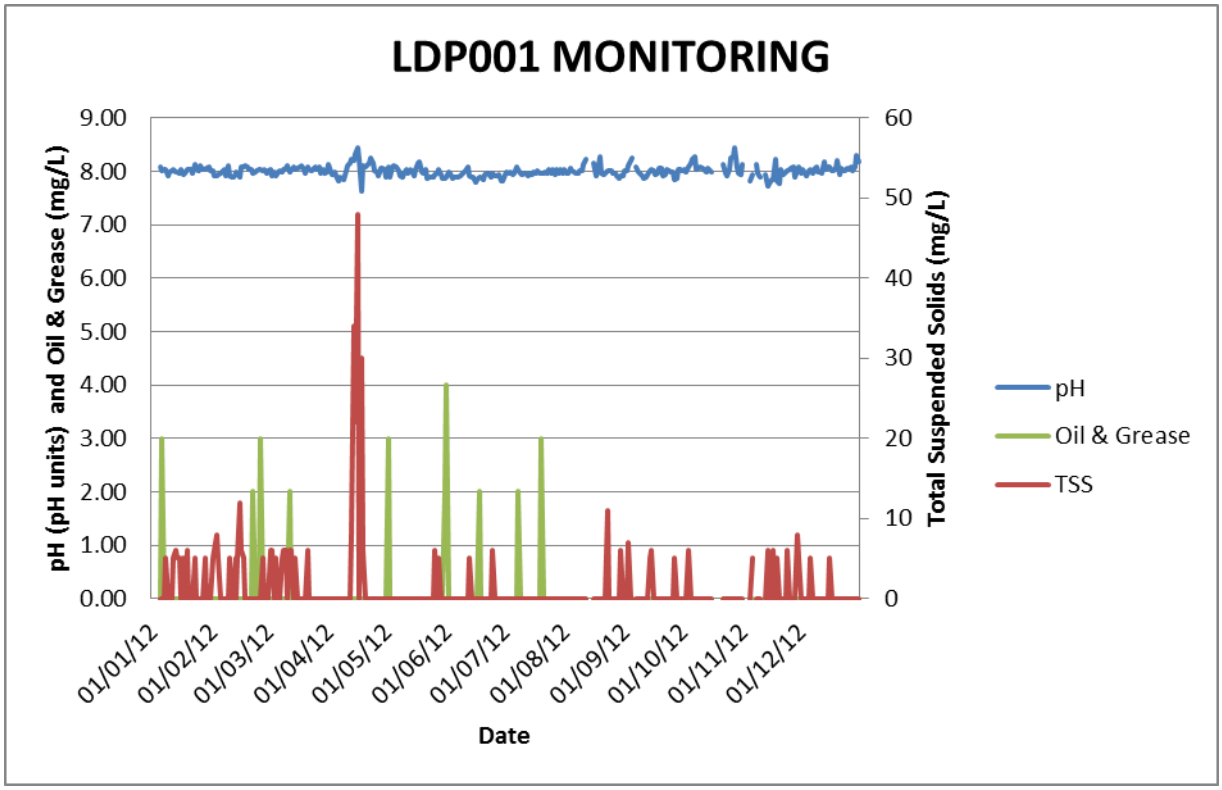
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Jan-12	493	4480	6210	6740	229	4320	7620	10090	13650	686	4970	4970		12800		8120	7830	333	6670	6890	2540	6750	5240	5486	7600
Feb-12	523	3110	6160	6710	147	3990	7820	9830	13500	-	4720	7900		12580		7750	7730	321	6640	6630	2400	6670	5260	5360	7550
Mar-12	489	7760	11470	12200	780	3940	7310	10000	13720	991	4750	7820		19610		8912	7620	247	6640	6530	2530	6820	5180	5330	7790
Apr-12	514	2520	5830	6220	125	3640	6960	9330	-	-	4290	7280		11180		7070	6720	-	-	-	2300	6140	5070	5320	7480
May-12	490	2490	5310	5680	267	3230	6310	8600	10810	447	4050	6610		9600		6780	6140	-	-	-	2230	6230	4910	4910	6750
Jun-12	470	-	-	-	-	2700	5870	7190	-	-	4140	6680		8030		6210	6060	-	-	-	2280	5010	4240	4370	6620
Jul-12	-	-	-	-	-	2450	4540	3200	-	-	-	-		9350		5150	3630	-	-	-	2150	5670	4620	4260	6260
Aug-12	483	768	6200	6640	371	3070	7530	10760	14370	919	4970	8040		14320		8030	8070	333	6210	6270	2480	6880	5050	5750	8380
Sep-12	508	1350	6240	6770	570	2960	7530	10610	14050	2020	4900	7890		13270		8220	7720	319	6300	6460	2430	6760	4920	5660	8382
Oct-12	495	1632	5760	5940	748	2720	6680	9680	11480	3460	4450	7450		11210		7180	7030	420	5640	6280	2430	6460	4810	5220	7590
Nov-12	525	1930	5020	4870	857	2340	5450	7390	13610	3810	3350	6410		8410		7920	7320	323	6020	5900	2310	5140	4480	4460	6010
Dec-12	469	2170	4930	5190	876	2340	5890	8020	9750	4840	4040	6730		9630		6570	6070	307	6080	6030	2420	5830	4520	4700	6530
Average	496	2821	6313	6696	497	3142	6626	8725	12771	2147	4421	7071		11666	#DIV/0!	7326	6828	325	6275	6374	2375	6197	4858	5069	7245

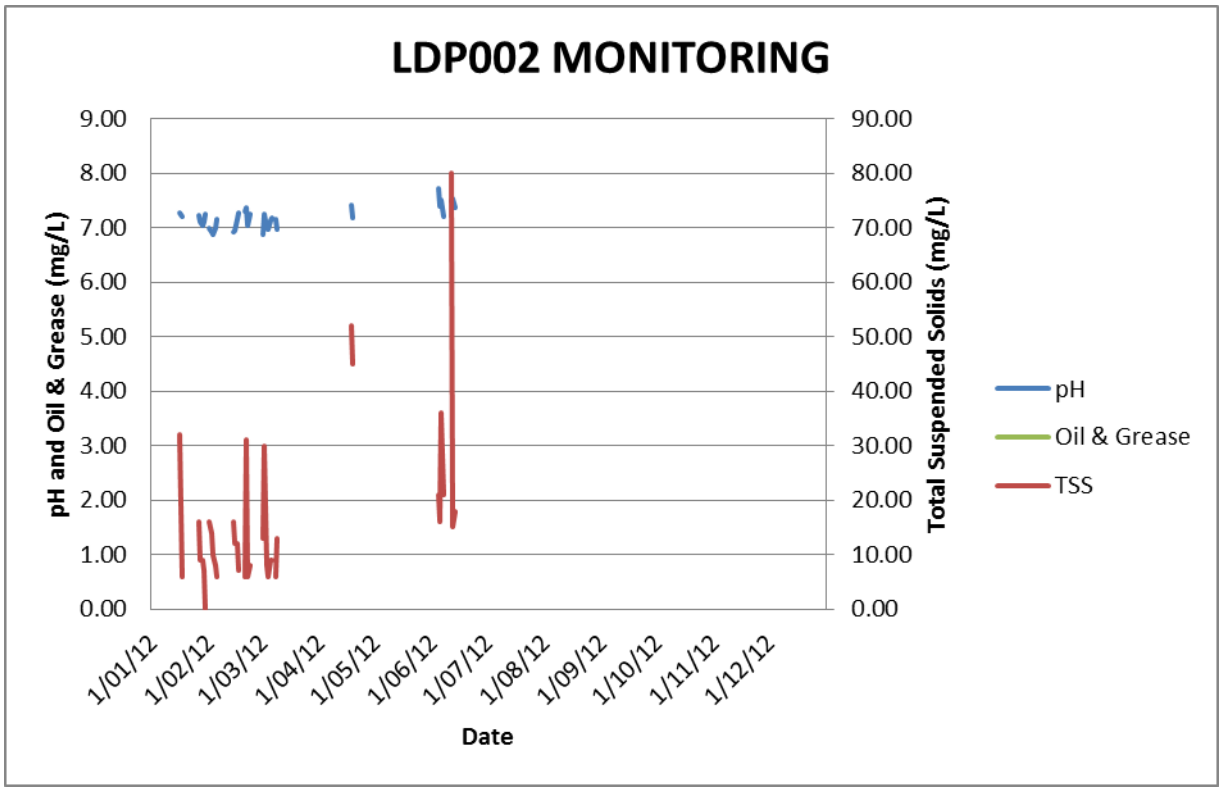
EC	BH013	BH014	BH015	BH17A1	BH20A	BH20B	BH21	BH21A	BH22A	BH22B	BH23	BH23A	BH23B	BH24A	BH24B	BH24C	BH25A	BH25B	BH25C	BH26A	BH26B	BH26C	BH27A	BH27B	BH27C
Jan-12	411	14290	3320	280	8250	6250	6850	0	11400	11400	6670	5930	4640	10940	11200	10520	6760	7170	7490	8980	6940	6680	0	5350	4820
Feb-12	0	11400	3330	376	8200	6290	7100	8670	-	-	6650	5970	4690	11360	11330	11160	6670	7120	7360	10550	6980	6560	1033	5610	4550
Mar-12	0	-	4480	494	7780	6100	0	8350	-	-	1211	1120	9870	10890	1783	2000	6570	7040	8260	11730	6930	6310	0	5610	4830
Apr-12	0	-	3340	648	8160	5440	7980	7450	-	-	5910	5490	5120	10160	10430	9960	6130	6660	7060	11360	6420	6140	0	5620	4770
May-12	4860	-	3890	1306	8210	5280	6170	7190	5100	9490	5800	3940	0	9770	10100	9990	5730	6080	6630	9820	6020	5650	0	5670	4680
Jun-12	-	-	4030	1727	7890	4900	3850	6100	-	-	5070	4360	3450	9630	9870	9140	5020	2040	4950	8790	5920	5580	0	5620	4470
Jul-12	-	-	3390	1602	7630	4310	4920	4940	-	-	4720	4760	3890	7890	7090	8350	5010	5640	6080	7740	5590	4530	0	5280	4310
Aug-12	0	14670	5810	1251	7780	6590	-	9050	5860	11380	6660	6100	4770	11690	11850	11560	6700	7310	7510	10160	7000	6130	0	-	4860
Sep-12	6700	15020	5820	1385	6930	6250	7060	8540	5800	11330	6630	5930	4640	10650	11050	10460	6690	7230	7510	9210	6780	6160	0	5760	4810
Oct-12	7000	12040	5220	1473	6530	5640	6830	7570	5330	10450	6470	5600	4320	9780	10570	10020	5920	6450	7050	8300	6470	5990	0	5660	4790
Nov-12	6070	10740	4170	2240	6970	8530	6260	6360	4780	8770	6690	5990	4890	8240	8960	8550	5330	5660	8200	6750	5560	5430	0	5000	4430
Dec-12	6540	11880	4360	2470	6440	4970	6271	6960	4640	8780	5700	5270	3850	8410	9040	8650	5480	6240	6710	7290	5930	5520	0	5330	4550
Average	3158	12863	4263	1271	7564	5879	5754	6765	6130	10229	5682	5038	4511	9951	9439	9197	6001	6220	7068	9223	6378	5890	86	5501	4656

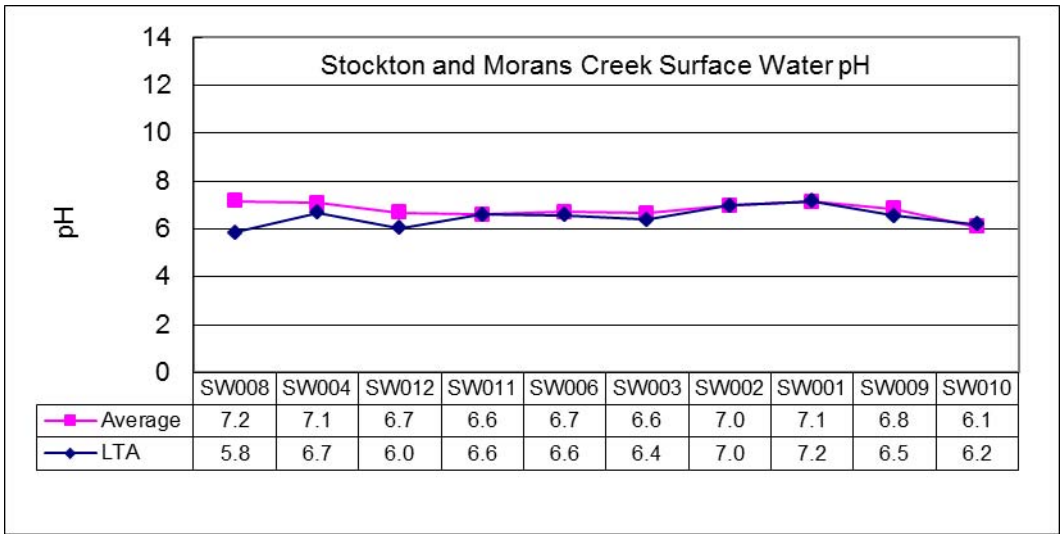
Depth	BH001	BH002	BH02A	BH02B	BH02C	BH003	BH003A	BH003B	BH004	BH005	BH006	BH006A	BH006B	BH007	BH007A	BH007B	BH008	BH009	BH009A	BH009B	BH010	BH010A	BH010B	BH011	BH012
Jan-12	3.43	1.98	20.96	2.68	3.05	3.32	2.71	17.18	0.22	0.6	1.76	10.12		0.78		10.3	1.42	1.74	10.64	14.66	1.23	3.87	12.05	0.84	0
Feb-12	3.18	1.84	21.08	2.70	2.26	3.21	2.29	17.20	0.10	-	2.36	9.77		0.51		9.66	1.38	1.15	8.03	16.08	1.02	3.96	12.31	0.31	0.54
Mar-12	3.23	1.69	21.20	2.76	2.17	3.28	2.47	19.46	0.12	0.61	2.34	9.9		0.57		9.73	1.52	1.65	15.19	14.84	0.05	4.05	12.50	0.78	0.84
Apr-12	3.43	1.75	20.07	2.75	2.04	3.09	2.43	19.15	-	-	2.56	9.74		1.09		11.42	1.73	-	-	-	1.29	4.29	12.97	0.42	1.03
May-12	3.31	1.86	21.13	3.07	2.29	3.54	2.52	19.52	0.29	0.68	2.77	9.72		0.99		10.92	1.54	-	-	-	1.42	4.24	12.81	0.86	0.99
Jun-12	3.30	-	-	-	-	3.18	2.52	18.91	-	-	2.53	9.56		0.72		10.06	1.47	-	-	-	1.22	3.99	12.30	0.42	0.67
Jul-12	-	-	-	-	-	3.14	2.38	18.13	-	-	-	-		0.70		9.77	1.4	-	-	-	1.14	3.94	12.21	0.32	0.58
Aug-12	3.49	1.66	20.88	2.54	1.86	3.14	2.41	17.96	0.33	0.58	2.66	9.9		1.00		9.72	1.42	1.82	16.12	17.45	1.28	3.96	12.18	0.49	0.47
Sep-12	3.41	2.64	20.90	2.57	1.88	3.34	2.64	17.87	0.60	0.89	2.68	9.53		1.17		9.56	1.61	1.88	9.86	17.91	1.48	4.30	12.24	0.99	1.36
Oct-12	3.48	1.81	20.87	2.67	2.01	3.28	2.62	17.37	0.69	1.08	2.84	9.55		1.67		9.98	1.75	2.03	15.53	18.63	1.61	4.59	12.64	1.09	1.34
Nov-12	3.64	2.03	20.93	2.81	2.09	3.56	2.69	16.62	1.10	1.78	3.4	9.76		1.76		9.84	1.83	2.25	16.03	18.53	2.06	5.38	14.42	1.18	1.99
Dec-12	3.60	1.99	21.01	2.93	2.13	3.55	2.84	17.22	1.08	1.61	3.11	9.8		1.85		9.65	1.88	2.38	16.07	18.66	2.00	4.86	14.03	1.44	1.68
Average	3.41	1.93	20.90	2.75	2.22	3.30	2.54	18.05	0.43	0.89	2.64	9.76		1.07	#DIV/0!	10.05	1.58	1.86	13.43	17.10	1.32	4.29	12.72	0.76	0.96

Depth	BH013	BH014	BH015	BH17A1	BH20A	BH20B	BH21	BH21A	BH22A	BH22B	BH23	BH23A	BH23B	BH24A	BH24B	BH24C	BH25A	BH25B	BH25C	BH26A	BH26B	BH26C	BH27A	BH27B	BH27C
Jan-12	0.49	0.53	2.66	2.47	2.15	2.23	52.70	0	2.13	11.80	53.46	15.88	2.95	1.34	8.58	2.93	0.60	3.74	5.60	1.79	0.84	5.52	-	77.04	69.8
Feb-12	0	0.32	2.68	2.45	1.85	2.03	53.10	2.38	-	-	55.38	16.02	3.10	1.10	8.89	2.63	0.21	3.51	6.76	1.52	0.84	5.43	10.27	77.42	70.89
Mar-12	0	-	2.46	2.38	2.06	2.07	53.12	2.59	-	-	55.97	15.91	2.86	1.30	10.03	3.23	0.29	3.77	7.09	1.36	0.77	6.26	11.61	77.22	70.54
Apr-12	0	-	2.5	2.24	2.16	2.1	53.05	2.56	-	-	57.04	16.12	2.82	1.28	9.96	2.35	0.40	2.95	5.01	2.07	1.05	6.77	0.00	73.57	73.5
May-12	0.32	-	2.55	2.28	2.21	2.18	53.06	2.54	1.61	10.87	56.88	15.93	0.00	1.48	9.58	2.48	0.61	3.33	5.50	2.26	1.18	7.10	0.00	77	74.57
Jun-12	-	-	2.56	2.43	2.15	1.36	53.27	2.53	-	-	57.06	16.06	2.87	1.21	9.74	2.35	0.90	3.43	5.88	2.02	1.03	6.20	12.21	77.04	74.51
Jul-12	-	-	2.3	2.51	2.00	1.94	53.94	2.35	-	-	58.10	15.90	2.69	1.35	9.44	4.12	0.11	2.99	6.02	2.03	1.05	7.45	12.40	77.31	76.47
Aug-12	0	0.49	2.36	2.23	2.12	1.9	53.43	2.57	1.57	10.18	57.39	16.00	2.62	1.22	8.92	9.87	0.35	3.37	6.39	1.43	0.35	6.91	-	79.33	76.8
Sep-12	0.68	0.66	2.39	2.32	1.74	2.13	53.23	2.5	1.8	10.31	57.21	15.70	2.77	1.46	9.22	13.39	0.83	3.40	6.38	1.71	0.6	7.02	0.00	79.31	77.24
Oct-12	0.87	0.95	2.63	2.21	1.93	1.49	53.20	2.66	2.22	11.36	57.46	16.05	2.75	1.80	9.64	15.37	1.06	4.14	7.39	1.96	1.11	7.81	0.00	77.55	77.11
Nov-12	1.07	1.01	2.9	2.31	2.09	1.67	53.13	2.86	2.46	10.42	57.17	16.07	2.84	1.92	10.27	16.52	1.19	3.73	4.02	1.98	1.04	7.66	0.00	77.68	77.95
Dec-12	1.41	1.15	2.97	2.49	1.85	1.68	52.84	2.93	2.88	10.59	57.26	15.90	2.88	2.00	10.29	17.28	1.34	4.65	5.23	2.03	1.09	7.83	0.00	77.29	79.6
Average	0.48	0.73	2.58	2.36	2.03	1.90	53.17	2.37	2.10	10.79	56.70	15.96	2.60	1.46	9.55	7.71	0.66	3.58	5.94	1.85	0.91	6.83	4.65	77.31	74.92

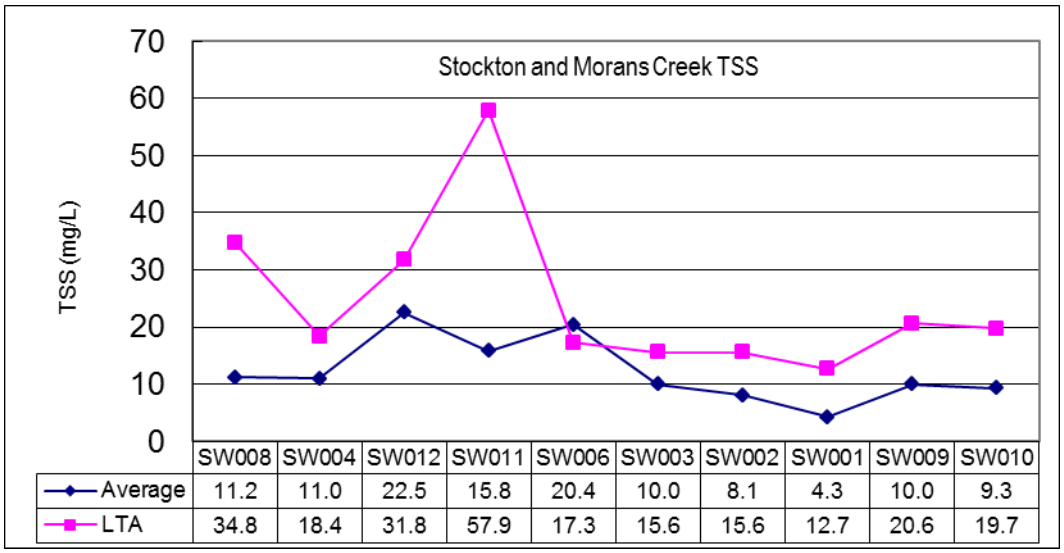
APPENDIX 6
Surface Water Monitoring



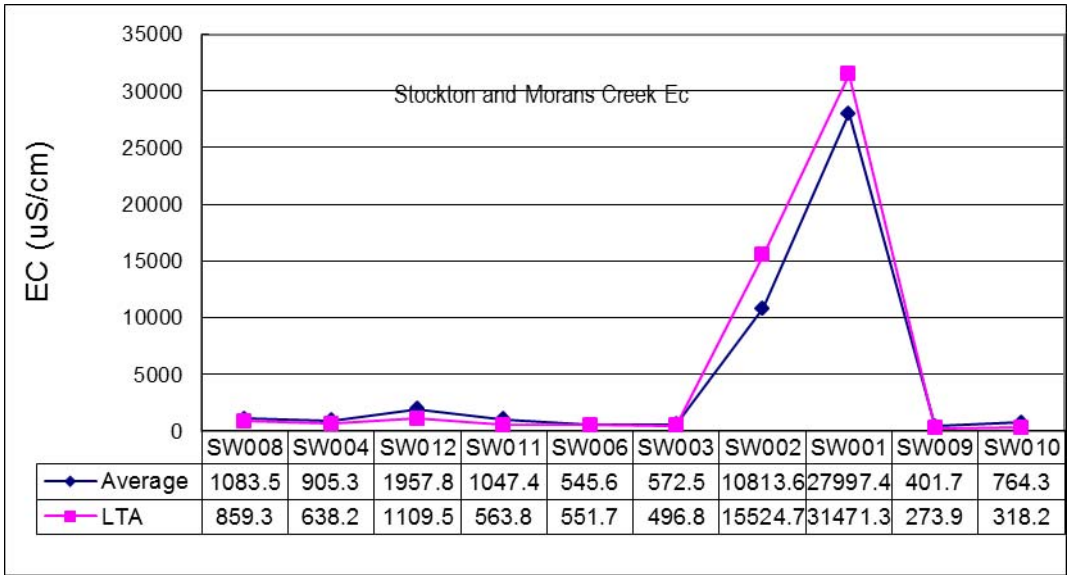




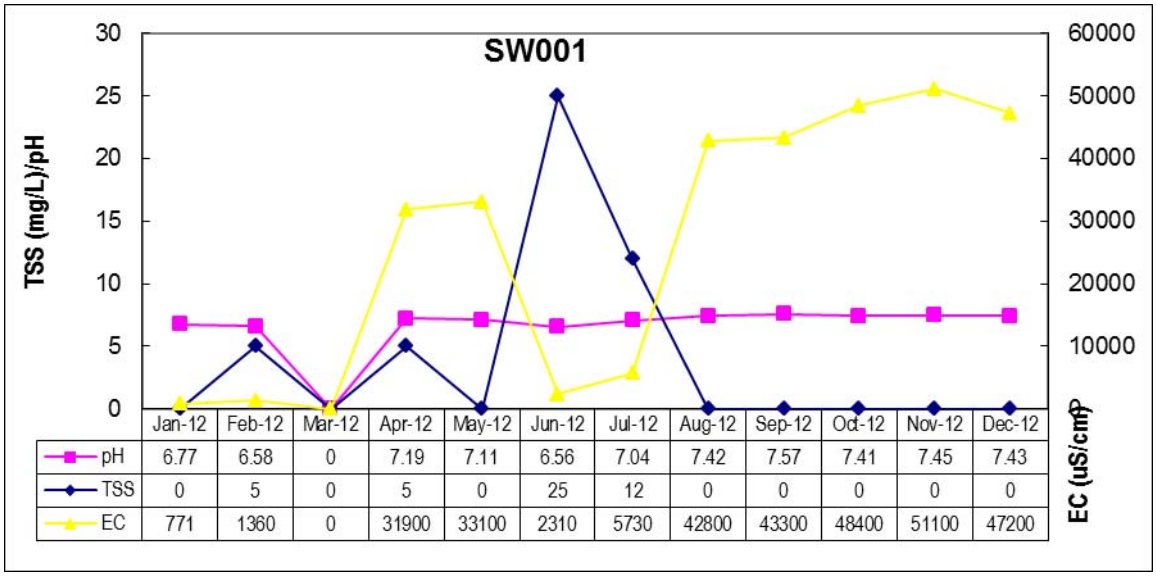
	SW008	SW004	SW012	SW011	SW006	SW003	SW002	SW001	SW009	SW010
Average	7.2	7.1	6.7	6.6	6.7	6.6	7.0	7.1	6.8	6.1
LTA	5.8	6.7	6.0	6.6	6.6	6.4	7.0	7.2	6.5	6.2



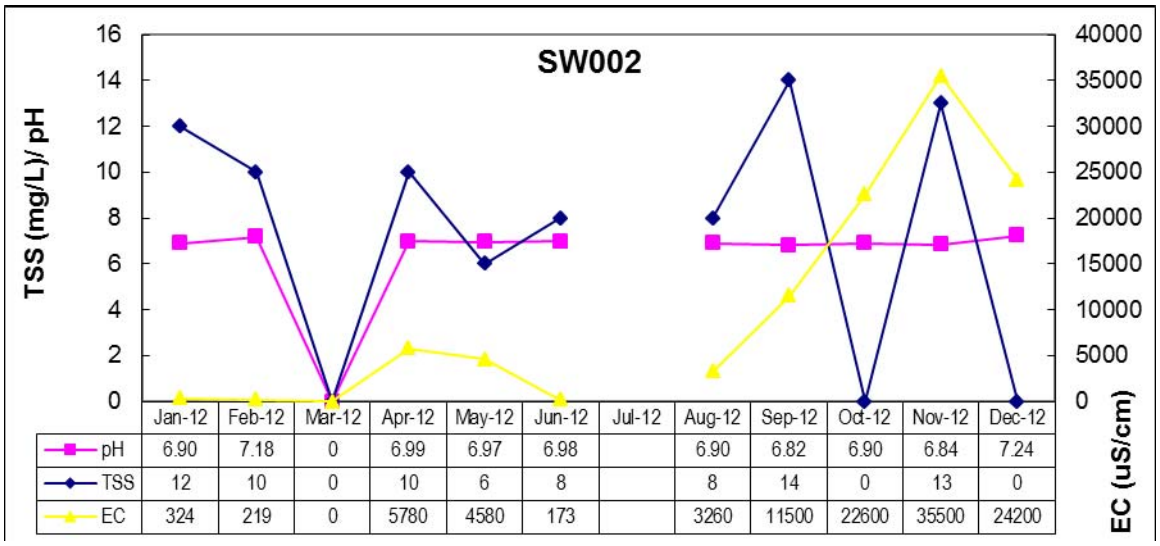
	SW008	SW004	SW012	SW011	SW006	SW003	SW002	SW001	SW009	SW010
Average	11.2	11.0	22.5	15.8	20.4	10.0	8.1	4.3	10.0	9.3
LTA	34.8	18.4	31.8	57.9	17.3	15.6	15.6	12.7	20.6	19.7



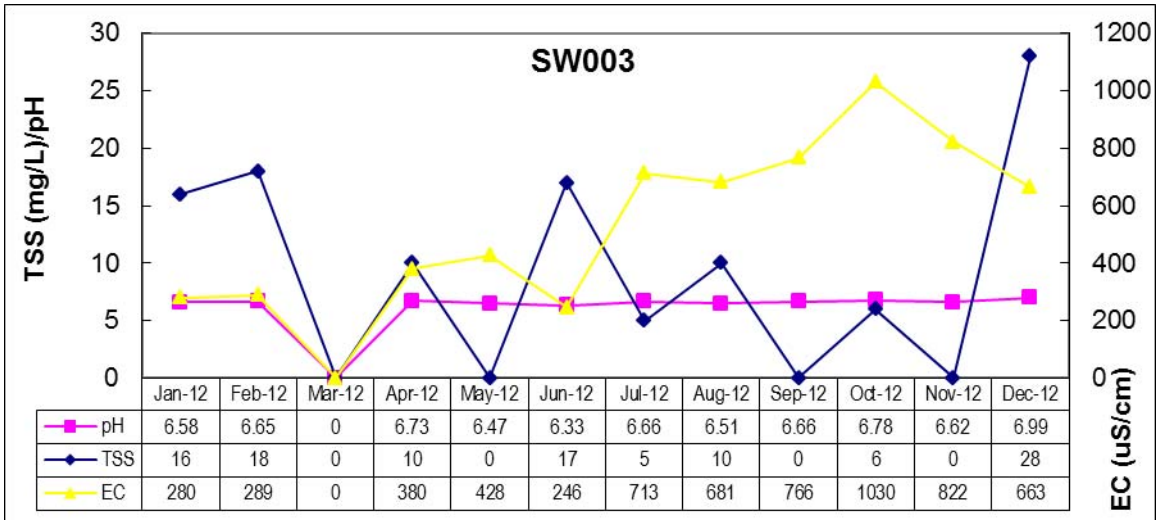
	SW008	SW004	SW012	SW011	SW006	SW003	SW002	SW001	SW009	SW010
Average	1083.5	905.3	1957.8	1047.4	545.6	572.5	10813.6	27997.4	401.7	764.3
LTA	859.3	638.2	1109.5	563.8	551.7	496.8	15524.7	31471.3	273.9	318.2



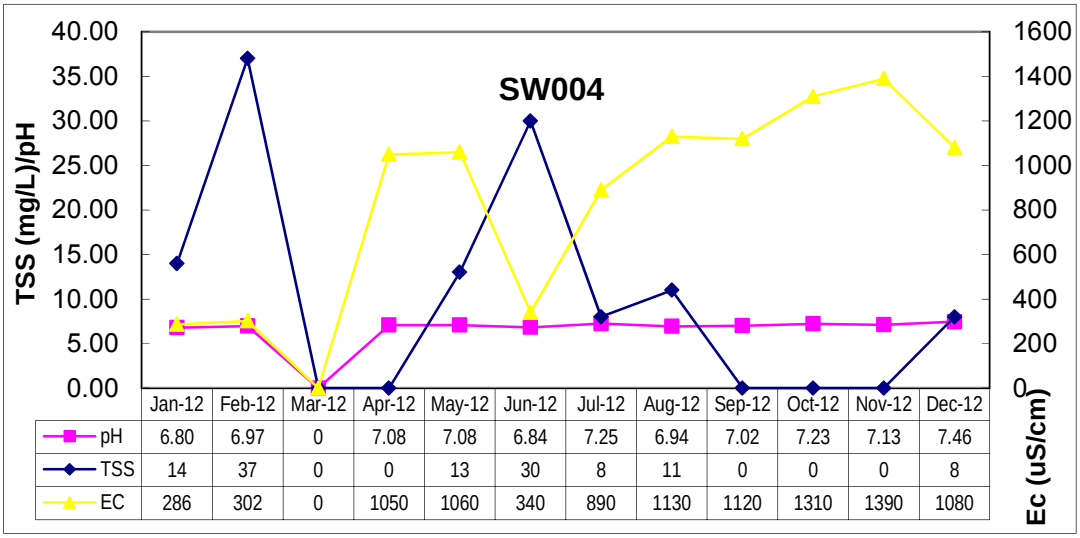
	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12
pH	6.77	6.58	0	7.19	7.11	6.56	7.04	7.42	7.57	7.41	7.45	7.43
TSS	0	5	0	5	0	25	12	0	0	0	0	0
EC	771	1360	0	31900	33100	2310	5730	42800	43300	48400	51100	47200



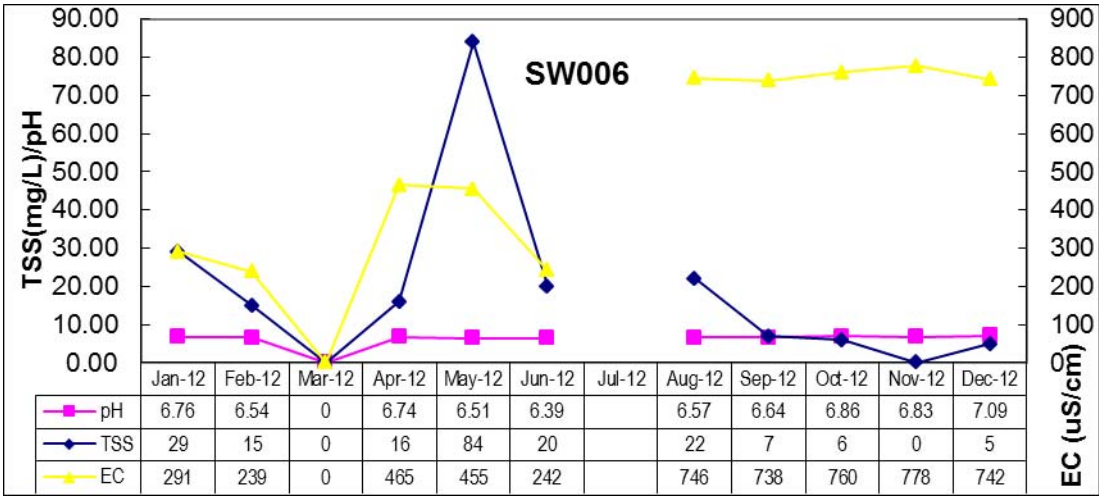
	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12
pH	6.90	7.18	0	6.99	6.97	6.98		6.90	6.82	6.90	6.84	7.24
TSS	12	10	0	10	6	8		8	14	0	13	0
EC	324	219	0	5780	4580	173		3260	11500	22600	35500	24200



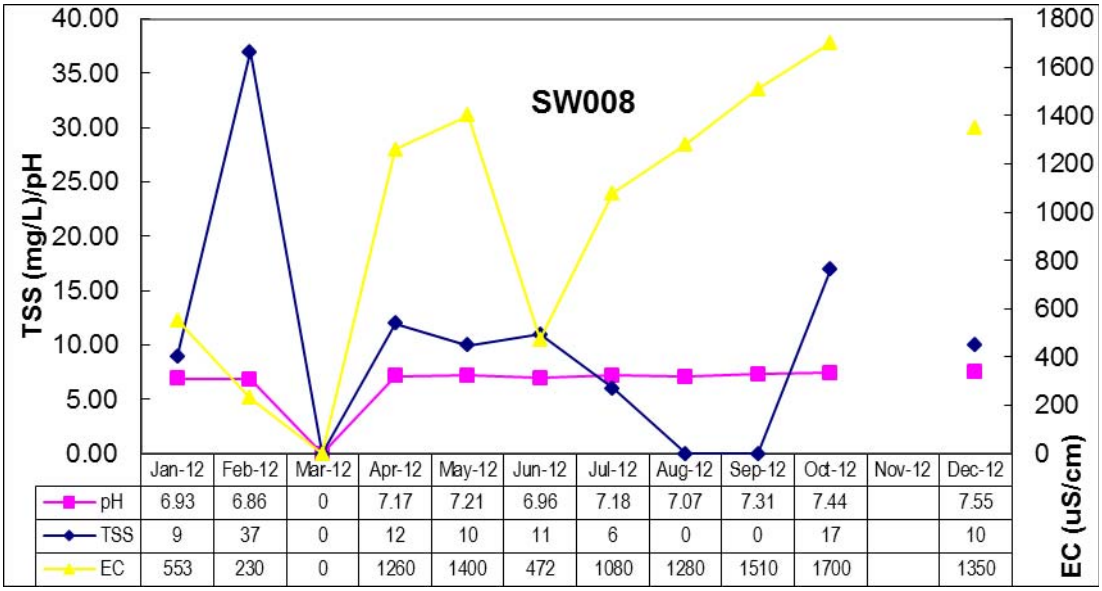
	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12
pH	6.58	6.65	0	6.73	6.47	6.33	6.66	6.51	6.66	6.78	6.62	6.99
TSS	16	18	0	10	0	17	5	10	0	6	0	28
EC	280	289	0	380	428	246	713	681	766	1030	822	663



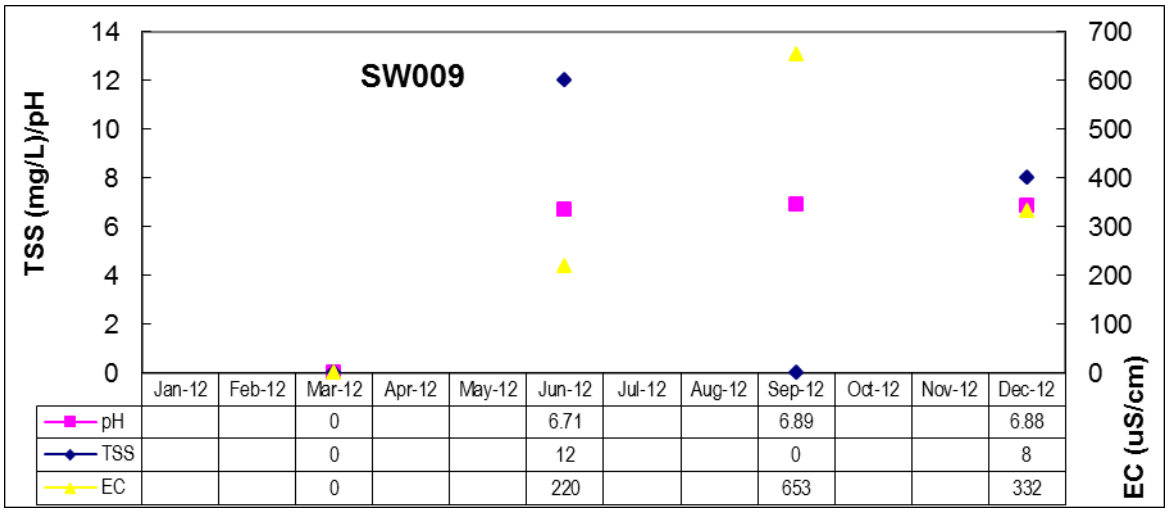
	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12
pH	6.80	6.97	0	7.08	7.08	6.84	7.25	6.94	7.02	7.23	7.13	7.46
TSS	14	37	0	0	13	30	8	11	0	0	0	8
EC	286	302	0	1050	1060	340	890	1130	1120	1310	1390	1080



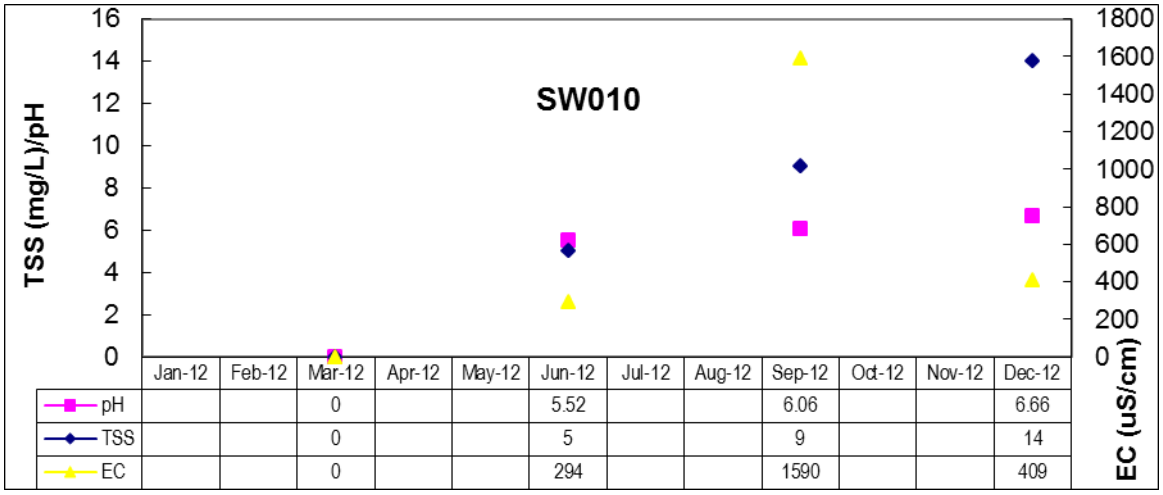
	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12
pH	6.76	6.54	0	6.74	6.51	6.39		6.57	6.64	6.86	6.83	7.09
TSS	29	15	0	16	84	20		22	7	6	0	5
EC	291	239	0	465	455	242		746	738	760	778	742



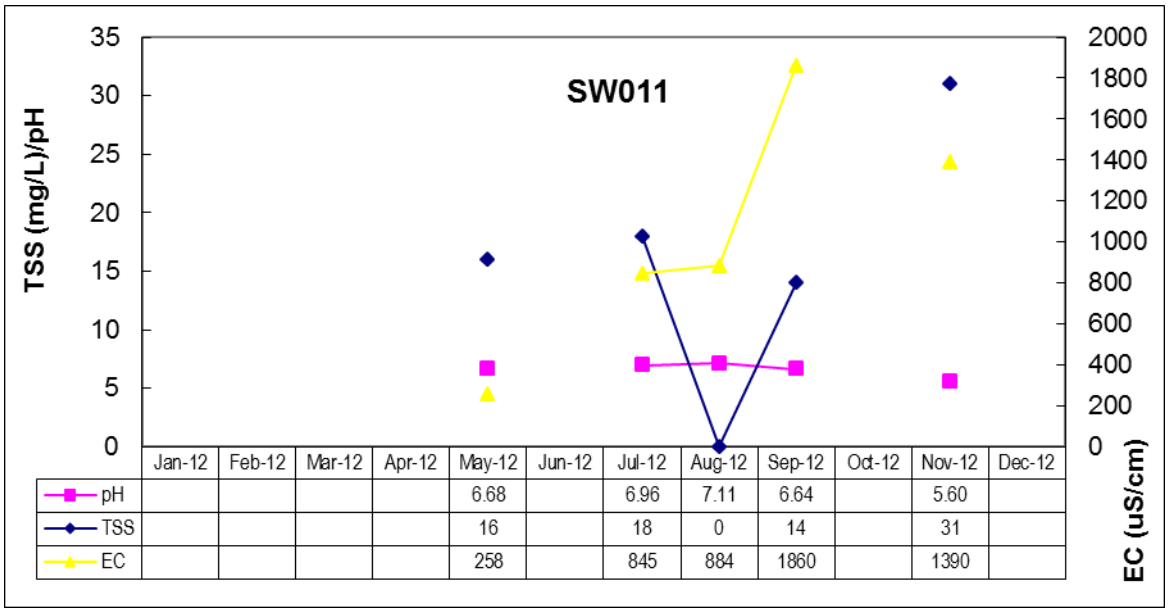
	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12
pH	6.93	6.86	0	7.17	7.21	6.96	7.18	7.07	7.31	7.44		7.55
TSS	9	37	0	12	10	11	6	0	0	17		10
EC	553	230	0	1260	1400	472	1080	1280	1510	1700		1350



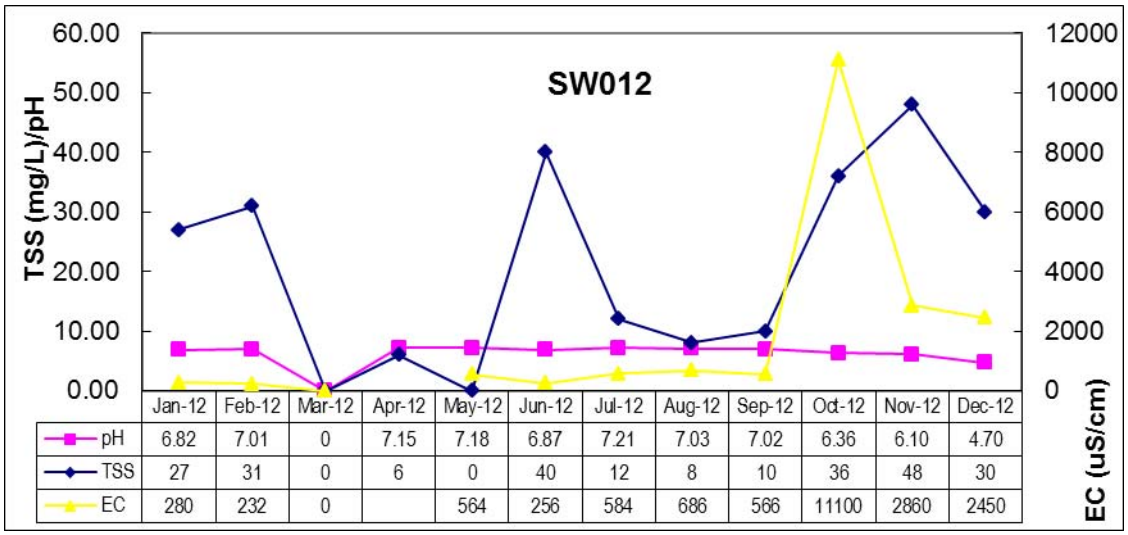
	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12
pH			0			6.71			6.89			6.88
TSS			0			12			0			8
EC			0			220			653			332



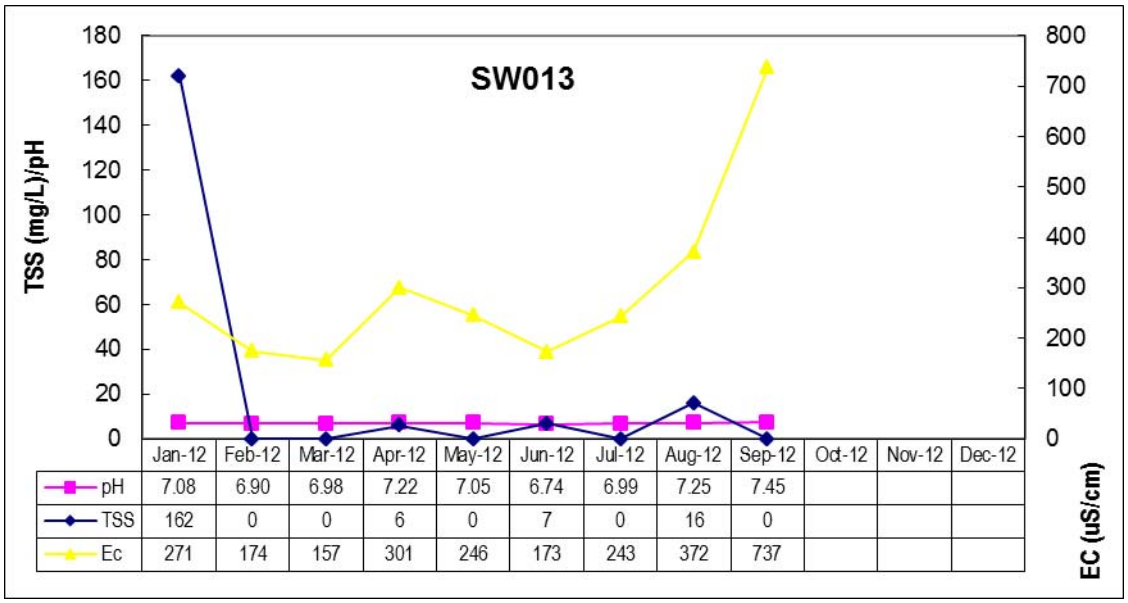
	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12
pH			0			5.52			6.06			6.66
TSS			0			5			9			14
EC			0			294			1590			409



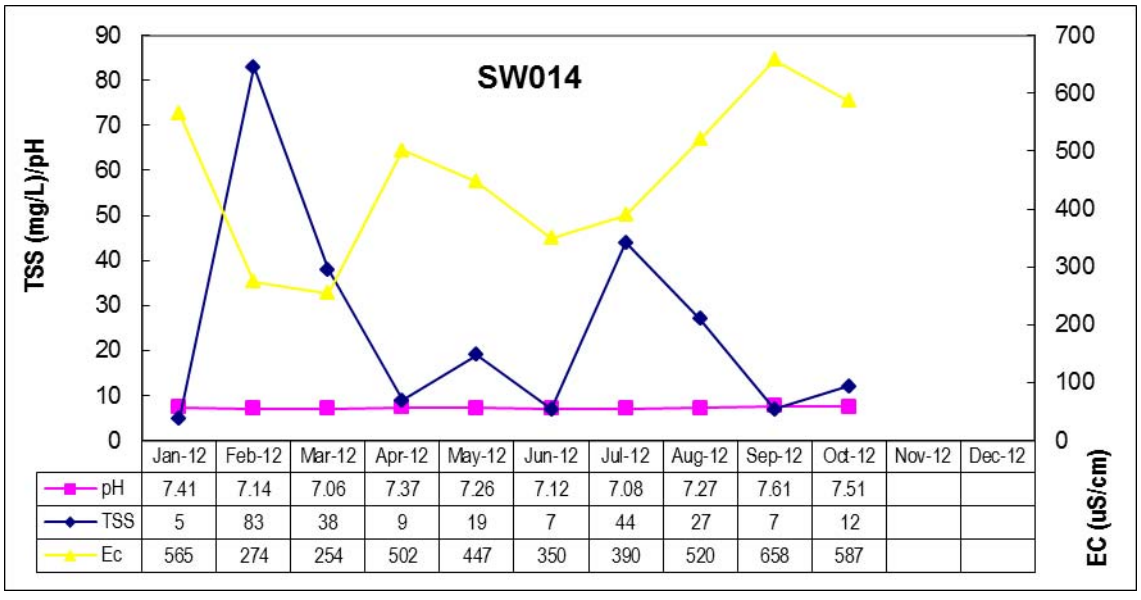
	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12
pH					6.68		6.96	7.11	6.64		5.60	
TSS					16		18	0	14		31	
EC					258		845	884	1860		1390	



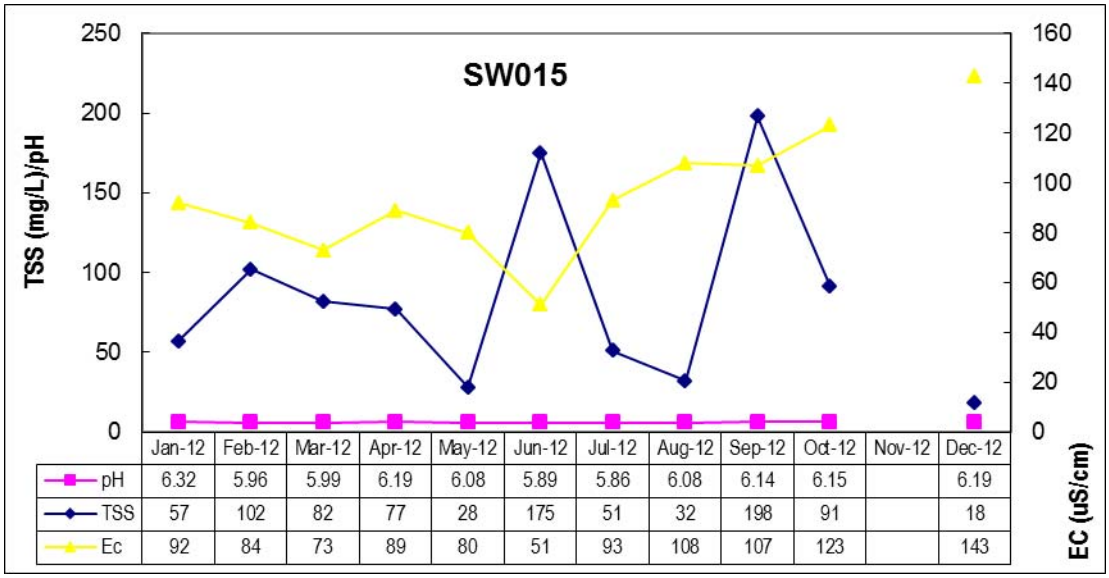
	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12
pH	6.82	7.01	0	7.15	7.18	6.87	7.21	7.03	7.02	6.36	6.10	4.70
TSS	27	31	0	6	0	40	12	8	10	36	48	30
EC	280	232	0		564	256	584	686	566	11100	2860	2450



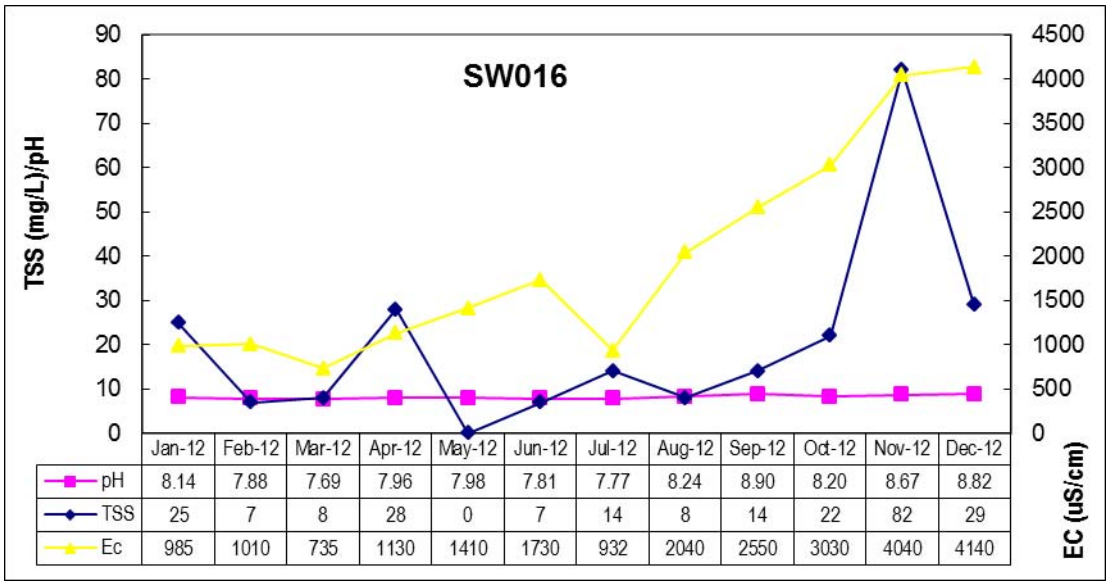
	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12
pH	7.08	6.90	6.98	7.22	7.05	6.74	6.99	7.25	7.45			
TSS	162	0	0	6	0	7	0	16	0			
Ec	271	174	157	301	246	173	243	372	737			



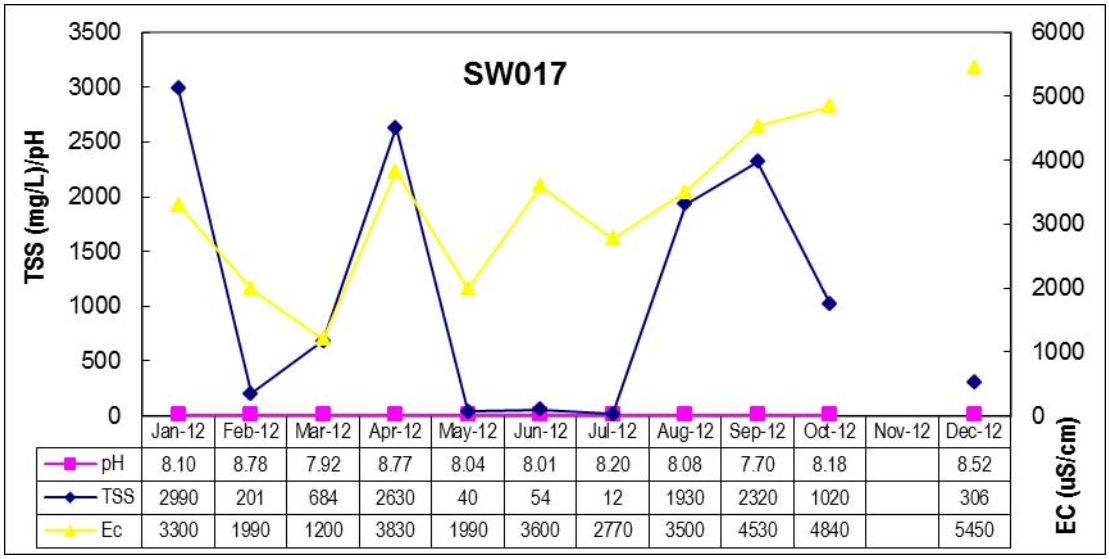
	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12
pH	7.41	7.14	7.06	7.37	7.26	7.12	7.08	7.27	7.61	7.51		
TSS	5	83	38	9	19	7	44	27	7	12		
Ec	565	274	254	502	447	350	390	520	658	587		



	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12
pH	6.32	5.96	5.99	6.19	6.08	5.89	5.86	6.08	6.14	6.15		6.19
TSS	57	102	82	77	28	175	51	32	198	91		18
Ec	92	84	73	89	80	51	93	108	107	123		143

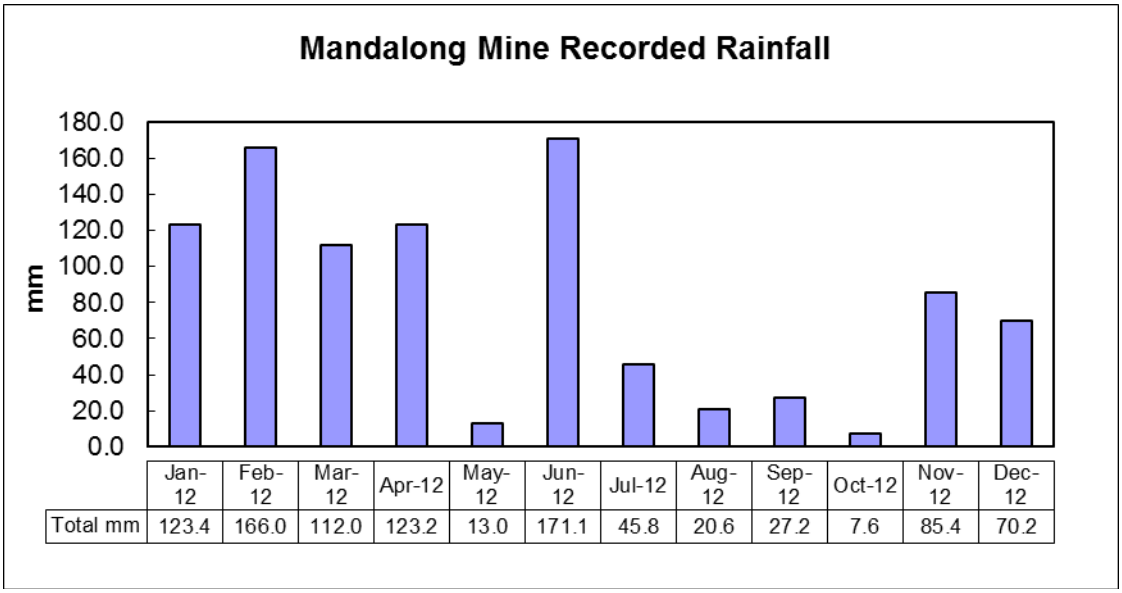


	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12
pH	8.14	7.88	7.69	7.96	7.98	7.81	7.77	8.24	8.90	8.20	8.67	8.82
TSS	25	7	8	28	0	7	14	8	14	22	82	29
Ec	985	1010	735	1130	1410	1730	932	2040	2550	3030	4040	4140



	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12
pH	8.10	8.78	7.92	8.77	8.04	8.01	8.20	8.08	7.70	8.18		8.52
TSS	2990	201	684	2630	40	54	12	1930	2320	1020		306
Ec	3300	1990	1200	3830	1990	3600	2770	3500	4530	4840		5450

APPENDIX 7
Rainfall Data



	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12
Total mm	123.4	166.0	112.0	123.2	13.0	171.1	45.8	20.6	27.2	7.6	85.4	70.2

APPENDIX 8
Noise and Blast Monitoring Reports

global environmental solutions

Mandalong Mine

Noise Compliance Assessment

October 2012

Report Number 630.02130-R1

14 November 2012

Centennial Coal Company Limited
PO Box 1000
Toronto NSW 2283

Version: Revision 1

Mandalong Mine

Noise Compliance Assessment

October 2012

PREPARED BY:

SLR Consulting Australia Pty Ltd
ABN 29 001 584 612
Level 1, 14 Watt Street Newcastle NSW 2300 Australia

(PO Box 1768 Newcastle NSW 2300 Australia)
T: 61 2 4908 4500 F: 61 2 4908 4501
E: newcastleau@slrconsulting.com www.slrconsulting.com

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1 INTRODUCTION

Centennial Coal Company Limited (Centennial) has commissioned SLR Consulting Australia Pty Ltd (SLR Consulting) 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 Program August 2009.

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

- Measure the ambient noise levels at four (4) focus receptor locations (potentially worst affected) surrounding the mine and coal handling facilities. Noise surveys comprise both continuous unattended monitoring and operator attended monitoring, in 15 minute intervals, coinciding with day, evening and night-time periods. 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 with respect to the limits contained in the Development Consent.

2 MANDALONG COAL MINE CONSENT CONDITIONS

Condition 44 of the consent is relevant to the noise impact assessment 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.

3 PROCEDURES AND METHODOLOGY

3.1 General Requirements

The operational noise monitoring programme was conducted with reference to the Mandalong Mine Noise Monitoring Program August 2009 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.

3.2 Monitoring Locations

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

Table 2 Monitoring Locations

Site	Receivers	Description
M1	Residences west of the Mandalong mine access site	On the eastern facade within 30m of the property located at property reference 82 as defined in the consent condition 44. We note that the unattended noise logger was located at this property. However, to minimise disturbance to residents all attended day, evening and night measurements were conducted at the centennial coal owned property (reference 83) adjacent to property 82 and represents a worst case scenario.
M2	Residences southwest of the Mandalong mine access site	On the northern facade within 30m of the property located at property reference 97 as defined in the consent condition 44.
M3	Residences east of the Mandalong mine access site	In front of the residence on Gimberts Road. Define as noise receiver location 85" in the consent condition 44.
M4	Residences near the Cooranbong service site	On the western side of Gradwells Road approximately 90m north west of the nearest residence, to minimise disturbance to residents and the potential effects of barking dogs. Define as noise receiver location "23" in the consent condition 44.

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

3.3 Unattended Continuous Noise Monitoring

Environmental noise loggers were deployed on Thursday 18 October 2012 at locations M1 to M4 (see **Table 2**). All unattended monitoring equipment was programmed to continuously record statistical noise level indices in 15 minute intervals including the L_{Amax}, L_{A1}, L_{A10}, L_{A90} and L_{Aeq}. An explanation of how these statistical noise level indices are determined is contained within **Appendix B**. Instrument calibration was conducted before and after each measurement survey, with the variation in calibrated levels not exceeding ±0.5 dBA.

3.4 Operator Attended Monitoring

Operator attended surveys were conducted at each of the four monitoring locations for day, evening and night-time periods, to verify the unattended logging results and to determine the character and relative contribution of ambient noise sources.

4 OPERATOR ATTENDED NOISE MONITORING

4.1 Results of Operator Attended Monitoring

Operator attended noise measurements were conducted during the day, evening and night-time periods on Thursday 18 October 2012 at monitoring locations M1 to M4.

The results of the operator attended noise measurements are given in **Table 3** to **Table 6**. 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 (L_{Amax}) and contributed noise levels.

Table 3 Operator Attended Noise Monitoring Results - Location M1

Date/Start Time Weather	Measurement Description (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	
18/10/2012 4:00 pm W = 4.7m/s E Temp = 20.8°C	Daytime Ambient (35 dBA)	71	62	59	55	57	Traffic noise dominant (F3); 58– 63 Intermittent Traffic Noise (Mandalong Road) 56-62 Birds 58 - 71. Mandalong mine inaudible.
		Mandalong Colliery inaudible					
18/10/2012 9:45 pm W = Calm Temp = 14.8°C	Evening Ambient (35 dBA)	61	59	57	53	55	Traffic noise dominant (F3); 56– 61 Intermittent Traffic Noise (Mandalong Road) 56-57 Frogs/insects ~ 50-52. Birds 55 Mandalong mine audible horn 54
		Mandalong Colliery Audible LAeq (15 minute) <30dBA					
18/10/2012 10:08 pm W = Calm Temp = 14.3°C	Night-time Ambient (35 dBA)	70	61	59	53	57	Traffic noise dominant (F3); 56– 63 bird 70 Insects/crickets 44-51 (constant) Mandalong mine inaudible
		Mandalong Colliery inaudible					

Table 4 Operator Attended Noise Monitoring Results - Location M2

Date/Start Time Weather	Measurement Description (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	
18/10/2012 4:20 pm W = 4.7m/s E Temp = 20.6°C	Daytime Ambient (37 dBA)	92	82	73	54	70	Traffic noise dominant (F3); 55– 57 Intermittent Traffic Noise (Mandalong Road) 61-92 Mandalong mine audible - Impact noise 58 (1 event)
		Mandalong Colliery Audible LAeq (15 minute) <30dBA					
18/10/2012 9:25 pm W = Calm Temp = 14.8°C	Evening Ambient (37 dBA)	87	64	63	50	64	Traffic noise dominant (F3); 46– 48 Intermittent Traffic Noise (Mandalong Road) 65-87 Frog/insect ~ 44-46. Birds 67 Mandalong mine inaudible
		Mandalong Colliery inaudible					
18/10/2012 10:29 pm W = Calm Temp = 13.5°C	Night-time Ambient (37 dBA)	83	72	59	51	60	Traffic noise dominant (F3); 54– 61 Intermittent Traffic Noise (Mandalong Road) 57-83 Frog/insect ~ 51-51. Bird 60 Mandalong mine inaudible
		Mandalong Colliery inAudible					

Table 5 Operator Attended Noise Monitoring Results - Location M3

Date/Start Time Weather	Measurement Description (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	
18/10/2012 4:40 pm W = 3.6m/s E Temp = 19.7°C	Daytime Ambient (43 dBA)	69	65	61	56	59	Traffic noise dominant (F3); 58– 63 (constant) Intermittent Traffic Noise (Gimberts Road) 67-69 Birds ~ 66. Mandalong mine inaudible.
		Mandalong Colliery inaudible					
18/10/2010 9:05 pm W = Calm Temp = 16.3°C	Evening Ambient (43 dBA)	76	67	59	52	57	Traffic noise dominant (F3); 57– 60 (constant) Intermittent Traffic Noise (Gimberts Road) 67-76 Mandalong mine inaudible
		Mandalong Colliery inaudible					
18/10/2012 10:48 pm W = Calm Temp = 13.3°C	Night-time Ambient (43 dBA)	73	63	61	53	58	Traffic noise dominant (F3); 58– 60 (constant) Intermittent Traffic Noise (Gimberts Road) 73 Mandalong mine inaudible
		Mandalong Colliery inaudible					

Table 6 Operator Attended Noise Monitoring Results - Location M4

Date/Start Time Weather	Measurement Description (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	
18/10/2012 5:09 pm W = 4.1m/s E Temp = 17.8°C	Daytime Ambient (38 dBA)	75	56	50	39	49	Dominant EPS[1] industrial hum ~ 36, Birds 51 – 65 Gradwells Road 75 Train pass-by 55 Trees in wind 47-48 Cooranbong site audible 36.
		Mandalong Colliery Audible LAeq (15 minute) 36 dBA					
18/10/2012 8:40 pm W = 0.5 m/s E Temp = 18°C	Evening Ambient (38 dBA)	58	58	56	51	54	Dominant EPS[1] industrial hum ~ 37, Insect/frogs up 53 to 56 (dominate) Dog barking 57 Cooranbong site audible 37.
		Mandalong Colliery Audible LAeq (15 minute) 37 dBA					
18/10/2012 11:17 pm W = Calm Temp = 13.3°C	Night-time Ambient (38 dBA)	75	59	58	54	56	Dominant EPS[1] industrial hum ~ 39, Insect/frogs up 50 to 55 (dominate) Train 57 - 60 Cooranbong site audible 40
		Mandalong Colliery Audible LAeq (15 minute) 40 dBA					

4.2 Operator Attended Monitoring Summary

Daytime and night-time attended noise surveys at locations M1, M2 and M3 were conducted during Mandalong shift changes when maximum surface activity occurs and therefore providing a worst case operational scenario.

During the M4 attended noise surveys conducted on 18 October 2012, the coal handling plant (CHP) and drift conveyor (loaded with coal) were operating at the Cooranbong Colliery, as well as loading from the stockpiles and road haulage. This also provides a worst case operational scenario for the Cooranbong Colliery.

It is noted that during the evening period no shift changes occur at the Mandalong mine. However, the measurements were considered to be representative of a worst case operational scenario during this time period.

M1 – Operator Attended Monitoring Location

Continuous road traffic noise from the F3 dominated the ambient noise levels during all three attended noise surveys making it difficult to distinguish any Mandalong mine noise sources. L_{A90} noise levels were generally above 53 dBA throughout the day time, evening and night-time attended surveys. However, during the evening time period, a single event horn noise was audible from the mine. The estimated mine noise contributions during the evening was an $L_{Aeq(15mintue)}$ of <30dBA, complying with the consent criteria of 35 dBA $L_{Aeq(15mintue)}$.

The day time and night-time attended noise survey observed several lulls in traffic noise providing L_{A90} noise levels in the order of 50 dBA. During these periods Mandalong mine remained inaudible suggesting that any contribution would be at least 10 dBA below the overall L_{A90} noise level (<40dBA) and likely to be below the consent level (35 dBA $L_{Aeq(15mintue)}$ day and night-time) at this location.

M2 – Operator Attended Monitoring Location

Continuous road traffic noise from the F3 dominated the ambient noise levels during the daytime attended noise surveys making it difficult to distinguish any Mandalong mine noise sources. L_{A90} noise levels were generally above 50 dBA throughout the day time, evening and night-time attended surveys. The daytime attended noise survey observed a single event impact noise from the mine. The estimated mine noise contributions during the day was an $L_{Aeq(15mintue)}$ of <30dBA. This contribution complies with the consent limit of 37 dBA $L_{Aeq(15mintue)}$.

The evening and night-time attended noise survey observed several lulls in traffic noise providing L_{A90} noise levels in the order of 48 dBA. During these periods Mandalong mine remained inaudible suggesting that any contribution would be at least 10 dBA below the overall L_{A90} noise level (<38 dBA) and likely to be below the consent level (37 dBA $L_{Aeq(15mintue)}$ evening and night-time) at this location.

M3 – Operator Attended Monitoring Location

Continuous road traffic noise from the F3 dominated the ambient noise levels during all three (3) attended noise surveys making it difficult to distinguish any Mandalong mine noise sources. L_{A90} noise levels were generally above 52 dBA throughout the day time, evening and night-time attended surveys. The night-time attended noise survey observed several lulls in traffic noise providing L_{A90} noise levels in the order of 46 dBA. During these periods Mandalong mine remained inaudible suggesting that any contribution would be at least 10 dBA below the overall L_{A90} noise level (36 dBA) and likely to be below the consent level (43 dBA $L_{Aeq(15mintue)}$ day, evening and night-time) at this location.

M4 – Operator Attended Monitoring Location

The mine contribution during the day time, evening and night-time attended surveys was estimated to be $L_{Aeq(15mintue)}$ 36 dBA, $L_{Aeq(15mintue)}$ 37 dBA and $L_{Aeq(15mintue)}$ 40 dBA respectively. Given the constant nature of the noise sources at the Cooranbong site, this contribution complies with the consent limit of 38 dBA $L_{Aeq(15mintue)}$ during the day and evening periods. However, a 2 dBA exceeded noise level was measured during the night-time period. We note that the consent criteria are based on the assumption that the coal handling plant 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.

5 UNATTENDED CONTINUOUS NOISE MONITORING

5.1 Results of Unattended Continuous Monitoring

A summary of the results of the unattended continuous noise monitoring is given in **Table 7**. A graphically daily basis of the unattended ambient noise logger data at M1 to M4 are attached as **Appendices C1** to **C4**. The ambient noise level data quantifies the overall noise level at a given location independent of its source or character.

The measured ambient noise levels were divided into three (3) periods representing day, evening and night as designated in the consent conditions.

Precautions were taken to minimise influences from extraneous noise sources (eg optimum placement of the loggers away from creeks, trees, houses, etc), however not all these sources or their effects can be eliminated. This is particularly the case during the warmer times of year when noise from insects, frogs, birds and other animals can become quite prevalent.

Weather data for the survey period was obtained from the nearest Bureau of Meteorology weather station located at Cooranbong, approximately 3 km north of the monitoring locations. Unattended noise data corresponding with periods of rainfall and/or wind speeds in excess of 5 m/s (approximately 18km/hr) were discarded in accordance with Industrial Noise Policy (INP) data exclusion methodology.

Table 7 Unattended Continuous Noise Monitoring Results (dBA Ref 20 µPa)

Location	Period	L_{A1}	L_{A10}	L_{A90}	L_{Aeq}
M1	Daytime	59	54	40	54
	Evening	58	53	40	51
	Night-time	55	49	35	50
M2	Daytime	60	55	41	56
	Evening	59	55	41	52
	Night-time	56	51	36	51
M3	Daytime	64	62	56	61
	Evening	63	61	53	59
	Night-time	63	60	46	58
M4	Daytime	63	50	37	57
	Evening	56	50	37	52
	Night-time	55	50	37	53

Note: Daytime is 7 am to 6 pm. Evening is 6pm to 10pm. Night-time is 10pm to 7 am.

5.2 Past unattended noise monitoring results

5.2.1 M1 – Monitoring Location

SLR Consulting has conducted annual noise compliance monitoring for Mandalong Mine at, or near, the 238 Mandalong Road residence (property reference 82) since 2008. **Table 8** presents a summary of those noise compliance monitoring results for the four (4) years 2008 to 2011.

Table 8 Unattended Continuous Noise Monitoring Results (dBA ref 20µPa)

Location / Dates of monitoring	Period	RBL* (dBA)	LAeq** (dBA)
220 Mandalong Road (238 Mandalong Road neighbouring property) 06/11/2008 – 14/11/2008	Day	41	62
	Night	37	56
238 Mandalong Road Residence 22/10/2009 – 30/10/2009	Day	46	53
	Evening	51	52
	Night	43	50
238 Mandalong Road Residence 11/08/2010 – 19/08/2010	Day	44	53
	Evening	49	53
	Night	44	53
220 Mandalong Road (238 Mandalong Road neighbouring property) 28/07/2011 – 07/08/2011	Day	49	56
	Evening	52	56
	Night	47	57
238 Mandalong Road Residence (Front yard next to palm tree) 18/07/2012 – 30/07/2012	Day	40	55
	Evening	41	52
	Night	37	50
238 Mandalong Road Residence 18/10/2012 – 24/10/2012	Day	40	54
	Evening	40	51
	Night	35	50

*RBL: Rating Background Level, as defined in the NSW Industrial Noise Policy (EPA, 2009)
**LAeq: The equivalent continuous noise level – the level of noise equivalent to the energy average of noise levels occurring over the measurement period.
Daytime 7.00 am to 6.00 pm; Evening 6.00 pm to 10.00 pm; Night-time 10.00 pm to 7.00 am
On Sundays and Public Holidays, Daytime 8.00 am to 6.00 pm; Evening 6.00 pm to 10.00 pm; Night-time 10.00 pm to 8.00 am
It is noted that monitoring in 2008 was conducted in accordance with the relevant Consent at the time which defined Daytime 7.00 am to 10.00 pm and Night-time 10.00 pm to 7.00 am.

5.2.2 M2 – Monitoring Location

SLR Consulting has only recently had access this year to install an unattended noise monitor to conduct annual noise compliance monitoring for Mandalong Mine at, or near, the 199 Mandalong Road residence (property reference 97). However, operator-attended noise monitoring was conducted at the property in 2011. **Table 8** presents a summary of those noise compliance monitoring results for 2011 and 2012.

Table 9 Operator-Attended and Unattended Continuous Noise Monitoring Results (dBA ref 20μPa)

Location / Dates of monitoring	Period	RBL (dBA)	LAeq (dBA)
199 Mandalong Road Residence (Operator-Attended noise monitoring) 09/08/2011	Day	48	53
	Evening	47	50
	Night	38	46
199 Mandalong Road Residence (Unattended Noise Monitoring) 18/10/2012 – 24/10/2012	Day	41	56
	Evening	41	52
	Night	36	51

5.2.3 M3 – Monitoring Location

SLR Consulting has conducted annual noise compliance monitoring for Mandalong Mine at, or near, the 184 Gimberts Road residence (property reference 85) since 2008. **Table 8** presents a summary of those noise compliance monitoring results for the four (4) years 2008 to 2011.

Table 10 Unattended Continuous Noise Monitoring Results (dBA ref 20μPa)

Location / Dates of monitoring	Period	RBL* (dBA)	LAeq** (dBA)
184 Gimberts Road property 06/11/2008 – 14/11/2008	Day	50	57
	Night	44	58
184 Gimberts Road property 22/10/2009 – 30/10/2009	Day	56	60
	Evening	54	57
	Night	48	56
184 Gimberts Road property 11/08/2010 – 19/08/2010	Day	56	61
	Evening	54	60
	Night	46	59
184 Gimberts Road property 28/07/2011 – 07/08/2011	Day	57	62
	Evening	55	60
	Night	49	60
184 Gimberts Road property 18/10/2012 – 24/10/2012	Day	56	61
	Evening	53	59
	Night	46	58

*RBL: Rating Background Level, as defined in the NSW Industrial Noise Policy (EPA, 2009)
**LAeq: The equivalent continuous noise level – the level of noise equivalent to the energy average of noise levels occurring over the measurement period.
Daytime 7.00 am to 6.00 pm; Evening 6.00 pm to 10.00 pm; Night-time 10.00 pm to 7.00 am
On Sundays and Public Holidays, Daytime 8.00 am to 6.00 pm; Evening 6.00 pm to 10.00 pm; Night-time 10.00 pm to 8.00 am
It is noted that monitoring in 2008 was conducted in accordance with the relevant Consent at the time which defined Daytime 7.00 am to 10.00 pm and Night-time 10.00 pm to 7.00 am.

5.2.4 M4 – Monitoring Location

SLR Consulting has conducted annual noise compliance monitoring for Mandalong Mine at, or near, the Mandalong Mine - Cooranbong Entry Site since 2008. **Table 8** presents a summary of those noise compliance monitoring results for the four (4) years 2008 to 2011.

Table 11 Unattended Continuous Noise Monitoring Results (dBA ref 20µPa)

Location / Dates of monitoring	Period	RBL* (dBA)	LAeq** (dBA)
Cooranbong 06/11/2008 – 14/11/2008	Day	38	57
	Night	39	58
Cooranbong 22/10/2009 – 30/10/2009	Day	38	60
	Evening	41	55
	Night	42	55
Cooranbong 11/08/2010 – 19/08/2010	Day	37	56
	Evening	41	49
	Night	40	50
Cooranbong 18/10/2012 – 24/10/2012	Day	37	57
	Evening	37	52
	Night	37	53

*RBL: Rating Background Level, as defined in the NSW Industrial Noise Policy (EPA, 2009)
**LAeq: The equivalent continuous noise level – the level of noise equivalent to the energy average of noise levels occurring over the measurement period.
Daytime 7.00 am to 6.00 pm; Evening 6.00 pm to 10.00 pm; Night-time 10.00 pm to 7.00 am
On Sundays and Public Holidays, Daytime 8.00 am to 6.00 pm; Evening 6.00 pm to 10.00 pm; Night-time 10.00 pm to 8.00 am
It is noted that monitoring in 2008 was conducted in accordance with the relevant Consent at the time which defined Daytime 7.00 am to 10.00 pm and Night-time 10.00 pm to 7.00 am.

6 SUMMARY OF RESULTS AND FINDINGS

SLR Consulting were engaged by Centennial Coal Company Limited to conduct a noise compliance assessment for the Mandalong Mine and Cooranbong Colliery in accordance the Mandalong Mine Noise Monitoring Program August 2009.

Operator-attended noise measurements were conducted at the four (4) focus locations surrounding the mine site during the day, evening and night-time period on Thursday 18 October 2012. 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 contributions were found to be within the relevant consent conditions at monitoring locations M1 to M4 with the exception of a 2dBA exceedance during the night-time at location M4.

However, it is noted that the consent criteria for location M4 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

7 CLOSURE

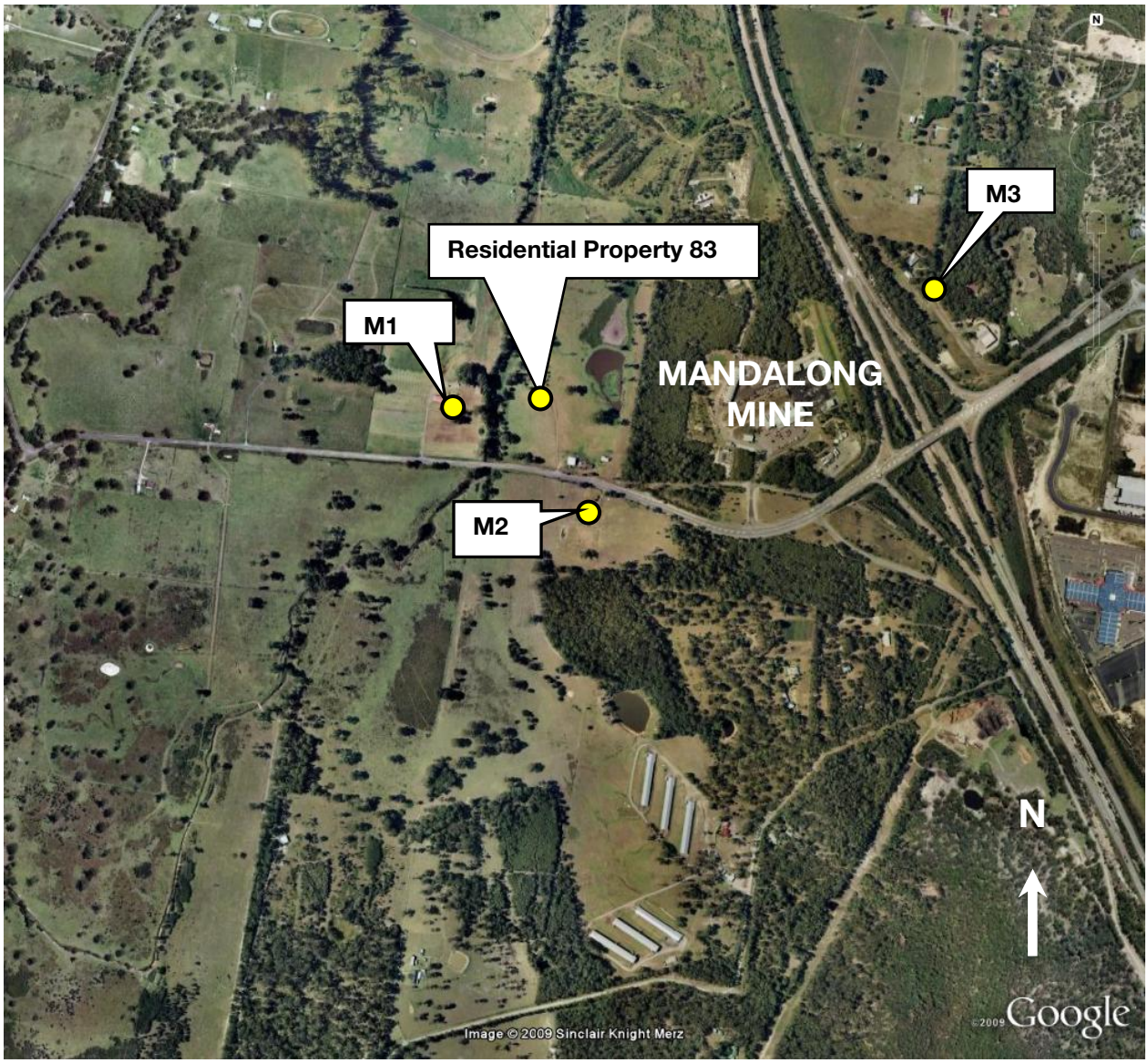
This report has been prepared by SLR Consulting Australia Pty Ltd with all reasonable skill, care and diligence, and taking account of the manpower and resources devoted to it by agreement with the client. Information reported herein is based on the interpretation of data collected and has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of Centennial Coal Company Limited. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR Consulting.

SLR Consulting disclaims any responsibility to the client and others in respect of any matters outside the agreed scope of the work.

Site Location Map

Mandalong Mine Site Map



Site Location Map

Cooranbong Colliery Site Map



Acoustic Terminology

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.

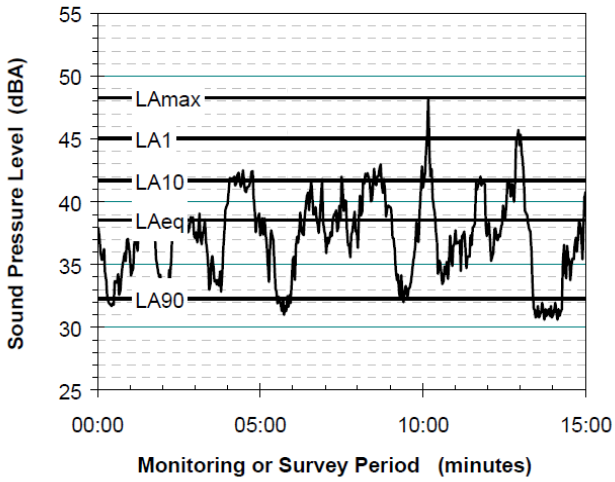
3 Sound Power Level

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 th source under consideration), or simply the background le el.

L_{Aeq} The A-weighted equivalent noise level (bas cally 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

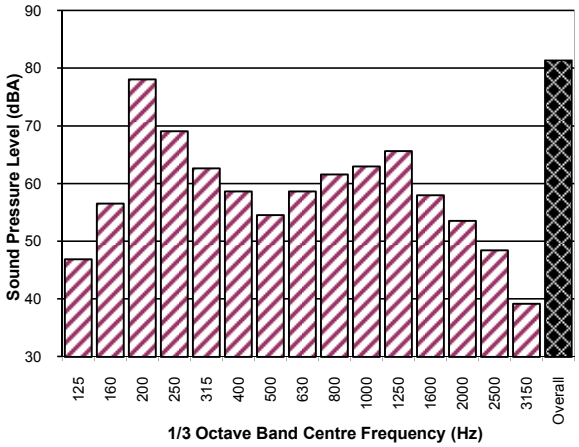
Frequency analysis is the process used to examine the tones (or frequency components) which make up the overall noise or vibration signal. This analysis was traditionally carried out using analogue electronic filters, but is now normally carried out using Fast Fourier Transform (FFT) analysers.

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

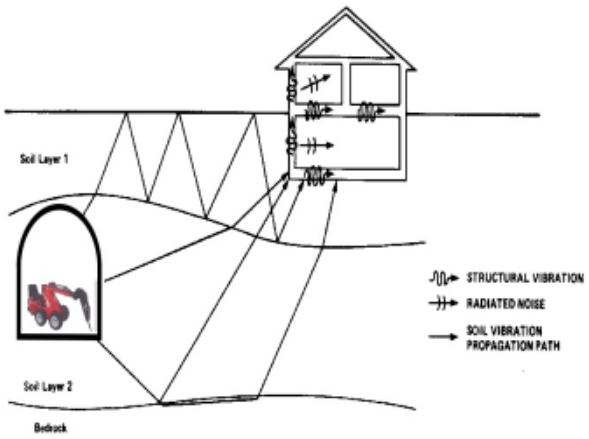
The term "over-pressure" is used to describe the air pressure pulse emitted during blasting or similar events. The peak level of an event is normally measured using a microphone in the same manner as linear noise (ie unweighted), at frequencies both in and below the audible range.

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.

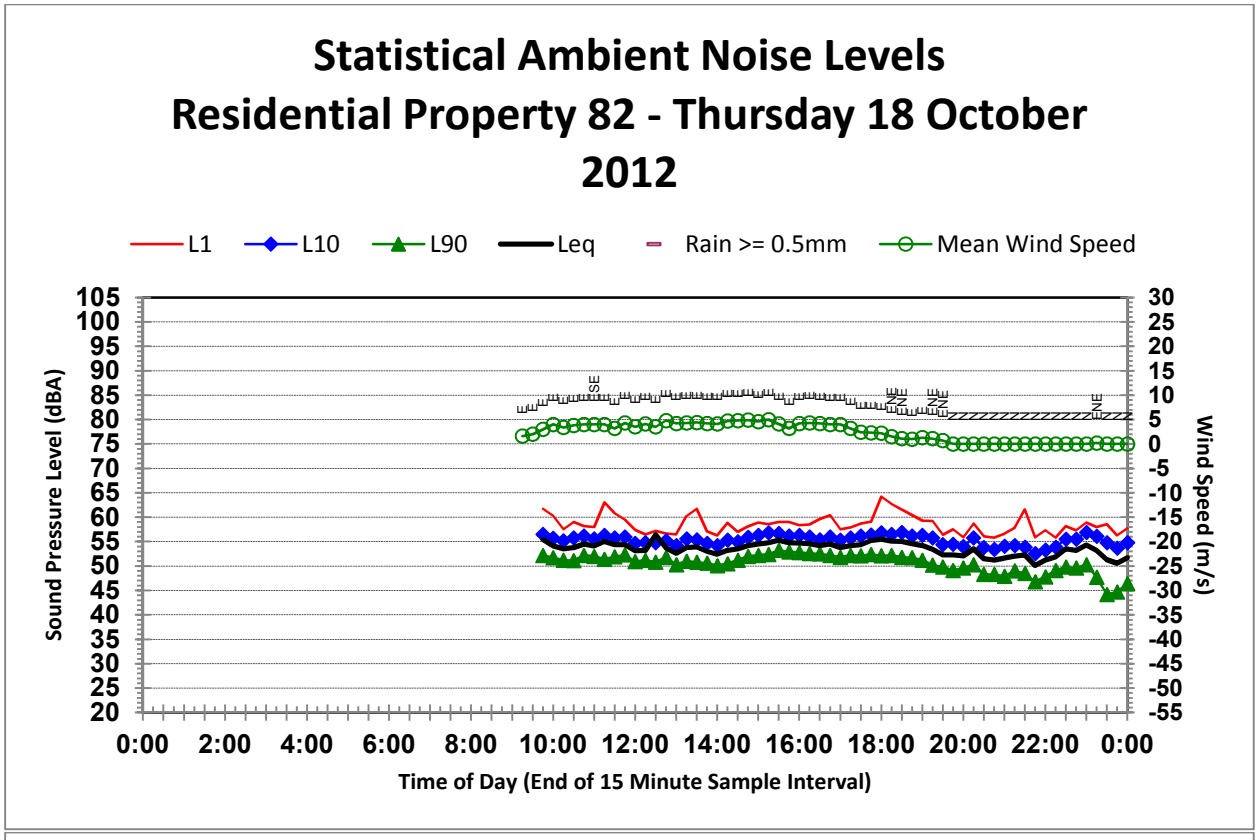
Typical sources of regenerated noise include tunnelling works, underground railways, excavation plant (eg rockbreakers), and building services plant (eg fans, compressors and generators).

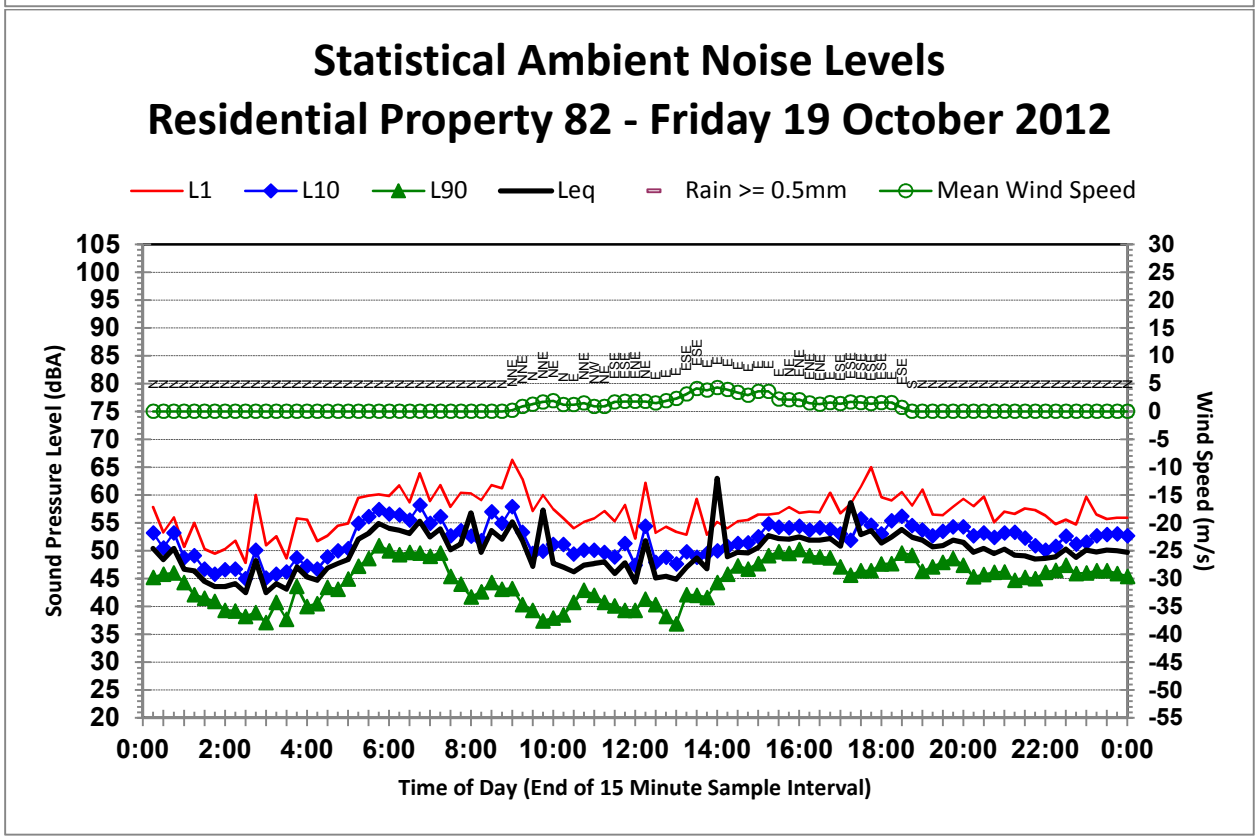
The following figure presents the various paths by which vibration and regenerated noise may be transmitted between a source and receiver for construction activities occurring within a tunnel.

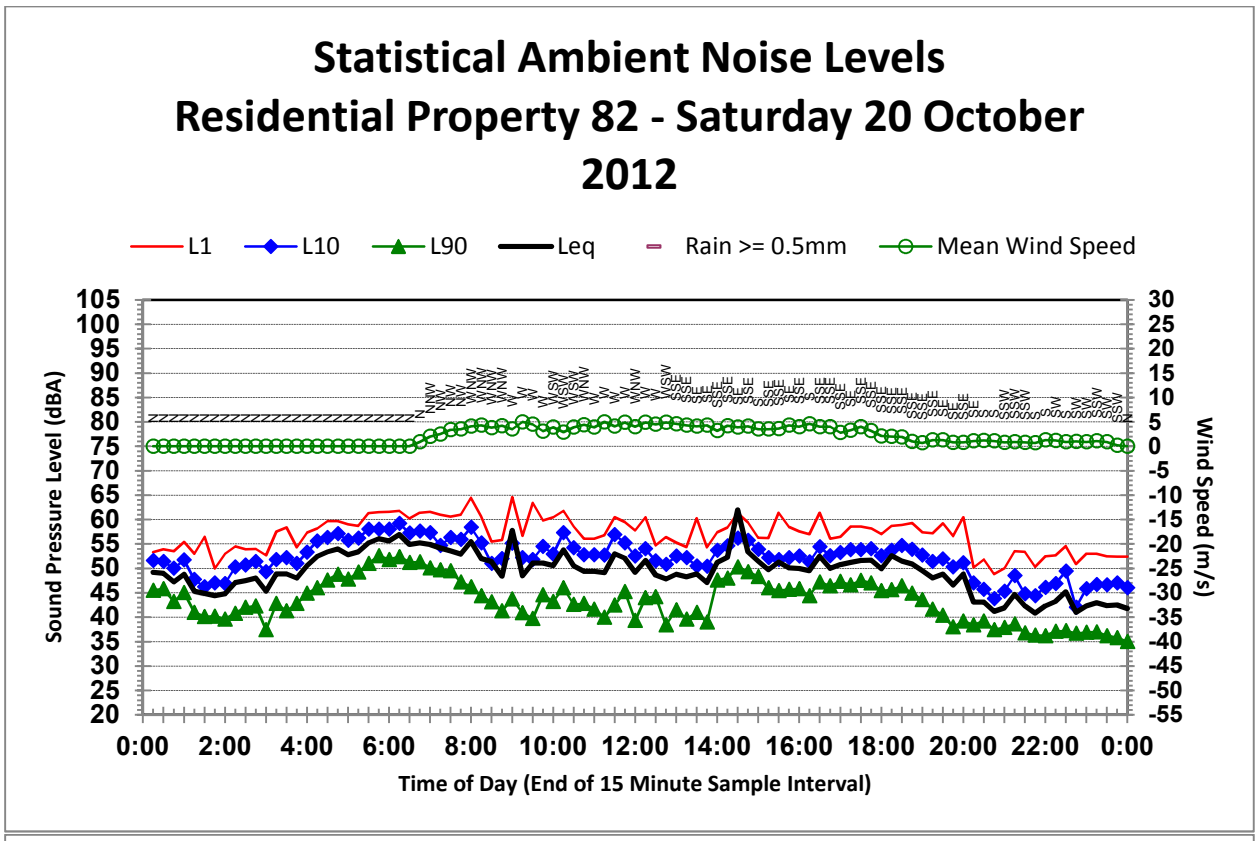


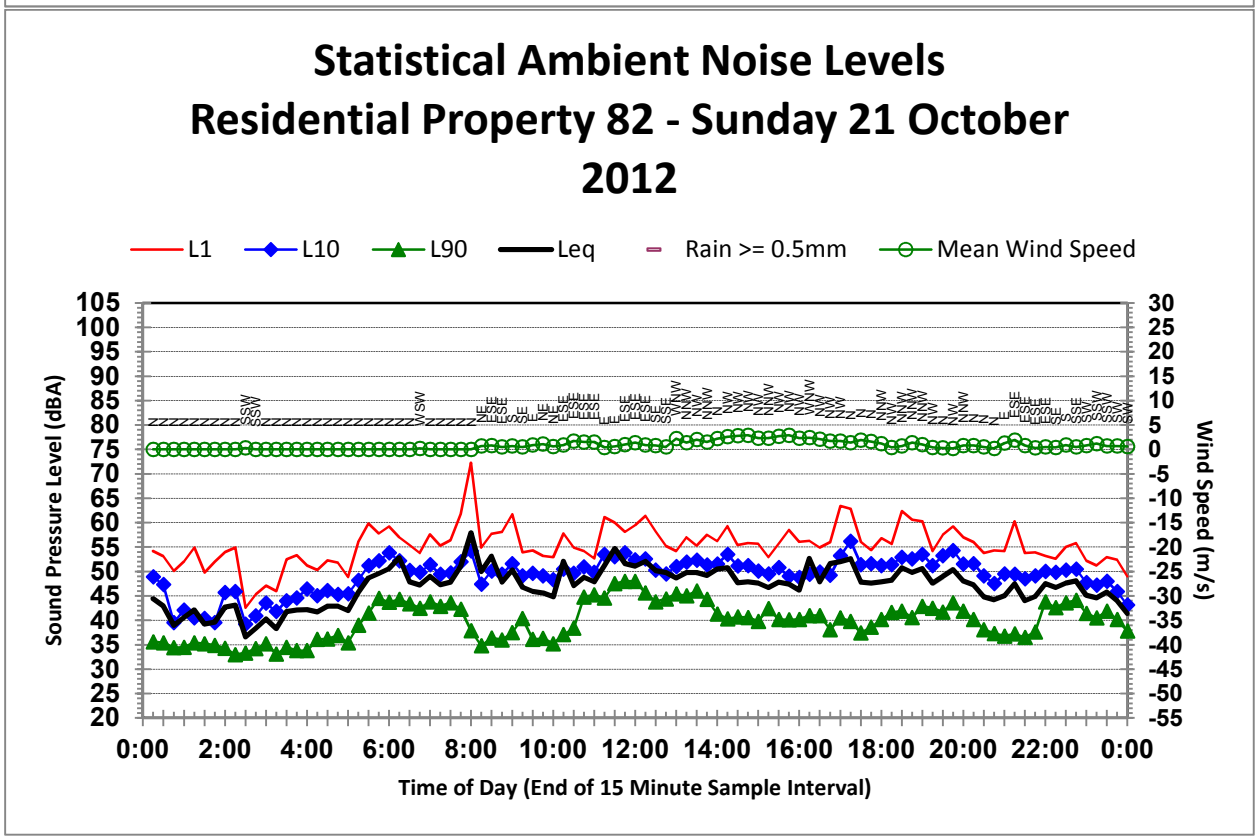
The term "regenerated noise" is also used to describe other types of noise that are emitted from the primary source as a different form of energy. One example would be a fan with a silencer, where the fan is the energy source and primary noise source. The silencer may effectively reduce the fan noise, 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.

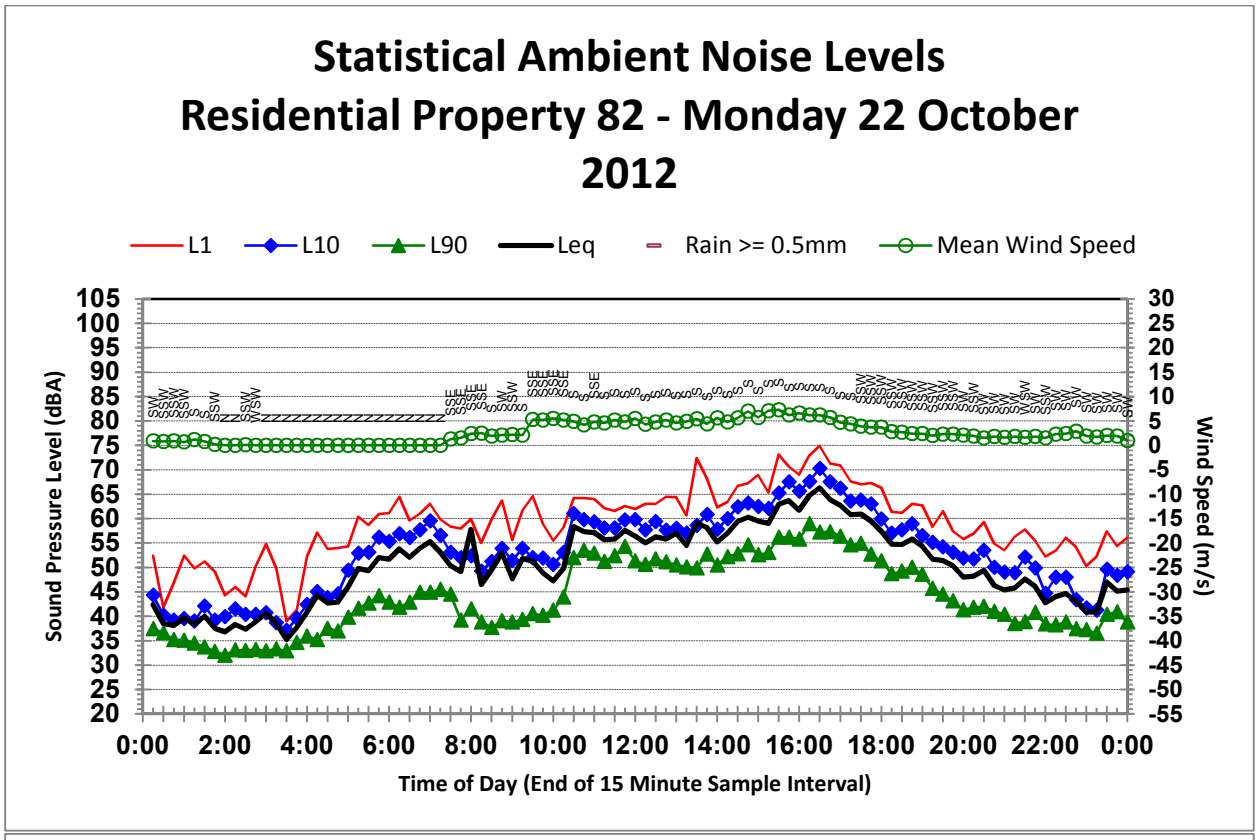
Statistical Ambient Noise Levels - Residential Property 82

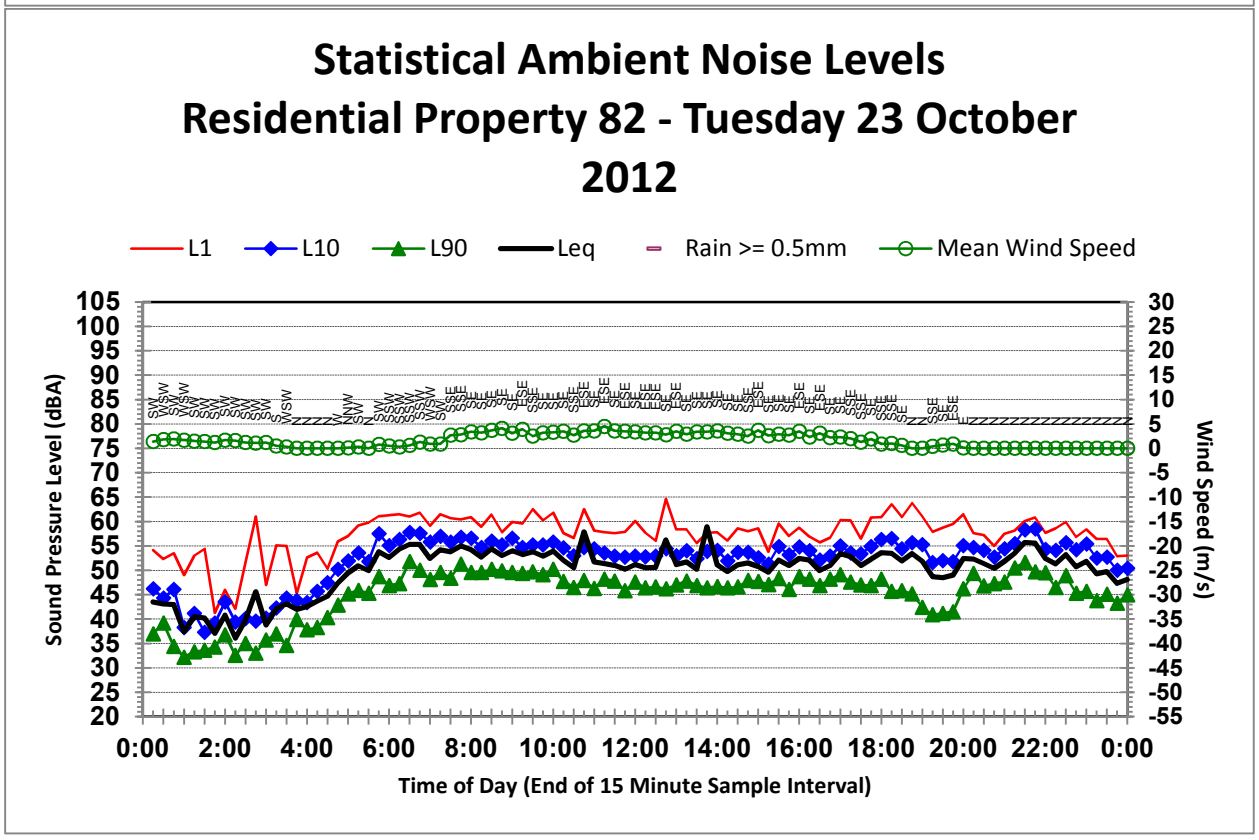




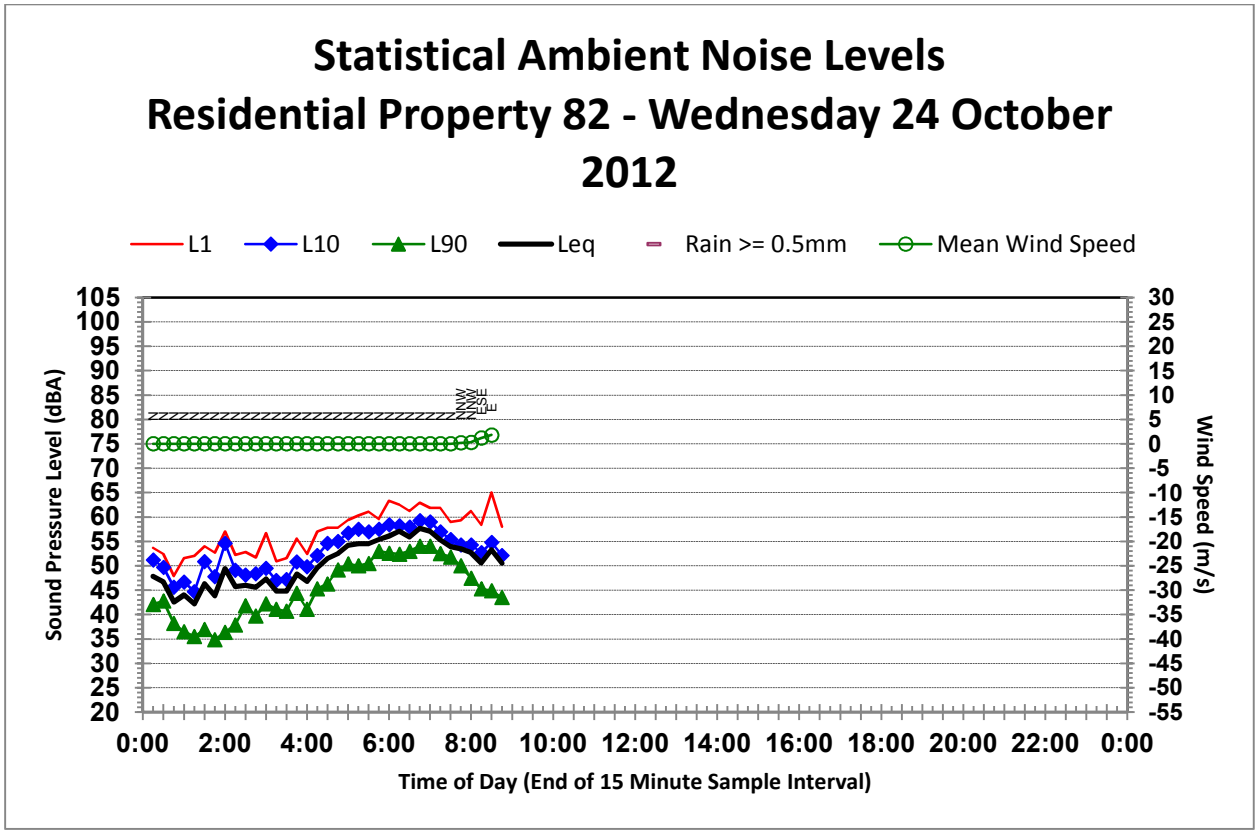

Statistical Ambient Noise Levels
Residential Property 82 - Saturday 20 October 2012
L1
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed
Sound Pressure Level (dBA)
Wind Speed (m/s)
105
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
30
25
20
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00
Time of Day (End of 15 Minute Sample Interval)

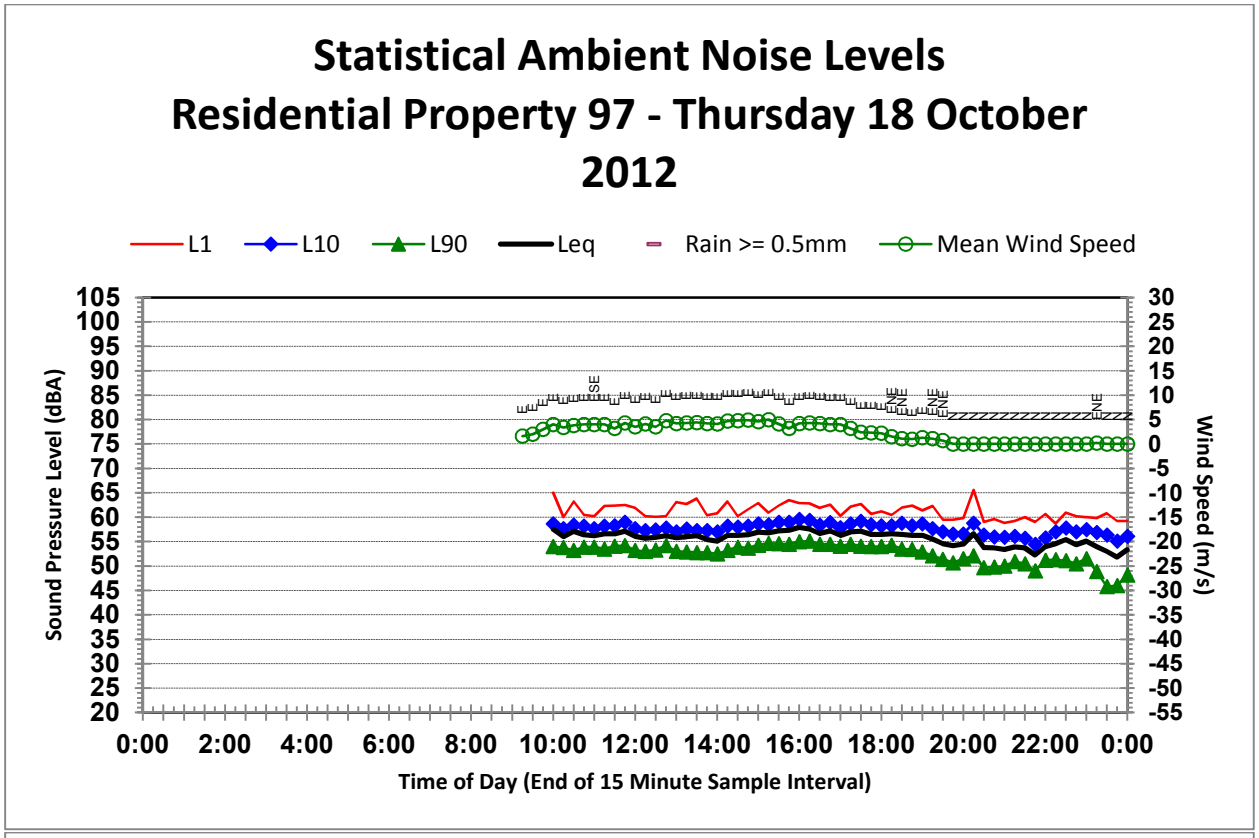

Statistical Ambient Noise Levels
Residential Property 82 - Sunday 21 October 2012
L1
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed
Sound Pressure Level (dBA)
Wind Speed (m/s)
105
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
30
25
20
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00
Time of Day (End of 15 Minute Sample Interval)

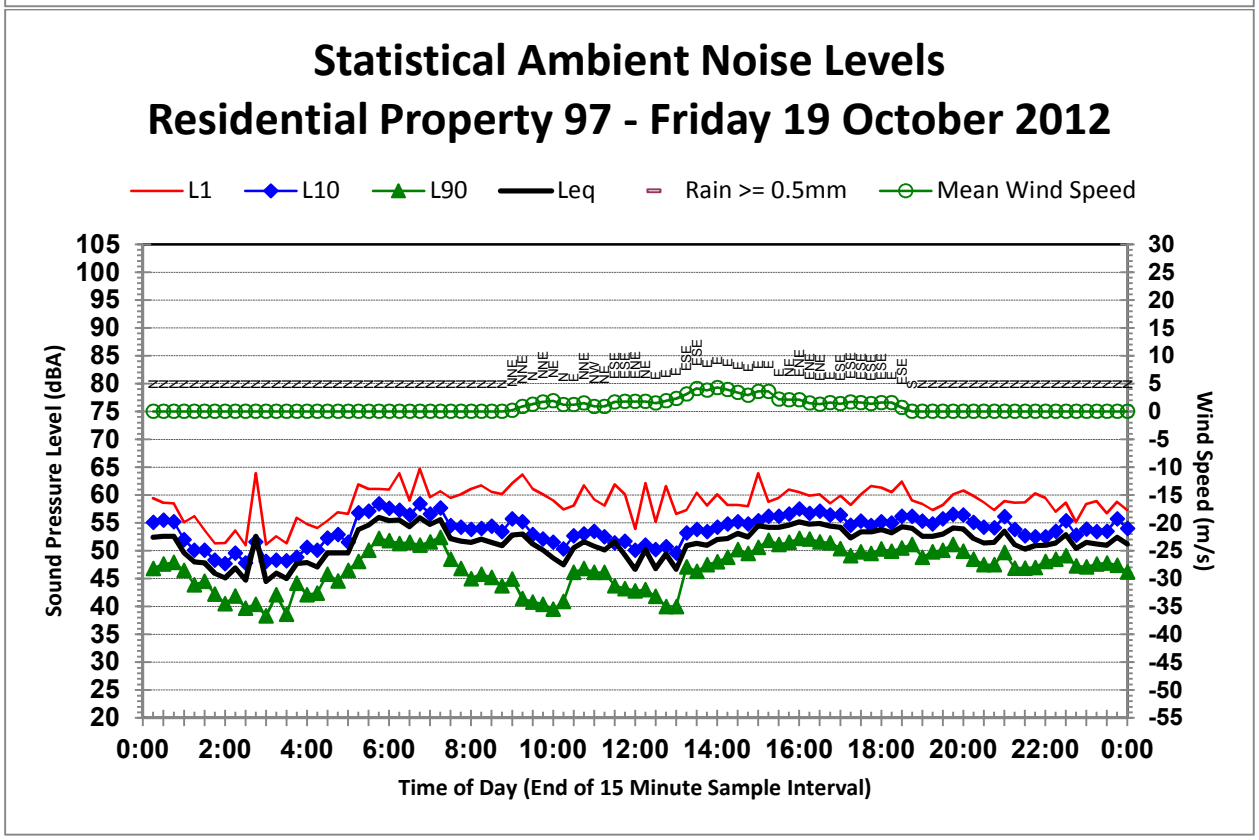

Statistical Ambient Noise Levels
Residential Property 82 - Monday 22 October 2012
L1
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed
Sound Pressure Level (dBA)
Wind Speed (m/s)
105 100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20
30 25 20 15 10 5 0 -5 -10 -15 -20 -25 -30 -35 -40 -45 -50 -55
0:00 2:00 4:00 6:00 8:00 10:00 12:00 14:00 16:00 18:00 20:00 22:00 0:00
Time of Day (End of 15 Minute Sample Interval)

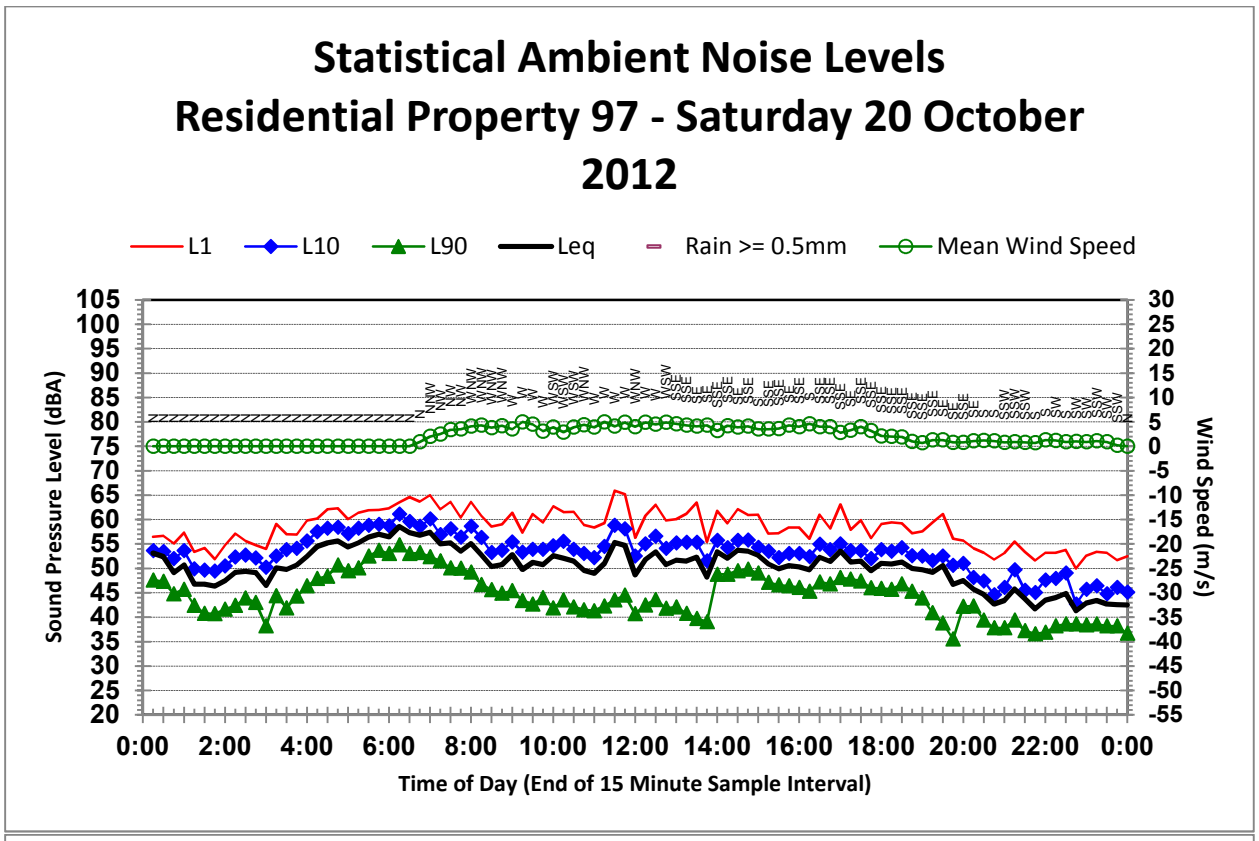

Statistical Ambient Noise Levels
Residential Property 82 - Tuesday 23 October 2012
L1
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed
Sound Pressure Level (dBA)
Wind Speed (m/s)
105 100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20
30 25 20 15 10 5 0 -5 -10 -15 -20 -25 -30 -35 -40 -45 -50 -55
0:00 2:00 4:00 6:00 8:00 10:00 12:00 14:00 16:00 18:00 20:00 22:00 0:00
Time of Day (End of 15 Minute Sample Interval)

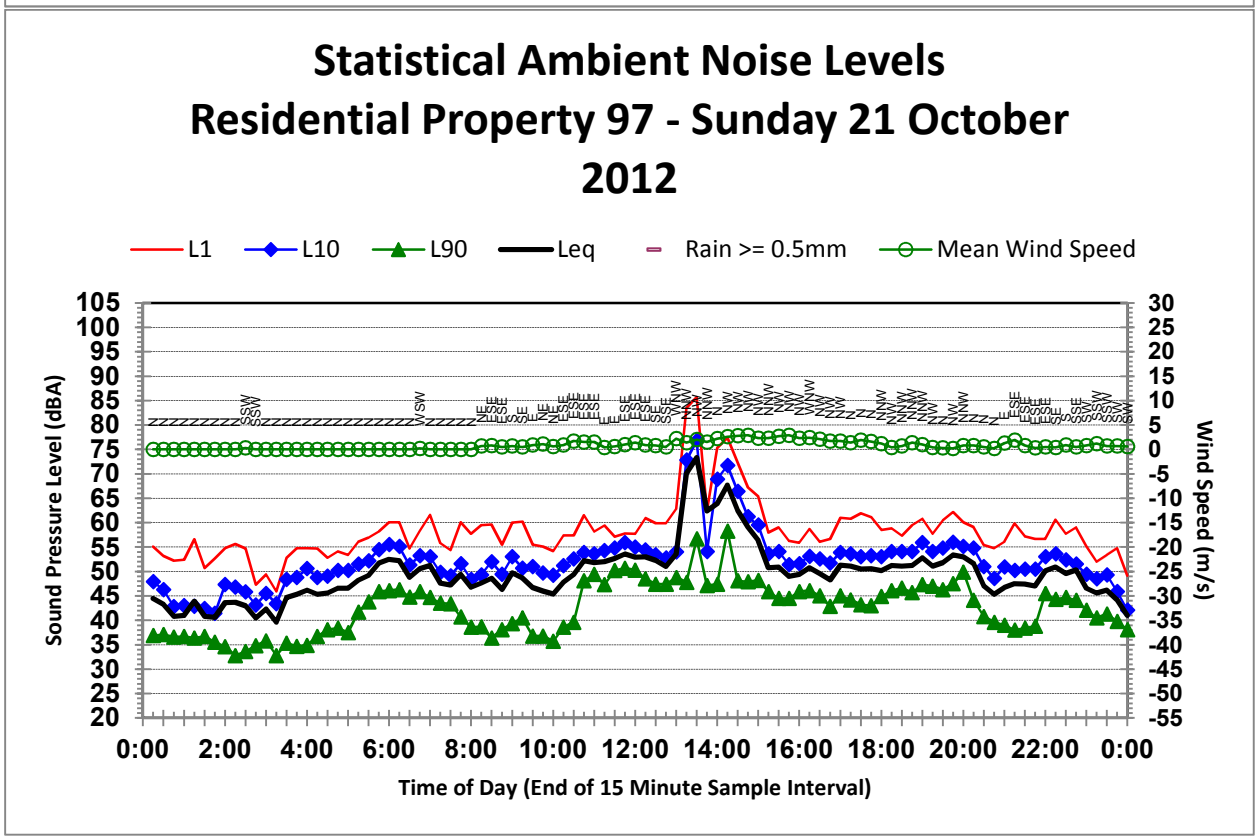
Statistical Ambient Noise Levels - Residential Property 82

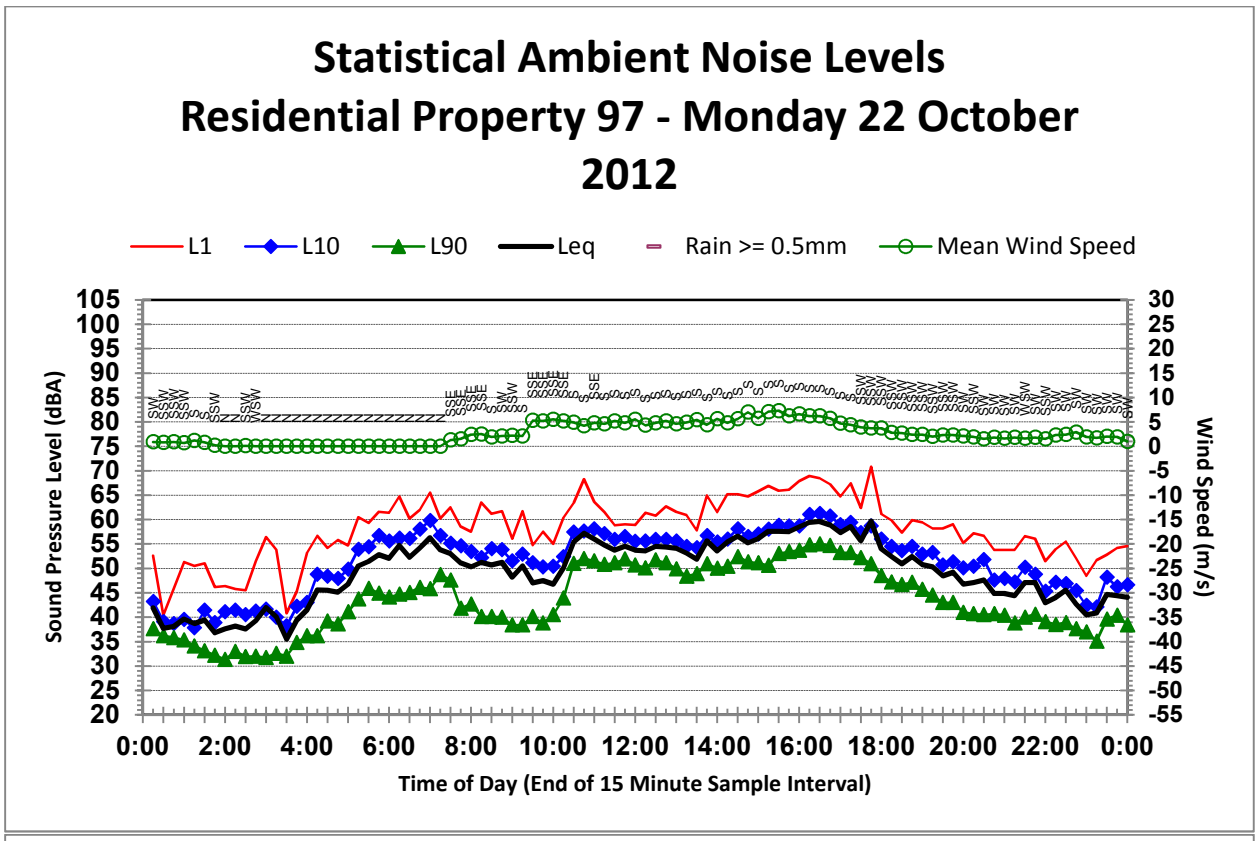


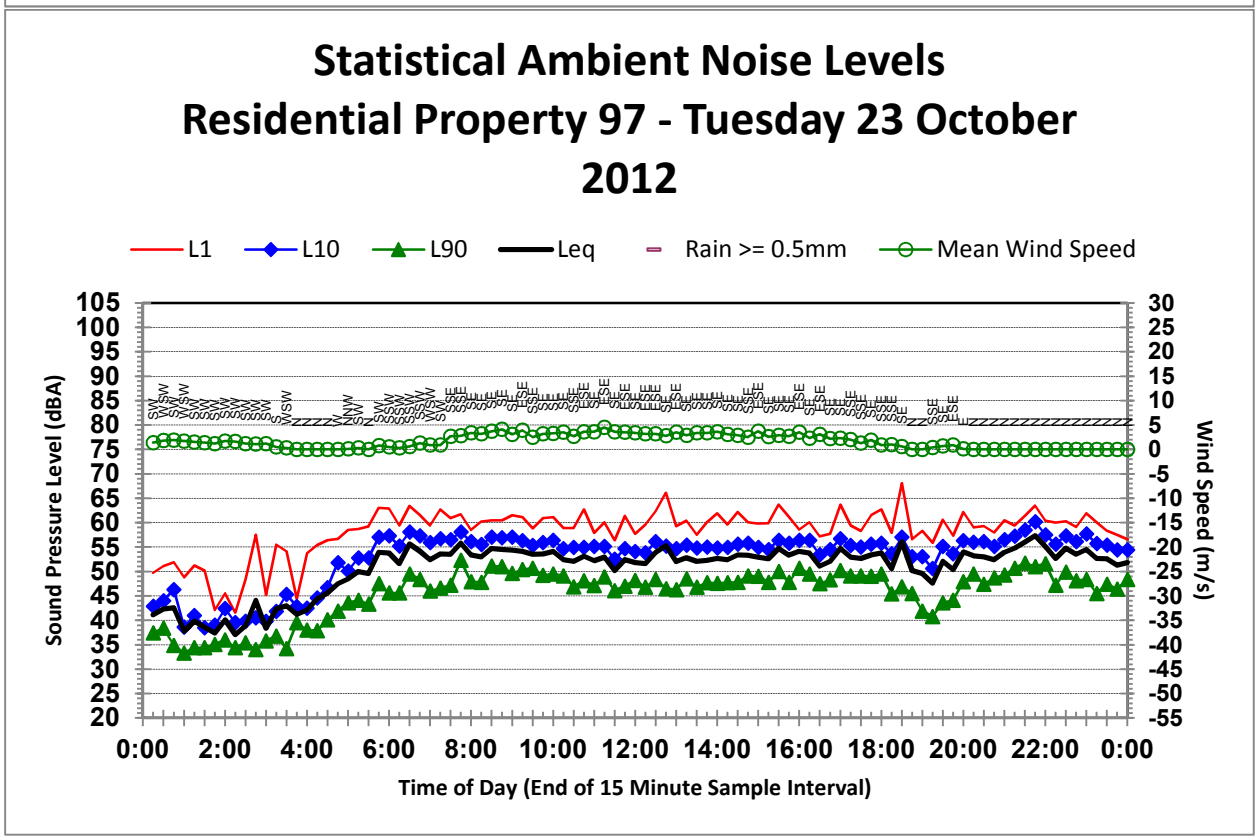

Statistical Ambient Noise Levels
Residential Property 97 - Thursday 18 October 2012
L1
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed
Sound Pressure Level (dBA)
Wind Speed (m/s)
105 100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20
30 25 20 15 10 5 0 -5 -10 -15 -20 -25 -30 -35 -40 -45 -50 -55
0:00 2:00 4:00 6:00 8:00 10:00 12:00 14:00 16:00 18:00 20:00 22:00 0:00
Time of Day (End of 15 Minute Sample Interval)


Statistical Ambient Noise Levels
Residential Property 97 - Friday 19 October 2012
L1
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed
Sound Pressure Level (dBA)
Wind Speed (m/s)
105 100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20
30 25 20 15 10 5 0 -5 -10 -15 -20 -25 -30 -35 -40 -45 -50 -55
0:00 2:00 4:00 6:00 8:00 10:00 12:00 14:00 16:00 18:00 20:00 22:00 0:00
Time of Day (End of 15 Minute Sample Interval)

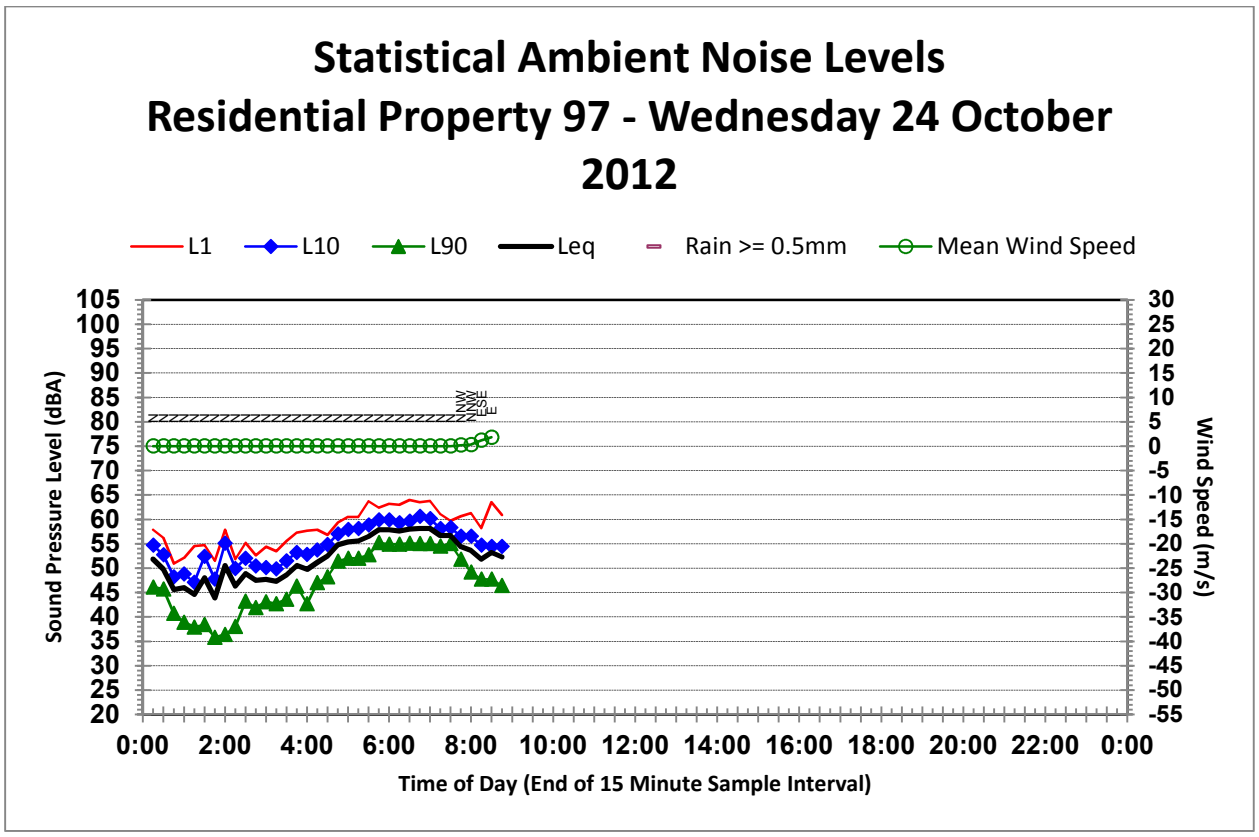

Statistical Ambient Noise Levels
Residential Property 97 - Saturday 20 October 2012
L1
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed
Sound Pressure Level (dBA)
Wind Speed (m/s)
105 100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20
30 25 20 15 10 5 0 -5 -10 -15 -20 -25 -30 -35 -40 -45 -50 -55
0:00 2:00 4:00 6:00 8:00 10:00 12:00 14:00 16:00 18:00 20:00 22:00 0:00
Time of Day (End of 15 Minute Sample Interval)

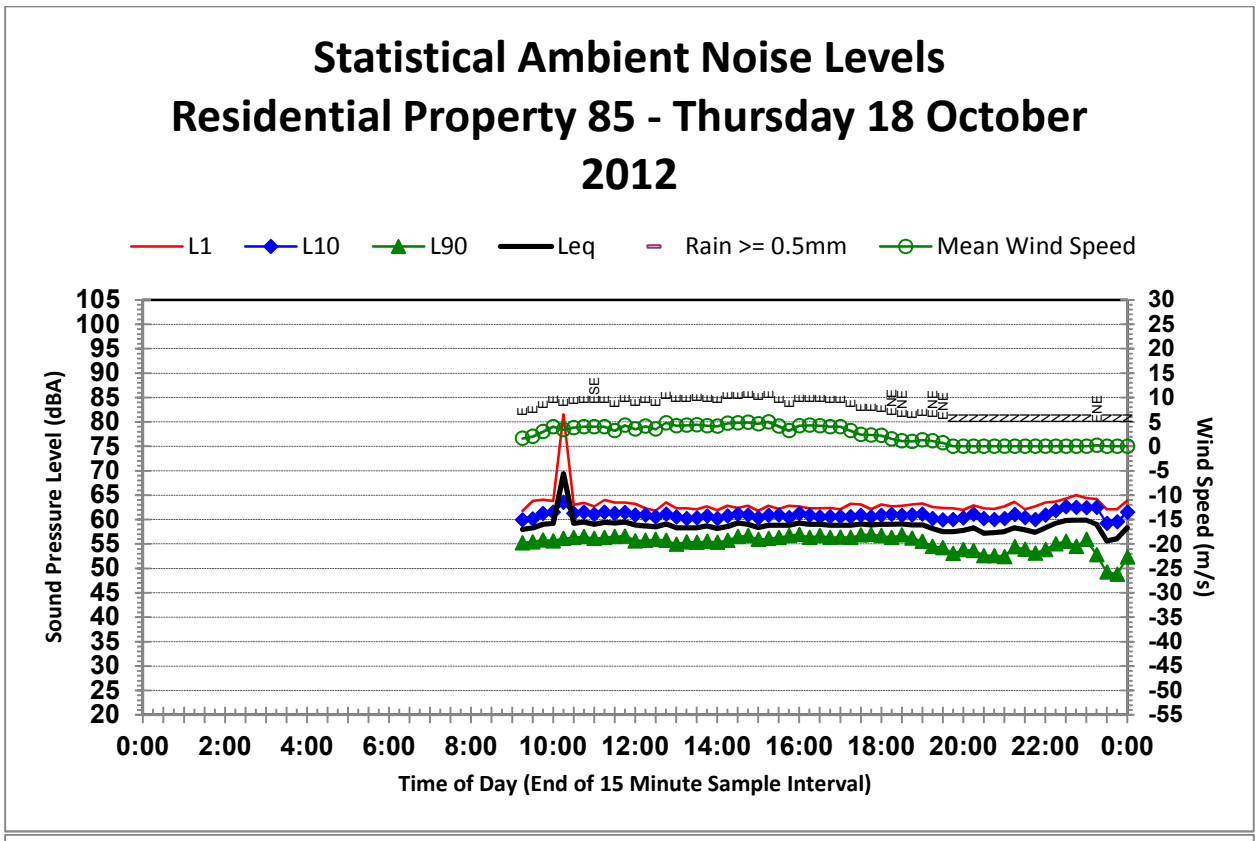

Statistical Ambient Noise Levels
Residential Property 97 - Sunday 21 October 2012
L1
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed
Sound Pressure Level (dBA)
Wind Speed (m/s)
105 100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20
30 25 20 15 10 5 0 -5 -10 -15 -20 -25 -30 -35 -40 -45 -50 -55
0:00 2:00 4:00 6:00 8:00 10:00 12:00 14:00 16:00 18:00 20:00 22:00 0:00
Time of Day (End of 15 Minute Sample Interval)

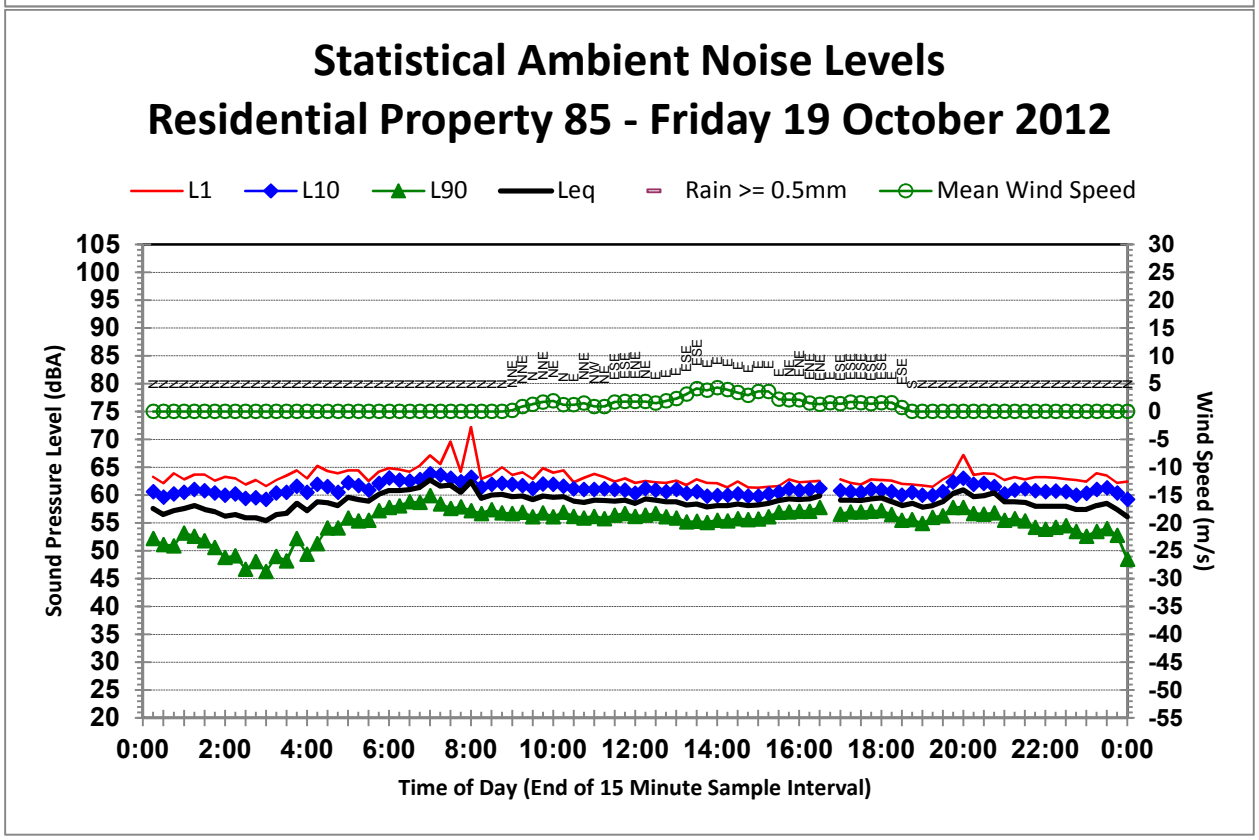

Statistical Ambient Noise Levels
Residential Property 97 - Monday 22 October 2012
L1
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed
Sound Pressure Level (dBA)
Wind Speed (m/s)
105
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
30
25
20
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00
Time of Day (End of 15 Minute Sample Interval)


Statistical Ambient Noise Levels
Residential Property 97 - Tuesday 23 October 2012
L1
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed
Sound Pressure Level (dBA)
Wind Speed (m/s)
105
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
30
25
20
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00
Time of Day (End of 15 Minute Sample Interval)

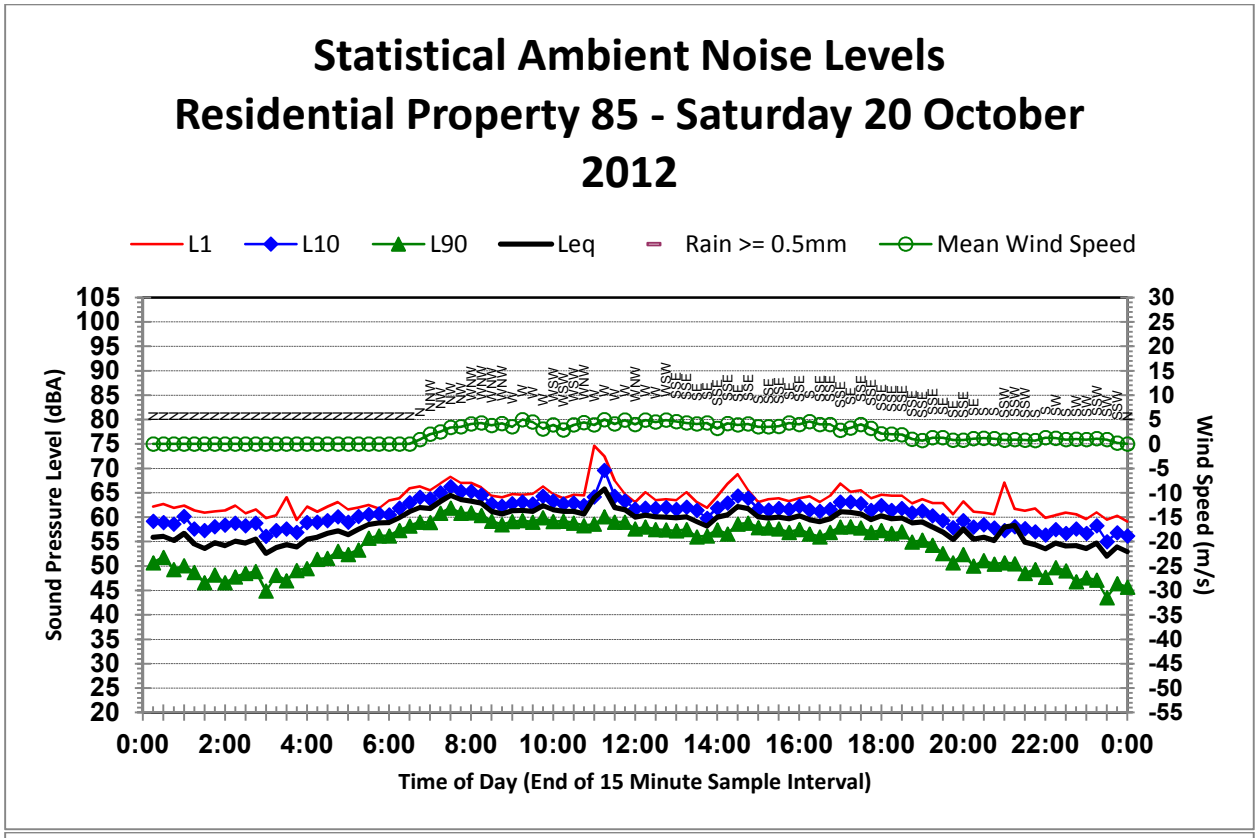
Statistical Ambient Noise Levels - Residential Property 97

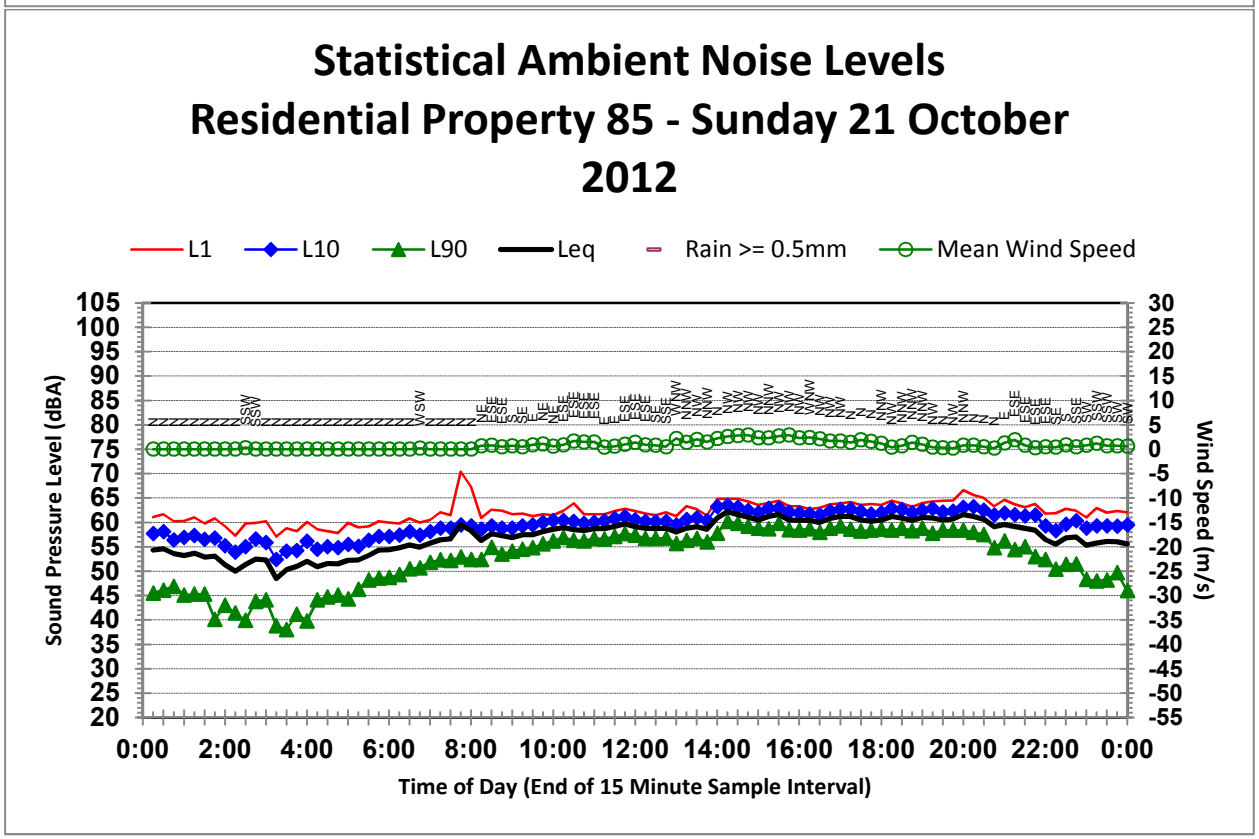


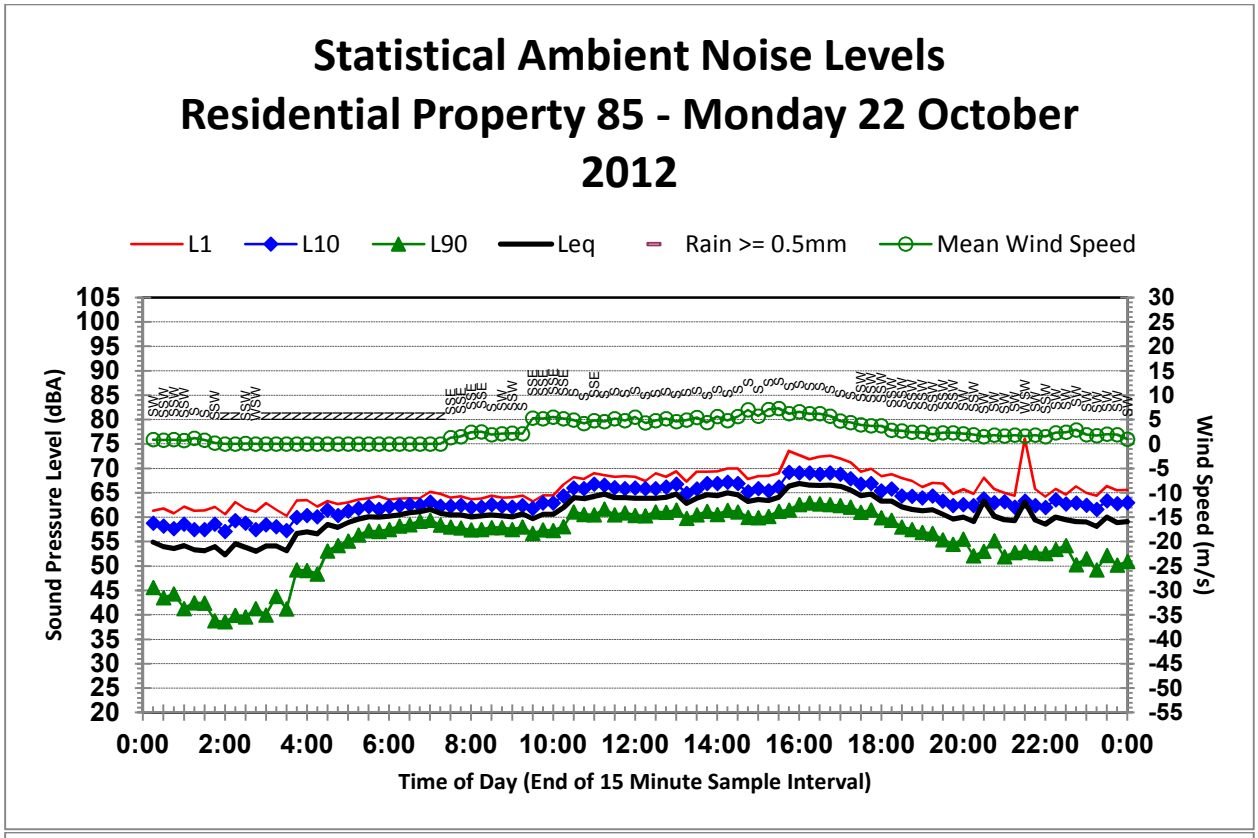

Statistical Ambient Noise Levels
Residential Property 85 - Thursday 18 October 2012
L1
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed
Sound Pressure Level (dBA)
Wind Speed (m/s)
105
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
30
25
20
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00
Time of Day (End of 15 Minute Sample Interval)

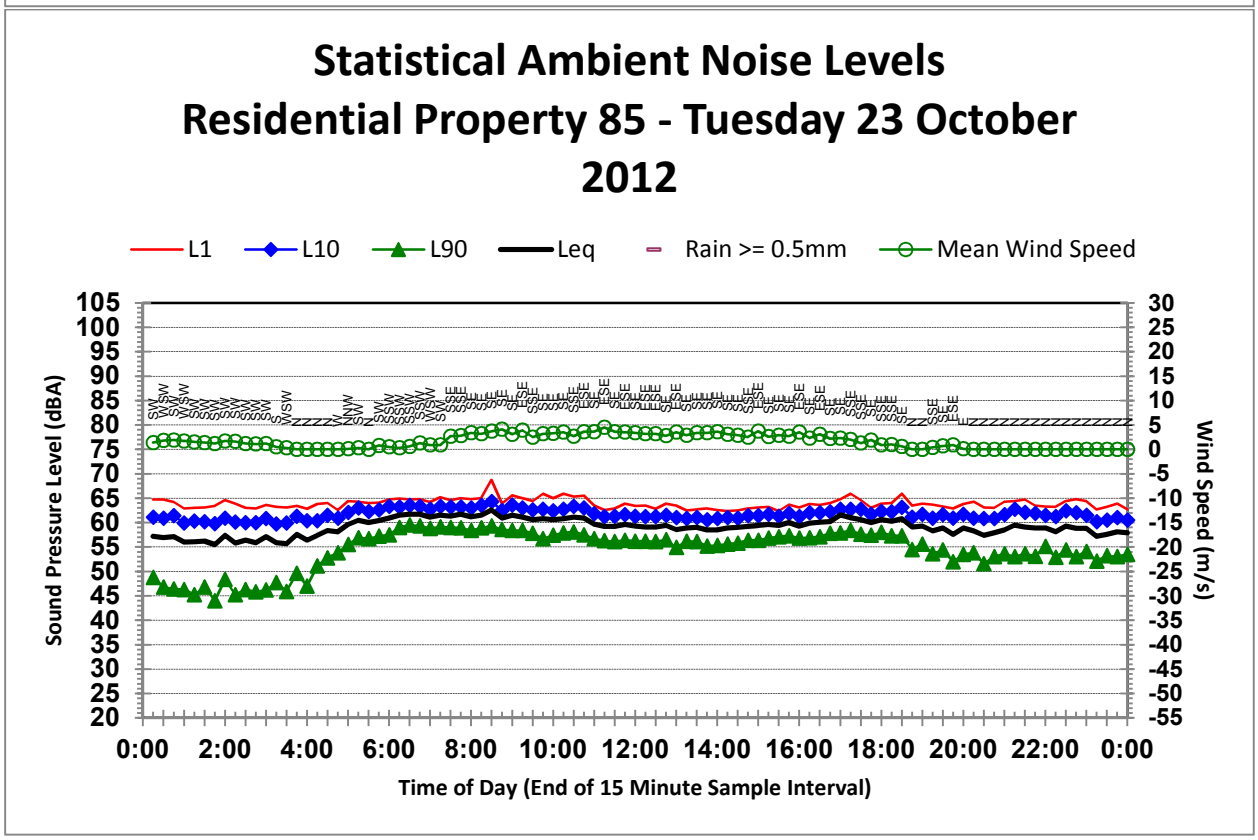

Statistical Ambient Noise Levels
Residential Property 85 - Friday 19 October 2012
L1
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed
Sound Pressure Level (dBA)
Wind Speed (m/s)
105
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
30
25
20
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00
Time of Day (End of 15 Minute Sample Interval)

Statistical Ambient Noise Levels - Residential Property 85

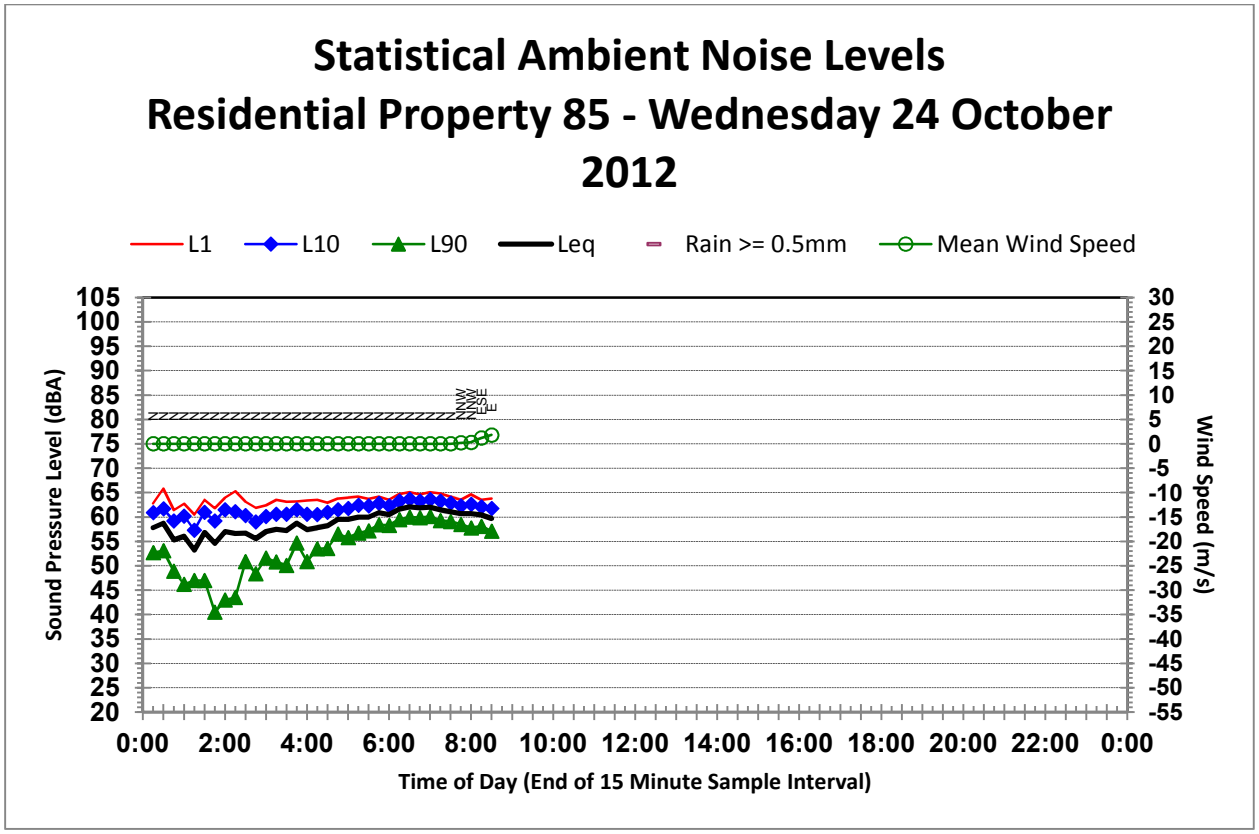




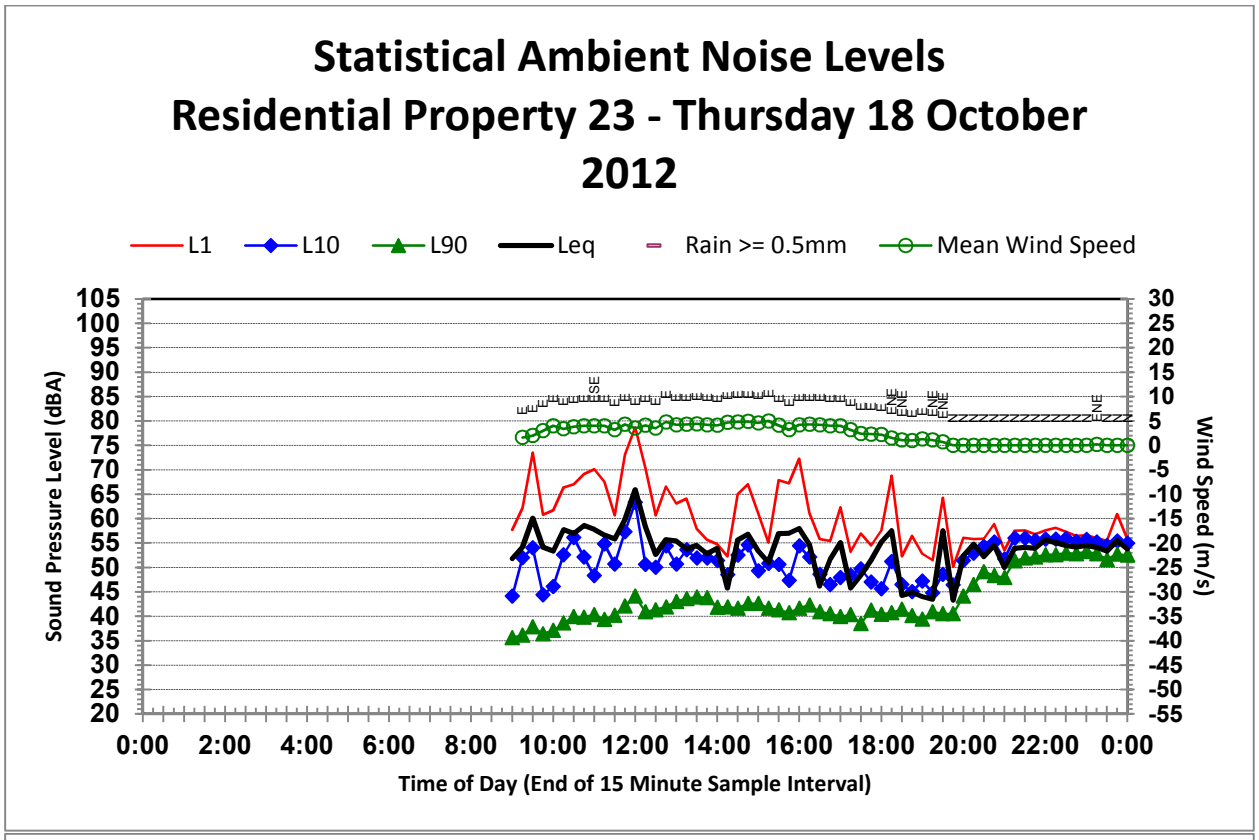

Statistical Ambient Noise Levels
Residential Property 85 - Monday 22 October 2012
L1
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed
Sound Pressure Level (dBA)
Wind Speed (m/s)
105
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
30
25
20
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00
Time of Day (End of 15 Minute Sample Interval)

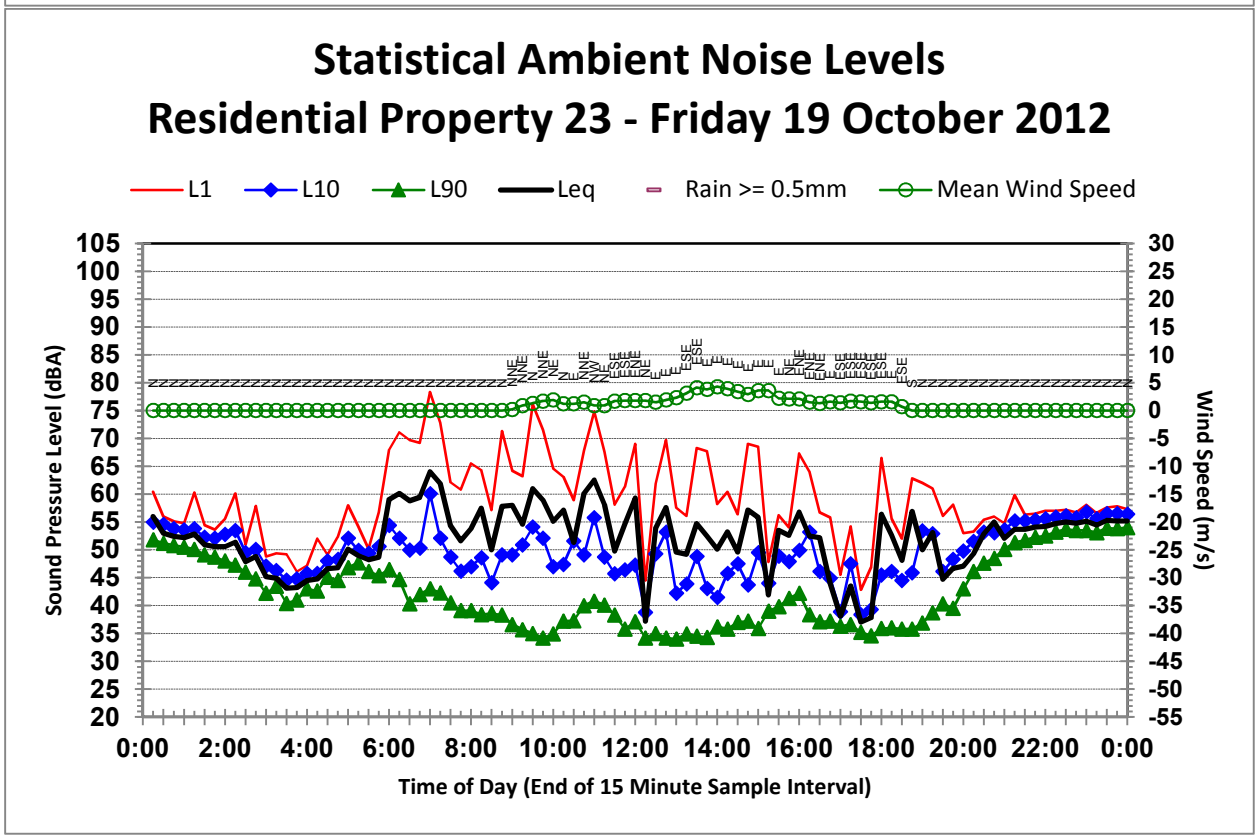

Statistical Ambient Noise Levels
Residential Property 85 - Tuesday 23 October 2012
L1
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed
Sound Pressure Level (dBA)
Wind Speed (m/s)
105
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
30
25
20
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00
Time of Day (End of 15 Minute Sample Interval)

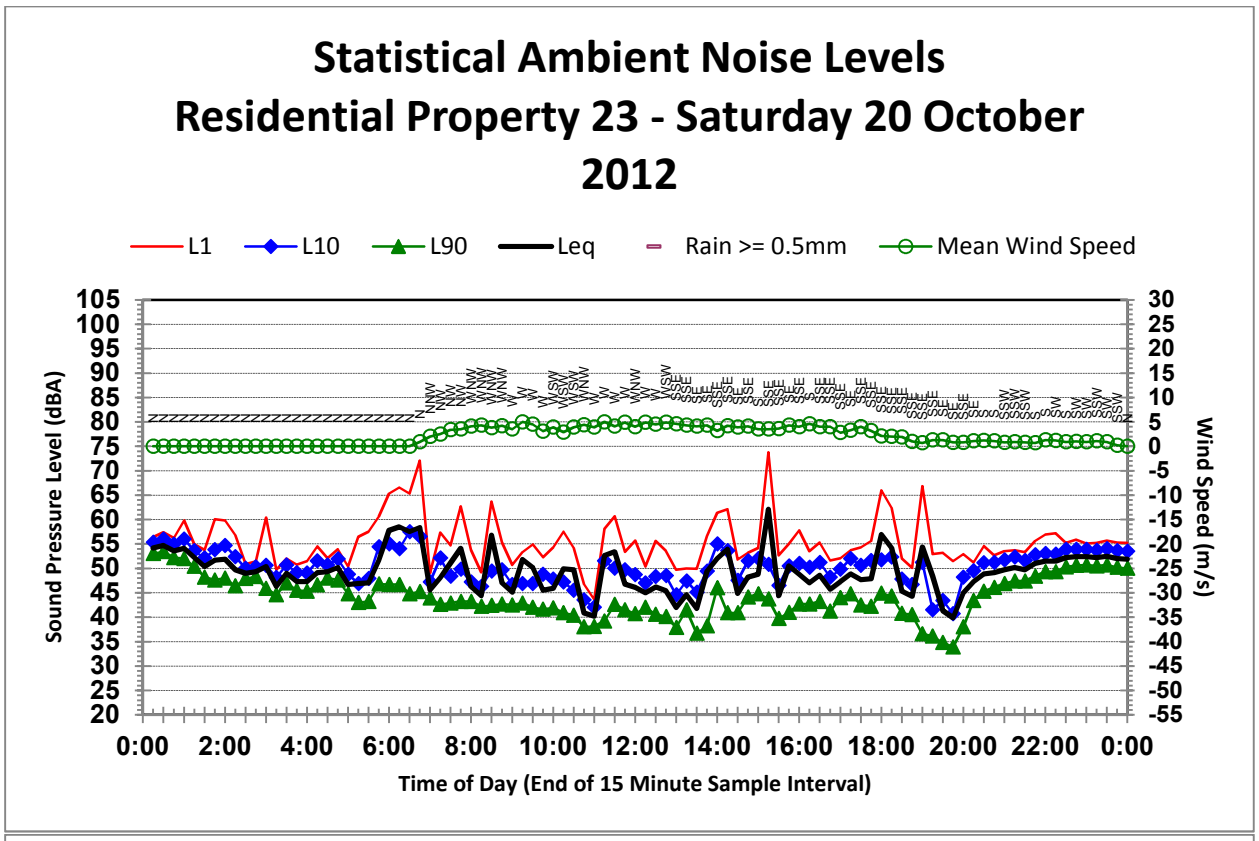
Statistical Ambient Noise Levels - Residential Property 85

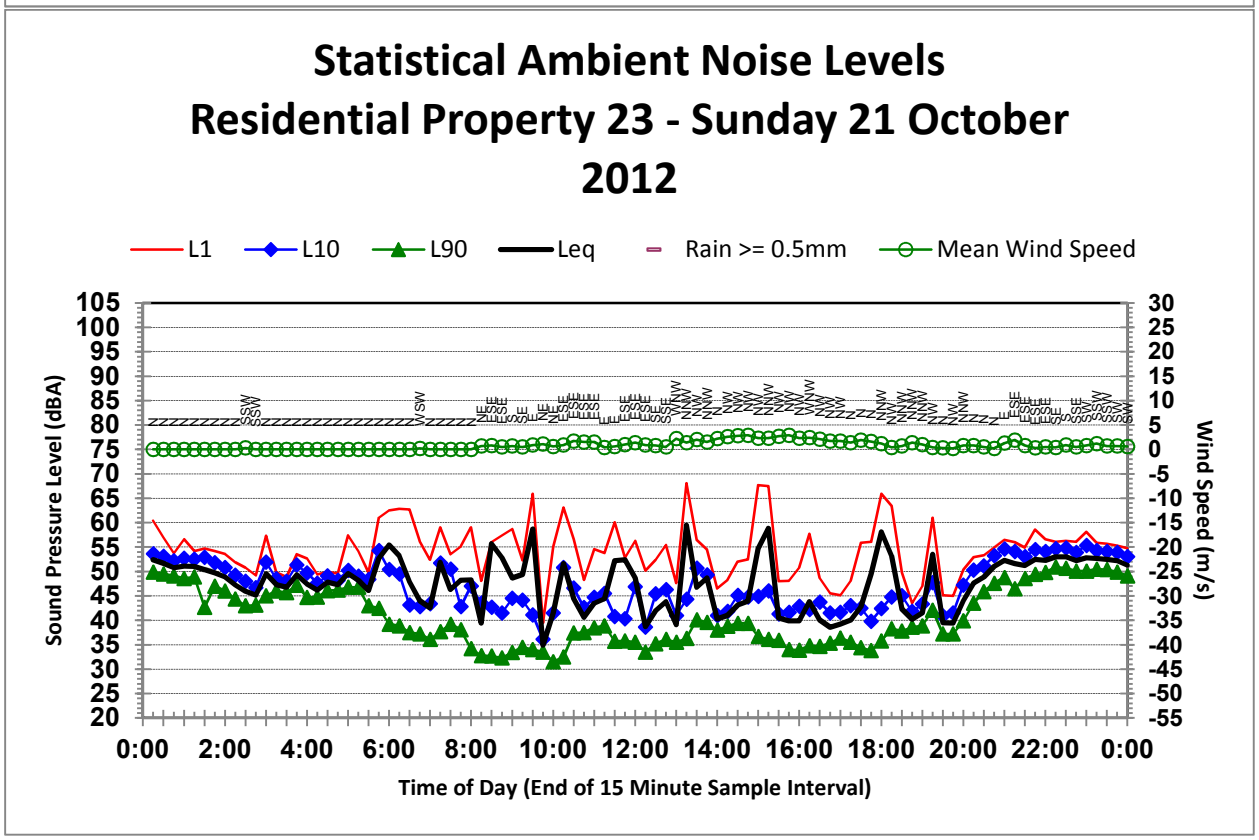


Statistical Ambient Noise Levels - Residential Property 23

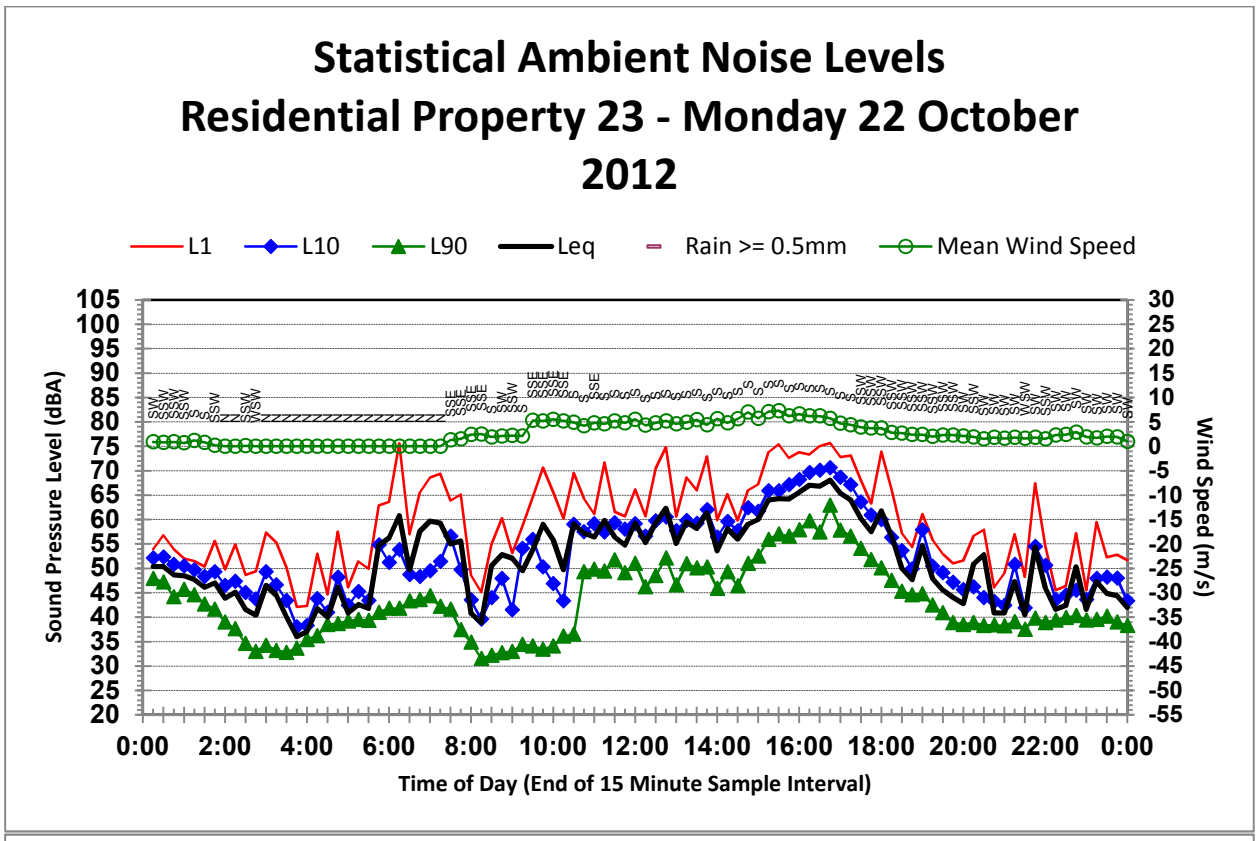


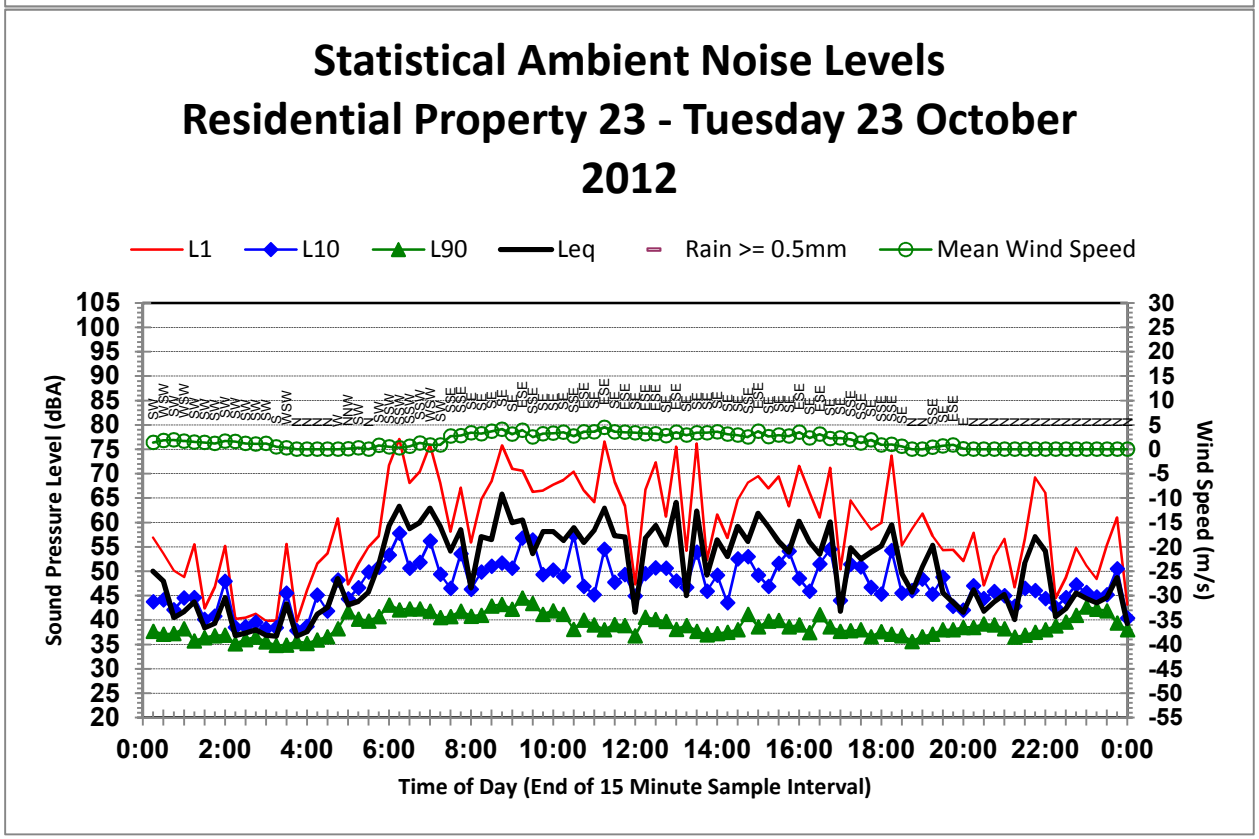



Statistical Ambient Noise Levels
Residential Property 23 - Saturday 20 October 2012
L1
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed
Sound Pressure Level (dBA)
Wind Speed (m/s)
105
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
30
25
20
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00
Time of Day (End of 15 Minute Sample Interval)

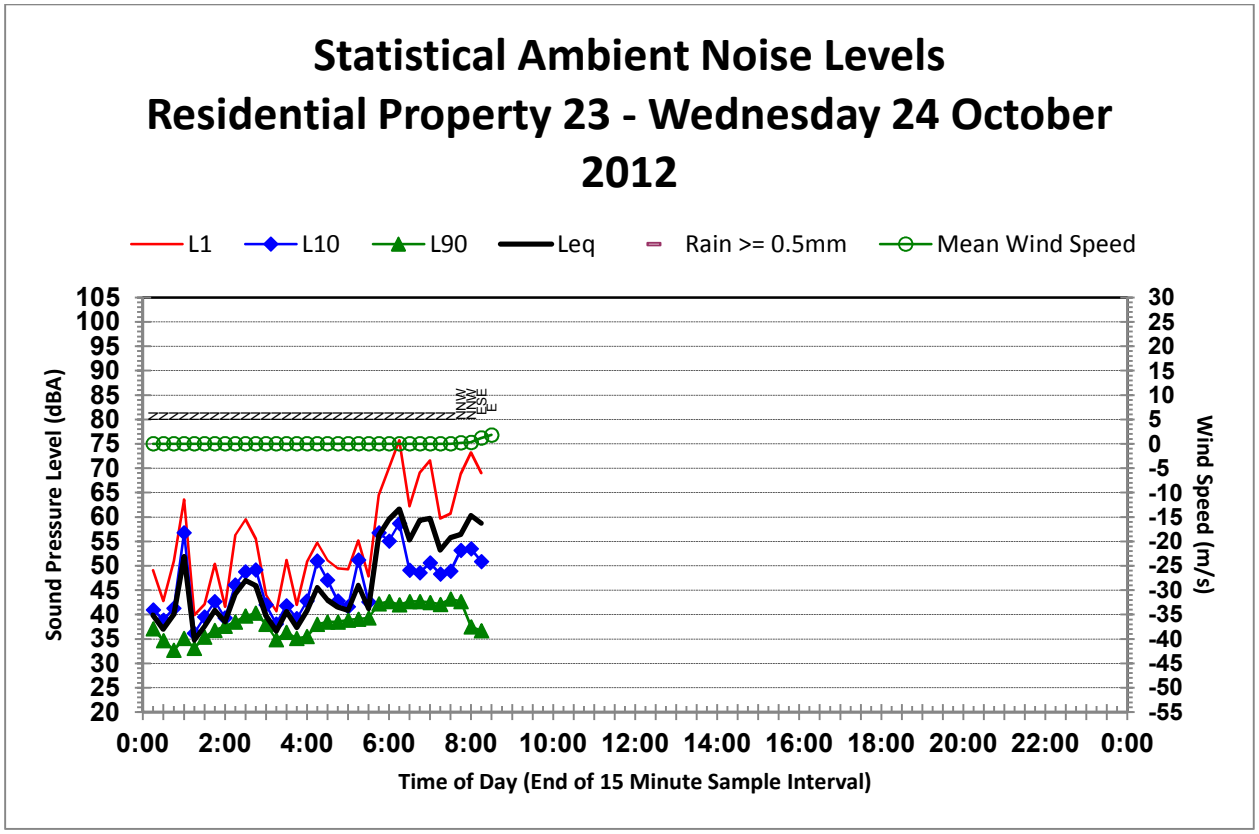

Statistical Ambient Noise Levels
Residential Property 23 - Sunday 21 October 2012
L1
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed
Sound Pressure Level (dBA)
Wind Speed (m/s)
105
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
30
25
20
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00
Time of Day (End of 15 Minute Sample Interval)

Statistical Ambient Noise Levels - Residential Property 23





Statistical Ambient Noise Levels - Residential Property 23



13 December 2012

630.02130.00100 LR August - December 20121205.docx

Centennial Coal Company Limited
PO Box 100
Toronto NSW 2283

Attention: Jeffrey Dunwoodie

Dear Jeffrey

Blast Monitoring Mandalong Mine
August 2012 to December 2012

1 Introduction

SLR Consulting Australia Pty Ltd (SLR Consulting) 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 28 August 2012 to 8 December 2012. This report presents the results of blasting overpressure and ground vibration monitoring.

2 Vibration and Overpressure Criteria

The Environmental Protection Authority (EPA) 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.

SLR Consulting Australia Pty Ltd Level 1, 14 Watt Street Newcastle NSW 2300 Australia
(PO Box 1768 Newcastle NSW 2300 Australia)
T: E: newcastleau@slrconsulting.com **www.slrconsulting.com**
ABN 29 001 584 612

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.

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**.

The full result reports for the blast monitoring are contained in **Appendix A and Appendix B**.

Table 2 Dyke Shot Firing Log

Date	Time
29/08/2012	Between1:00 pm and 3:30 pm
30/08/2012	Between1:00 pm and 3:30 pm
31/08/2012	Between1pm and 3:30 pm
06/09/2012	Between1:00 pm and 3:30 pm
20/09/2012	Between1:00 pm and 3:30 pm
18/10/2012	Between1:00 pm and 3:30 pm
24/10/2012	Between1:00 pm and 3:30 pm
01/11/2012	Between1:00 pm and 3:30 pm
06/11/2012	Between1:00 pm and 3:30 pm
12/11/2012	Between1:00 pm and 3:30 pm
14/11/2012	Between1:00 pm and 3:30 pm
08/12/2012	At 11:45 am

Table 3 Motoring Results Summary – 229 Sauls Road, Mandalong

Date/Time	Airblast (dB Lin peak)	Vibration Level (mm/s)				
			Trans.	Vert.	Long.	PVS
29/08/2012 Between1:00 pm and 3:30 pm	N/A	Peak Particle Velocity	1.41	1.03	1.24	1.52
30/08/2012 Between1:00 pm and 3:30 pm	N/A	Peak Particle Velocity	0.21	0.11	0.14	0.22
31/08/2012 Between1:00 pm and 3:30 pm	N/A	Peak Particle Velocity	0.13	0.14	0.11	0.19
06/09/2012 Between1:00 pm and 3:30 pm	N/A	Peak Particle Velocity	0.32	0.18	0.24	0.38
20/09/2012 Between1:00 pm and 3:30 pm	N/A	Peak Particle Velocity	1.21	0.43	0.78	1.43
18/10/2012 Between1:00 pm and 3:30 pm	N/A	Peak Particle Velocity	0.27	0.29	0.16	0.30
24/10/2012 Between1:00 pm and 3:30 pm	N/A	Peak Particle Velocity	0.18	0.21	0.14	0.23
01/11/2012 Between1:00 pm and 3:30 pm	N/A	Peak Particle Velocity	0.25	0.21	0.18	0.33
06/11/2012 Between1:00 pm and 3:30 pm	N/A	Peak Particle Velocity	0.22	0.24	0.13	0.25
12/11/2012 Between1:00 pm and 3:30 pm	N/A	Peak Particle Velocity	0.40	0.25	0.38	0.48
14/11/2012 Between1:00 pm and 3:30 pm	N/A	Peak Particle Velocity	0.10	0.08	0.13	0.15
08/12/2012 At 11:45 am	N/A	Peak Particle Velocity	0.24	0.08	0.11	0.24

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

Date/Time	Airblast (dB Lin peak)	Vibration Level (mm/s)				
			Trans.	Vert.	Long.	PVS
29/08/2012 Between1:00 pm and 3:30 pm	108 @ 6.5 Hz	Peak Particle Velocity	0.10	0.10	0.14	0.16
30/08/2012 Between1:00 pm and 3:30 pm	120 @ 13 Hz	Peak Particle Velocity	0.10	0.11	0.19	0.21
31/08/2012 Between1:00 pm and 3:30 pm	111 @ 64 Hz	Peak Particle Velocity	0.10	0.10	0.16	0.16
06/09/2012 Between1:00 pm and 3:30 pm	126 @ 4.8 Hz	Peak Particle Velocity	0.11	0.11	0.16	0.17
20/09/2012 Between1:00 pm and 3:30 pm	108 @ 73 Hz	Peak Particle Velocity	0.56	0.40	0.35	0.68
18/10/2012 Between1:00 pm and 3:30 pm	109 @ 4.6 Hz	Peak Particle Velocity	0.10	0.08	0.11	0.12
24/10/2012 Between1:00 pm and 3:30 pm	111 @ 5 Hz	Peak Particle Velocity	0.16	0.19	0.25	0.29
01/11/2012 Between1:00 pm and 3:30 pm	113 @ 13 Hz	Peak Particle Velocity	0.11	0.10	0.11	0.13
06/11/2012 Between1:00 pm and 3:30 pm	119 @ 14 Hz	Peak Particle Velocity	0.16	0.13	0.24	0.27
12/11/2012 Between1:00 pm and 3:30 pm	118 @ >100 Hz	Peak Particle Velocity	0.18	0.29	0.21	0.33
14/11/2012 Between1:00 pm and 3:30 pm	108 @ 3.3 Hz	Peak Particle Velocity	0.14	0.19	0.18	0.24
08/12/2012 At 11:45 am	98 @ 6.2 Hz	Peak Particle Velocity	0.10	0.06	0.11	0.12

The measured blast ground vibration results presented in **Table 3** and **Table 4** are well below the respective limit of 5 mm/sec at each location monitored. All blast overpressure monitoring results presented in **Table 4** are well below the respective limit of 115 dB (Lin peak) with the exception of measurements recorded on the 30/08/2012, 06/09/2012, 06/11/2012 and 12/11/2012. These monitoring results were due to excessive winds during the monitoring period and hence the likely blast overpressure level would likely be below the limit of 115 dB (Lin peak).

It should be noted that as the monitoring at the Mandalong Coal project site was conducted near the portal, it is predicted that ground vibration and blast overpressure will be met at the nearest potentially affected residential receiver locations.

5 Conclusion

Monitored blasting overpressure and ground vibration levels from blasting conducted at Mandalong mine for the period from 29 August 2012 to 8 December 2012 were found to be:

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

If you require any further information on this project please do not hesitate to contact me on phone 02 4908 4500 or email trobertson@slrconsulting.com.

Regards,



Tristan Robertson
SLR Consulting

Appendix A

Event Report

Histogram Start Time	05:00:31 August 29, 2012	**Serial Number**	BE10614 V 8.01-8.0 MiniMate Plus
Histogram Finish Time	05:00:28 August 30, 2012	**Battery Level**	6.8 Volts
Number of Intervals	95 at 15 minutes	**Calibration**	July 8, 2011 by Standards & Testing Lab.
Range	Geo :31.7 mm/s	**File Name**	L614EFNS.KV0
Sample Rate	1024sps		
Job Number:	2130		

Notes
Location:
Client:
User Name:
General:

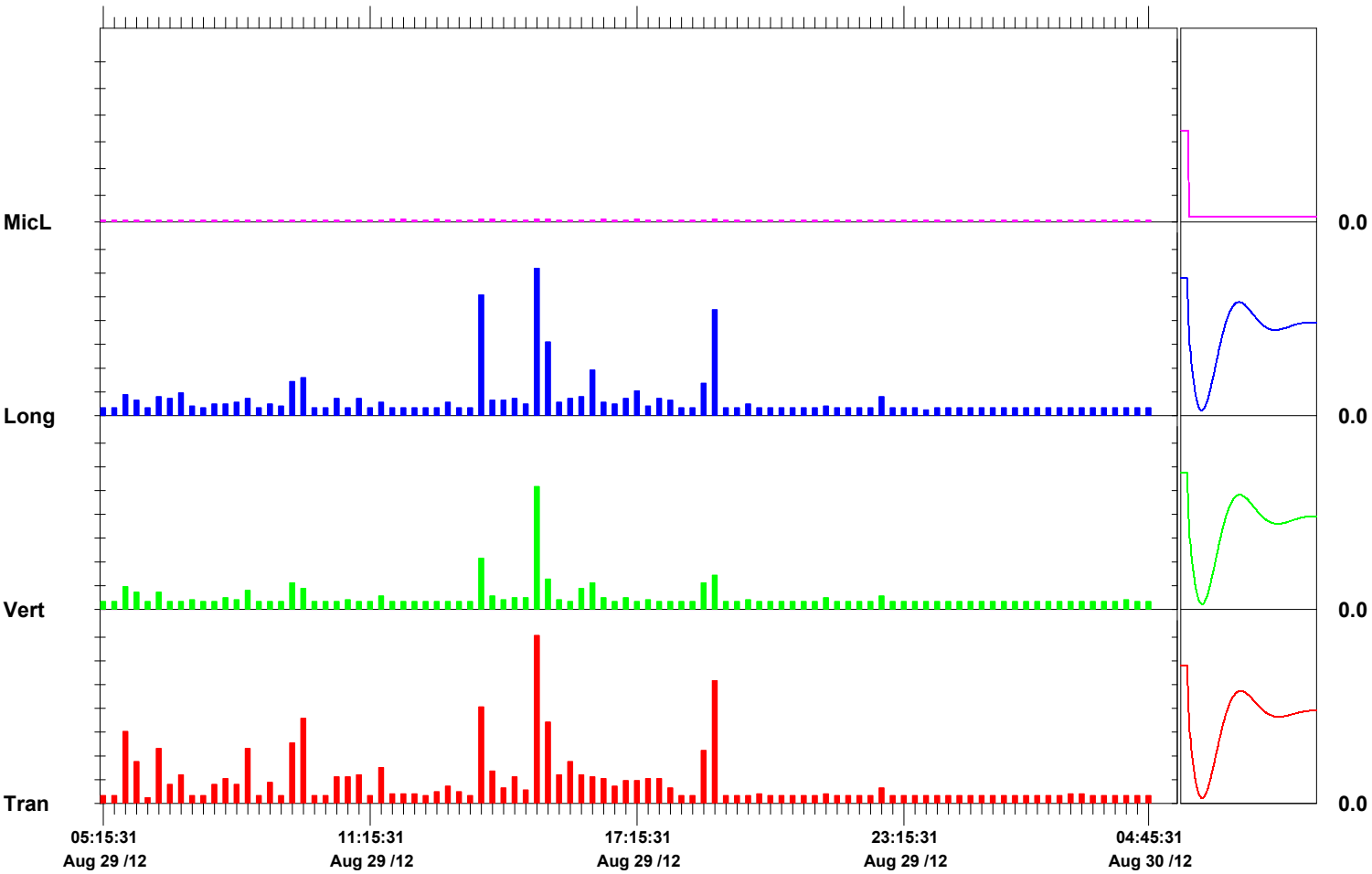
Extended Notes

Post Event Notes

Microphone Linear Weighting
PSPL <88 dB(L) 0.500 pa.(L) on August 29, 2012 at 11:45:31
ZC Freq >100 Hz
Channel Test Check (Freq = 0.0 Hz Amp = 0 mv)

	Tran	Vert	Long	
PPV	1.41	1.03	1.24	mm/s
ZC Freq	73	>100	85	Hz
Date	Aug 29 /12	Aug 29 /12	Aug 29 /12	
Time	15:00:31	15:00:31	15:00:31	
Sensorcheck	Passed	Passed	Passed	
Frequency	7.3	7.5	7.5	Hz
Overswing Ratio	4.2	3.8	3.9	

Peak Vector Sum 1.52 mm/s on August 29, 2012 at 15:00:31



Time Scale: 15 minutes /div **Amplitude Scale:** Geo: 0.200 mm/s/div Mic: 5.00 pa.(L)/div Sensorcheck

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Event Report

Histogram Start Time	05:00:30 August 30, 2012	**Serial Number**	BE10614 V 8.01-8.0 MiniMate Plus
Histogram Finish Time	05:00:28 August 31, 2012	**Battery Level**	6.8 Volts
Number of Intervals	95 at 15 minutes	**Calibration**	July 8, 2011 by Standards & Testing Lab.
Range	Geo :31.7 mm/s	**File Name**	L614EFPN.8U0
Sample Rate	1024sps		
Job Number:	2130		

Notes
Location:
Client:
User Name:
General:

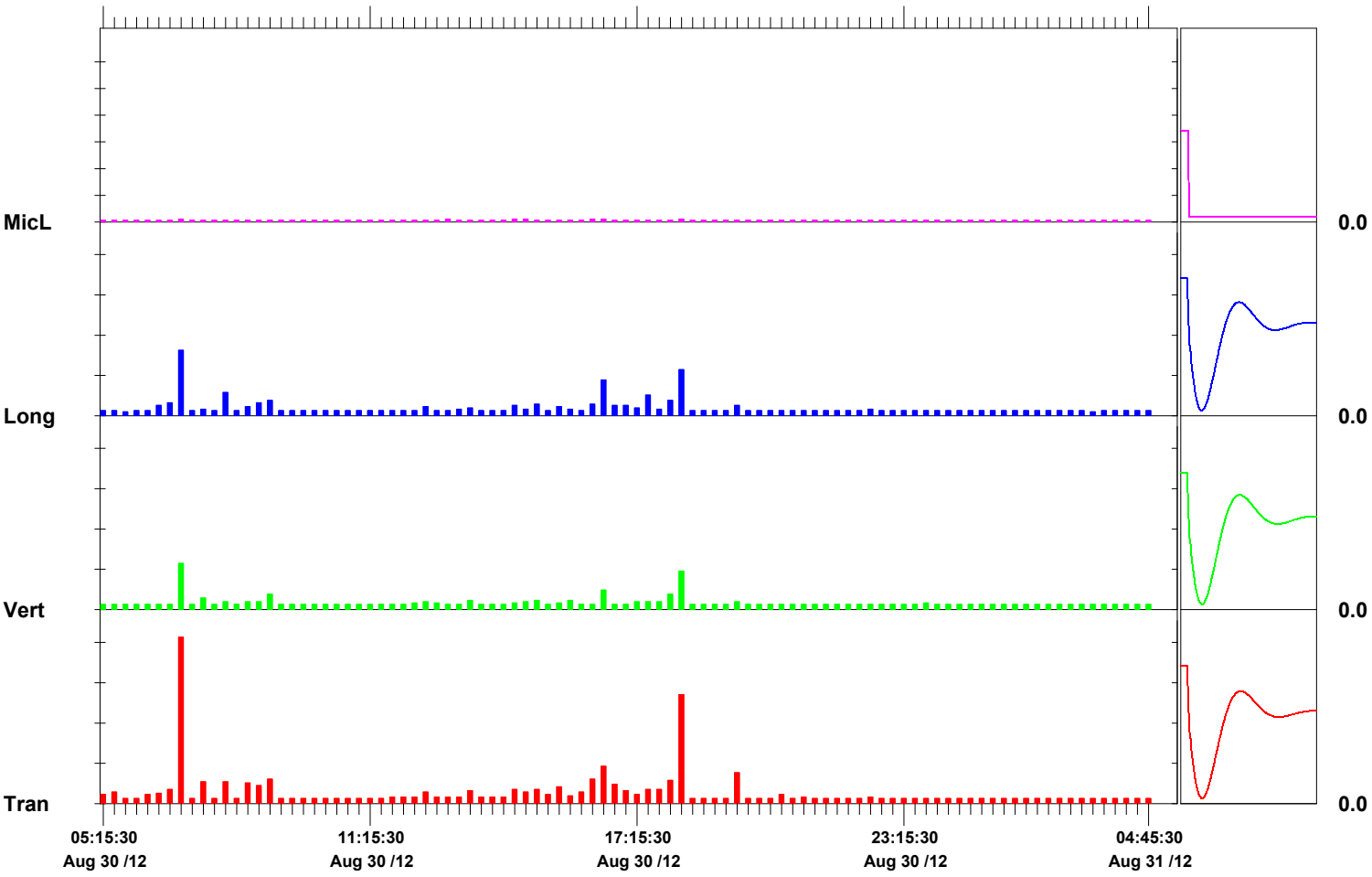
Extended Notes

Post Event Notes

Microphone Linear Weighting
PSPL <88 dB(L) 0.500 pa.(L) on August 30, 2012 at 07:00:30
ZC Freq >100 Hz
Channel Test Check (Freq = 0.0 Hz Amp = 0 mv)

	Tran	Vert	Long	
PPV	2.06	0.571	0.810	mm/s
ZC Freq	>100	>100	>100	Hz
Date	Aug 30 /12	Aug 30 /12	Aug 30 /12	
Time	07:00:30	07:00:30	07:00:30	
Sensorcheck	Passed	Passed	Passed	
Frequency	7.3	7.5	7.5	Hz
Overswing Ratio	4.2	3.8	3.9	

Peak Vector Sum 2.18 mm/s on August 30, 2012 at 07:00:30



Time Scale: 15 minutes /div **Amplitude Scale:** Geo: 0.500 mm/s/div Mic: 5.00 pa.(L)/div Sensorcheck

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Event Report

Histogram Start Time	05:00:30 August 31, 2012	**Serial Number**	BE10614 V 8.01-8.0 MiniMate Plus
Histogram Finish Time	05:00:28 September 1, 2012	**Battery Level**	6.9 Volts
Number of Intervals	95 at 15 minutes	**Calibration**	July 8, 2011 by Standards & Testing Lab.
Range	Geo :31.7 mm/s	**File Name**	L614EFRH.WU0
Sample Rate	1024sps		
Job Number:	2130		

Notes
Location:
Client:
User Name:
General:

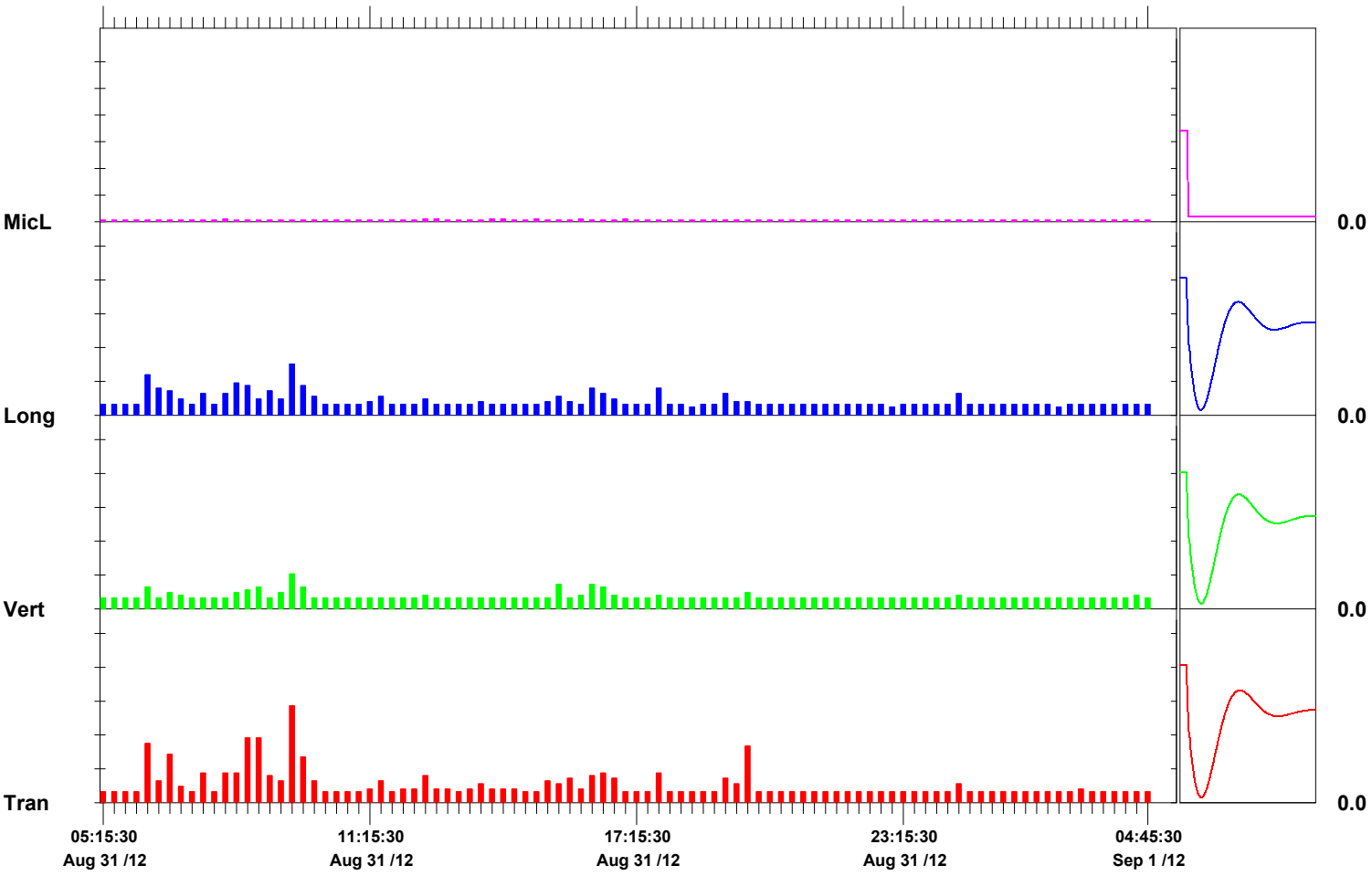
Extended Notes

Post Event Notes

Microphone Linear Weighting
PSPL <88 dB(L) 0.500 pa.(L) on August 31, 2012 at 08:00:30
ZC Freq >100 Hz
Channel Test Check (Freq = 0.0 Hz Amp = 0 mv)

	Tran	Vert	Long	
PPV	0.571	0.206	0.302	mm/s
ZC Freq	>100	85	>100	Hz
Date	Aug 31 /12	Aug 31 /12	Aug 31 /12	
Time	09:30:30	09:30:30	09:30:30	
Sensorcheck	Passed	Passed	Passed	
Frequency	7.3	7.5	7.5	Hz
Overswing Ratio	4.2	3.8	3.9	

Peak Vector Sum 0.591 mm/s on August 31, 2012 at 09:30:30



Time Scale: 15 minutes /div **Amplitude Scale:** Geo: 0.200 mm/s/div Mic: 5.00 pa.(L)/div Sensorcheck

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Event Report

Histogram Start Time	11:24:51 September 6, 2012	**Serial Number**	BE10614 V 8.01-8.0 MiniMate Plus
Histogram Finish Time	05:00:28 September 7, 2012	**Battery Level**	6.9 Volts
Number of Intervals	70 at 15 minutes	**Calibration**	July 8, 2011 by Standards & Testing Lab.
Range	Geo :31.7 mm/s	**File Name**	L614EG33.PF0
Sample Rate	1024sps		
Job Number:	2130		

Notes
Location:
Client:
User Name:
General:

Extended Notes

Post Event Notes

Microphone Linear Weighting
PSPL <88 dB(L) 0.500 pa.(L) on September 6, 2012 at 11:39:51
ZC Freq >100 Hz
Channel Test Check (Freq = 0.0 Hz Amp = 0 mv)

	Tran	Vert	Long	
PPV	0.889	1.94	0.730	mm/s
ZC Freq	>100	>100	>100	Hz
Date	Sep 6 /12	Sep 6 /12	Sep 6 /12	
Time	11:39:51	11:39:51	11:39:51	
Sensorcheck	Passed	Passed	Passed	
Frequency	7.2	7.4	7.5	Hz
Overswing Ratio	4.1	3.7	3.8	

Peak Vector Sum 2.16 mm/s on September 6, 2012 at 11:39:51



Time Scale: 15 minutes /div **Amplitude Scale:** Geo: 0.500 mm/s/div Mic: 5.00 pa.(L)/div Sensorcheck

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Event Report

Histogram Start Time	12:37:54 September 20, 2012	**Serial Number**	BE10614 V 8.01-8.0 MiniMate Plus
Histogram Finish Time	05:00:28 September 21, 2012	**Battery Level**	6.8 Volts
Number of Intervals	65 at 15 minutes	**Calibration**	July 8, 2011 by Standards & Testing Lab.
Range	Geo :31.7 mm/s	**File Name**	L614EGT4.F60
Sample Rate	1024sps		
Job Number:	2130		

Notes
Location:
Client:
User Name:
General:

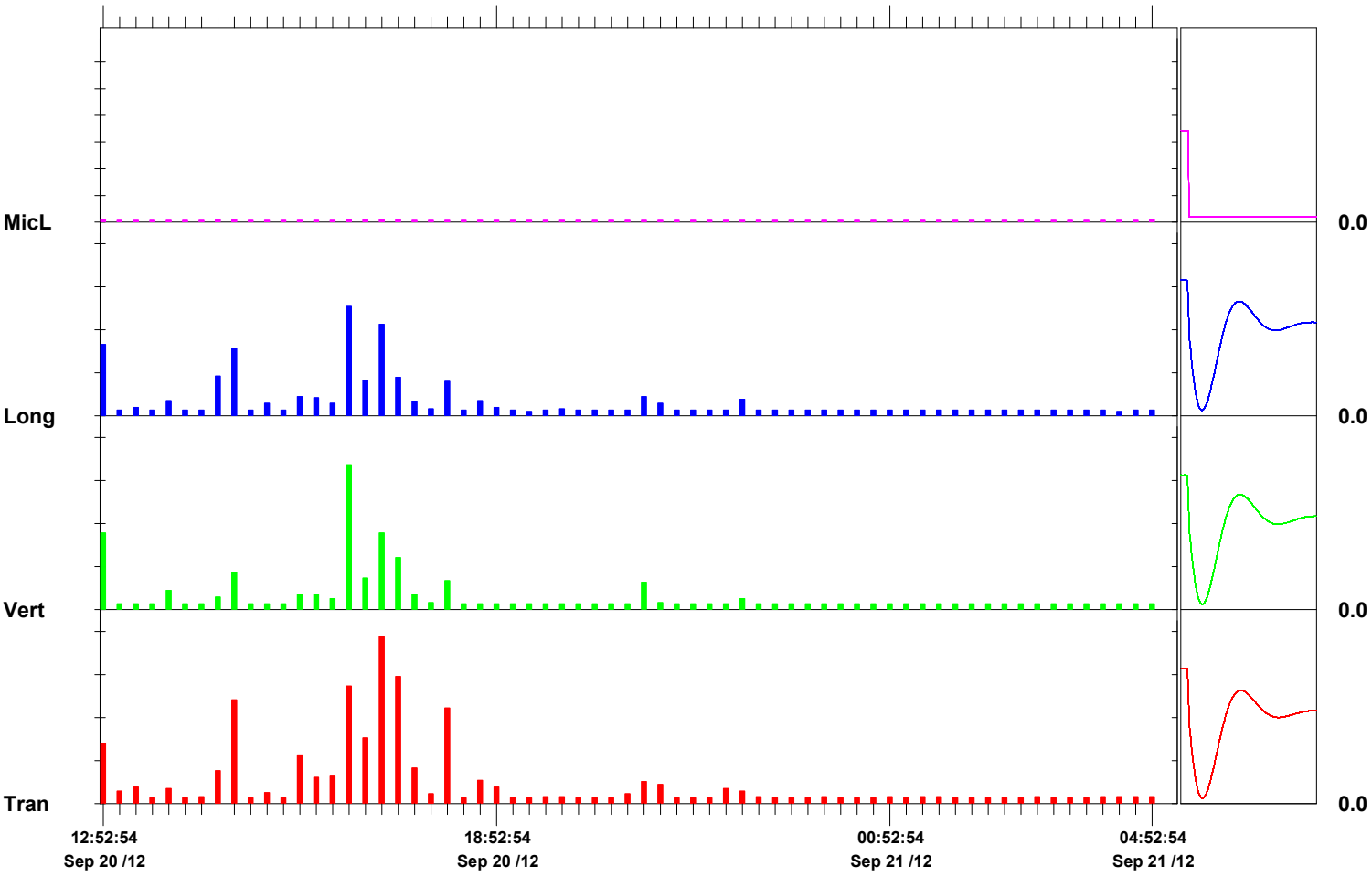
Extended Notes

Post Event Notes

Microphone Linear Weighting
PSPL <88 dB(L) 0.500 pa.(L) on September 20, 2012 at 12:52:54
ZC Freq >100 Hz
Channel Test Check (Freq = 0.0 Hz Amp = 0 mv)

	Tran	Vert	Long	
PPV	1.94	1.68	1.27	mm/s
ZC Freq	>100	>100	>100	Hz
Date	Sep 20 /12	Sep 20 /12	Sep 20 /12	
Time	17:07:54	16:37:54	16:37:54	
Sensorcheck	Passed	Passed	Passed	
Frequency	7.3	7.4	7.5	Hz
Overswing Ratio	4.0	3.7	3.8	

Peak Vector Sum 2.13 mm/s on September 20, 2012 at 16:37:54



Time Scale: 15 minutes /div **Amplitude Scale:** Geo: 0.500 mm/s/div Mic: 5.00 pa.(L)/div Sensorcheck

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Event Report

Histogram Start Time	05:00:28 October 18, 2012	**Serial Number**	BE10614 V 8.01-8.0 MiniMate Plus
Histogram Finish Time	05:00:28 October 19, 2012	**Battery Level**	6.8 Volts
Number of Intervals	96 at 15 minutes	**Calibration**	July 8, 2011 by Standards & Testing Lab.
Range	Geo :31.7 mm/s	**File Name**	L614EI8D.WS0
Sample Rate	1024sps		
Job Number:	2130		

Notes
Location:
Client:
User Name:
General:

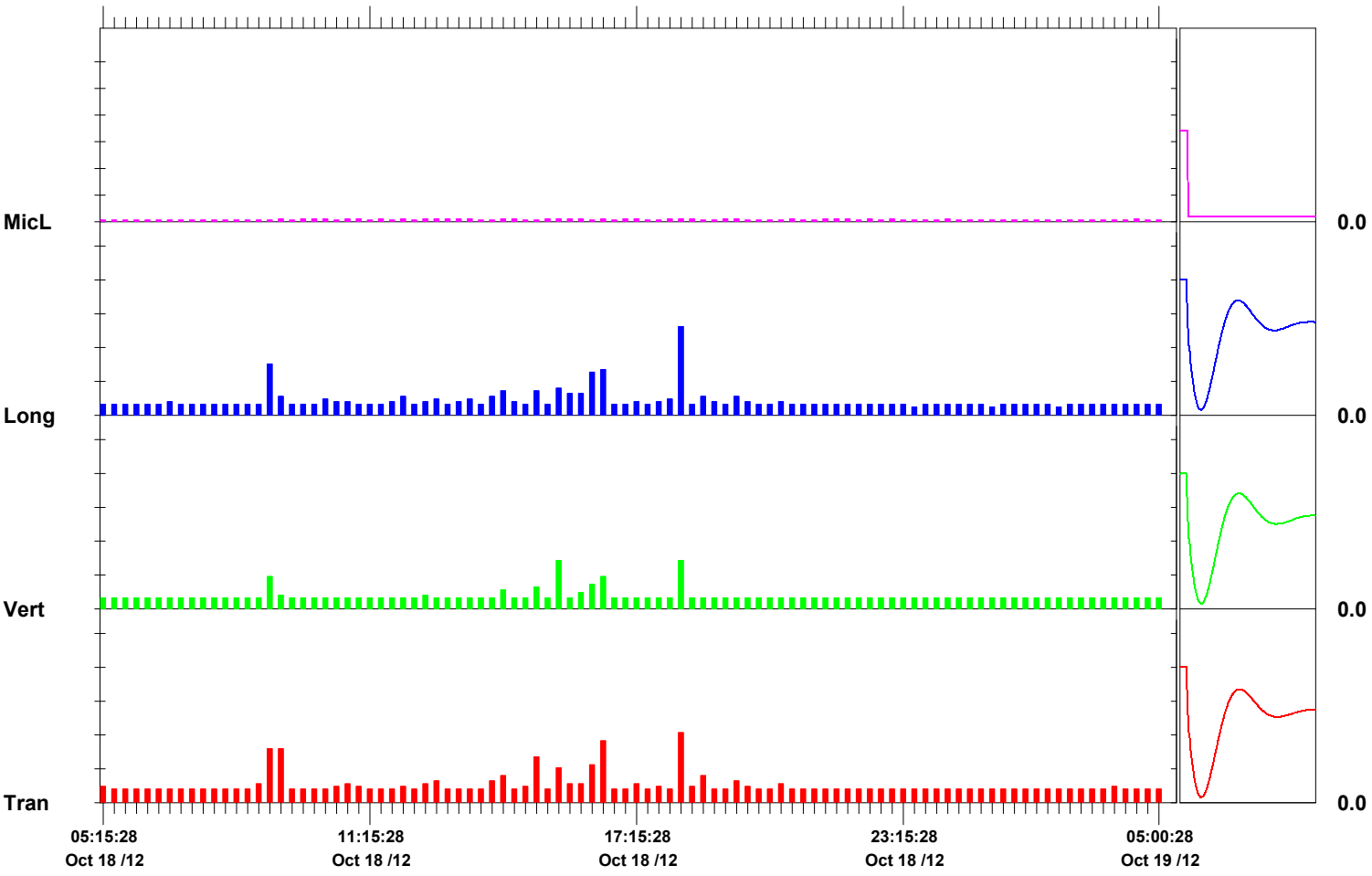
Extended Notes

Post Event Notes

Microphone Linear Weighting
PSPL <88 dB(L) 0.500 pa.(L) on October 18, 2012 at 09:15:28
ZC Freq >100 Hz
Channel Test Check (Freq = 0.0 Hz Amp = 0 mv)

	Tran	Vert	Long	
PPV	0.413	0.286	0.524	mm/s
ZC Freq	>100	64	>100	Hz
Date	Oct 18 /12	Oct 18 /12	Oct 18 /12	
Time	18:15:28	15:30:28	18:15:28	
Sensorcheck	Passed	Passed	Passed	
Frequency	7.3	7.5	7.6	Hz
Overswing Ratio	3.9	3.6	3.7	

Peak Vector Sum 0.585 mm/s on October 18, 2012 at 18:15:28



Time Scale: 15 minutes /div **Amplitude Scale:** Geo: 0.200 mm/s/div Mic: 5.00 pa.(L)/div Sensorcheck

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Event Report

Histogram Start Time	05:00:29 October 24, 2012	**Serial Number**	BE10614 V 8.01-8.0 MiniMate Plus
Histogram Finish Time	05:00:28 October 25, 2012	**Battery Level**	6.8 Volts
Number of Intervals	95 at 15 minutes	**Calibration**	July 8, 2011 by Standards & Testing Lab.
Range	Geo :31.7 mm/s	**File Name**	L614EIJH.WT0
Sample Rate	1024sps		
Job Number:	2130		

Notes
Location:
Client:
User Name:
General:

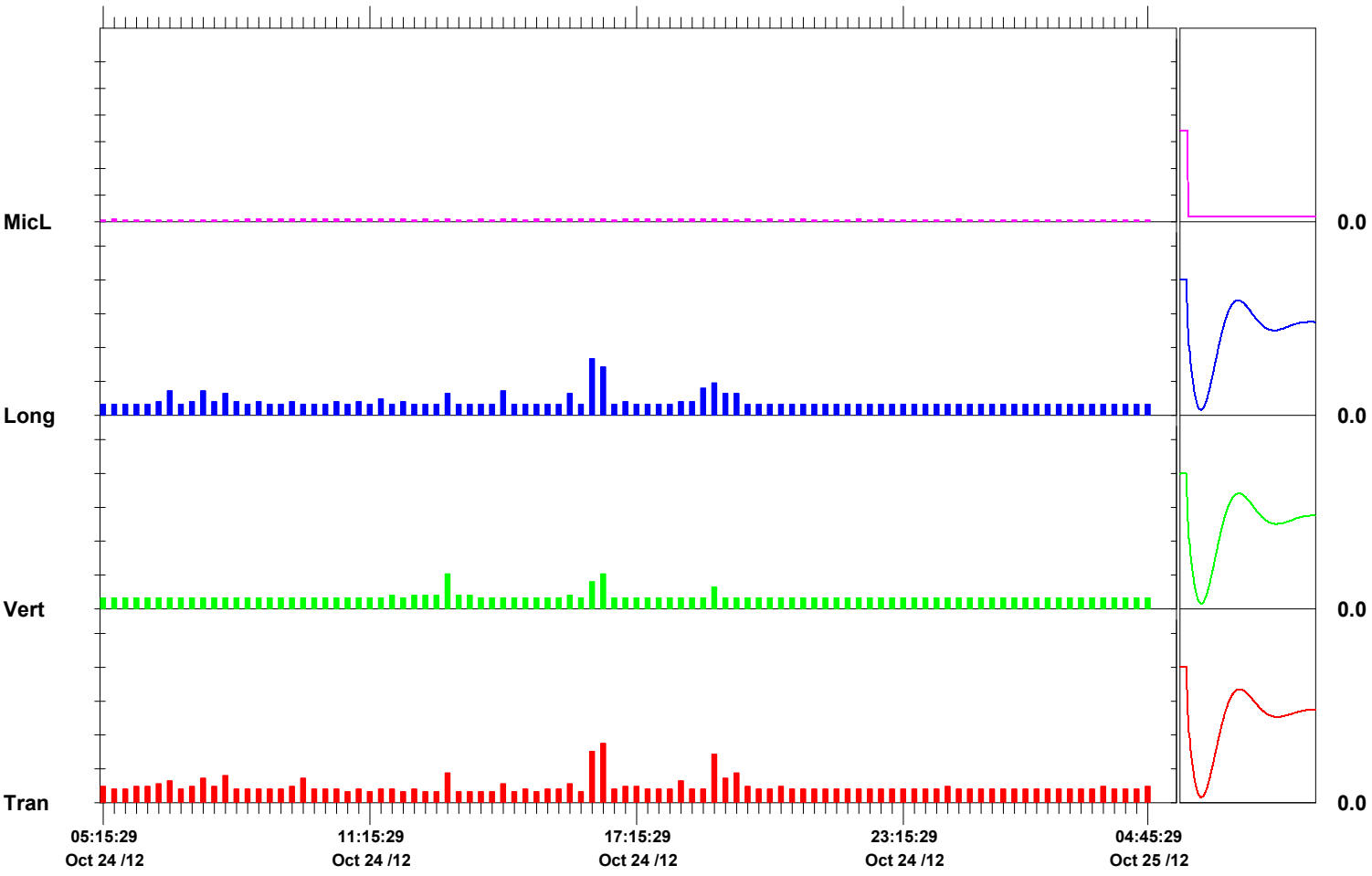
Extended Notes

Post Event Notes

Microphone Linear Weighting
PSPL <88 dB(L) 0.500 pa.(L) on October 24, 2012 at 05:30:29
ZC Freq >100 Hz
Channel Test Check (Freq = 0.0 Hz Amp = 0 mv)

	Tran	Vert	Long	
PPV	0.349	0.206	0.333	mm/s
ZC Freq	>100	85	>100	Hz
Date	Oct 24 /12	Oct 24 /12	Oct 24 /12	
Time	16:30:29	13:00:29	16:15:29	
Sensorcheck	Passed	Passed	Passed	
Frequency	7.3	7.5	7.6	Hz
Overswing Ratio	3.9	3.6	3.7	

Peak Vector Sum 0.379 mm/s on October 24, 2012 at 16:15:29



Time Scale: 15 minutes /div **Amplitude Scale:** Geo: 0.200 mm/s/div Mic: 5.00 pa.(L)/div Sensorcheck

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Event Report

Histogram Start Time	05:00:28 November 1, 2012	**Serial Number**	BE10614 V 8.01-8.0 MiniMate Plus
Histogram Finish Time	05:00:28 November 2, 2012	**Battery Level**	6.8 Volts
Number of Intervals	96 at 15 minutes	**Calibration**	July 8, 2011 by Standards & Testing Lab.
Range	Geo :31.7 mm/s	**File Name**	L614EIYB.8S0
Sample Rate	1024sps		
Job Number:	2130		

Notes
Location:
Client:
User Name:
General:

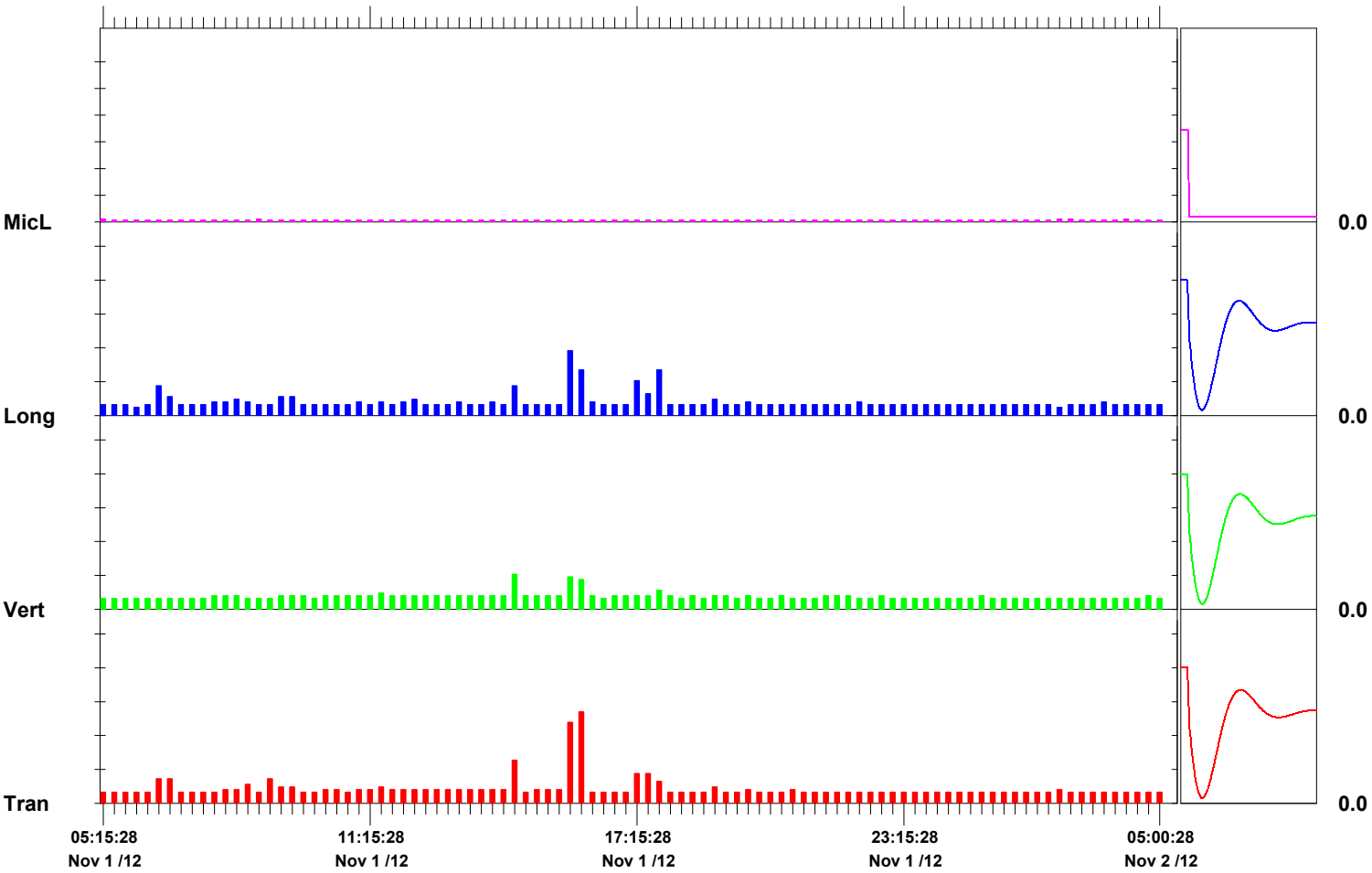
Extended Notes

Post Event Notes

Microphone Linear Weighting
PSPL <88 dB(L) 0.500 pa.(L) on November 1, 2012 at 05:15:28
ZC Freq >100 Hz
Channel Test Check (Freq = 0.0 Hz Amp = 0 mv)

	Tran	Vert	Long	
PPV	0.540	0.206	0.381	mm/s
ZC Freq	>100	57	>100	Hz
Date	Nov 1 /12	Nov 1 /12	Nov 1 /12	
Time	16:00:28	14:30:28	15:45:28	
Sensorcheck	Passed	Passed	Passed	
Frequency	7.3	7.4	7.5	Hz
Overswing Ratio	4.0	3.7	3.7	

Peak Vector Sum 0.598 mm/s on November 1, 2012 at 16:00:28



Time Scale: 15 minutes /div **Amplitude Scale:** Geo: 0.200 mm/s/div Mic: 5.00 pa.(L)/div Sensorcheck

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Event Report

Histogram Start Time	05:00:28 November 6, 2012	**Serial Number**	BE10614 V 8.01-8.0 MiniMate Plus
Histogram Finish Time	05:00:28 November 7, 2012	**Battery Level**	6.8 Volts
Number of Intervals	96 at 15 minutes	**Calibration**	July 8, 2011 by Standards & Testing Lab.
Range	Geo :31.7 mm/s	**File Name**	L614EJ7K.KS0
Sample Rate	1024sps		
Job Number:	2130		

Notes
Location:
Client:
User Name:
General:

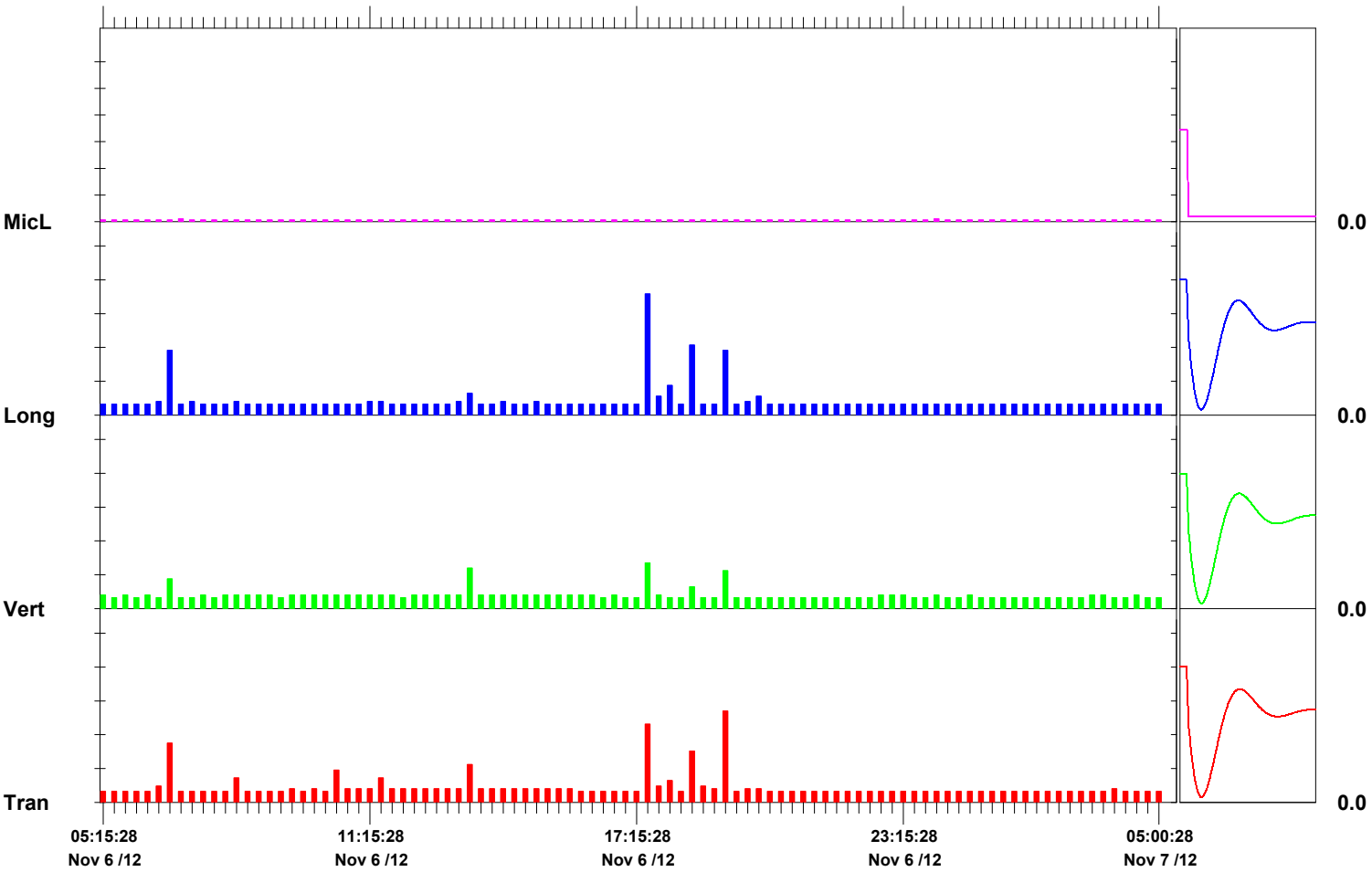
Extended Notes

Post Event Notes

Microphone Linear Weighting
PSPL <88 dB(L) 0.500 pa.(L) on November 6, 2012 at 07:00:28
ZC Freq >100 Hz
Channel Test Check (Freq = 0.0 Hz Amp = 0 mv)

	Tran	Vert	Long	
PPV	0.540	0.270	0.714	mm/s
ZC Freq	>100	>100	>100	Hz
Date	Nov 6 /12	Nov 6 /12	Nov 6 /12	
Time	19:15:28	17:30:28	17:30:28	
Sensorcheck	Passed	Passed	Passed	
Frequency	7.3	7.4	7.5	Hz
Overswing Ratio	4.0	3.7	3.7	

Peak Vector Sum 0.729 mm/s on November 6, 2012 at 17:30:28



Time Scale: 15 minutes /div **Amplitude Scale:** Geo: 0.200 mm/s/div Mic: 5.00 pa.(L)/div Sensorcheck

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Event Report

Histogram Start Time	05:00:30 November 12, 2012	**Serial Number**	BE10614 V 8.01-8.0 MiniMate Plus
Histogram Finish Time	05:00:28 November 13, 2012	**Battery Level**	6.8 Volts
Number of Intervals	95 at 15 minutes	**Calibration**	July 8, 2011 by Standards & Testing Lab.
Range	Geo :31.7 mm/s	**File Name**	L614EJIO.KU0
Sample Rate	1024sps		
Job Number:	2130		

Notes
Location:
Client:
User Name:
General:

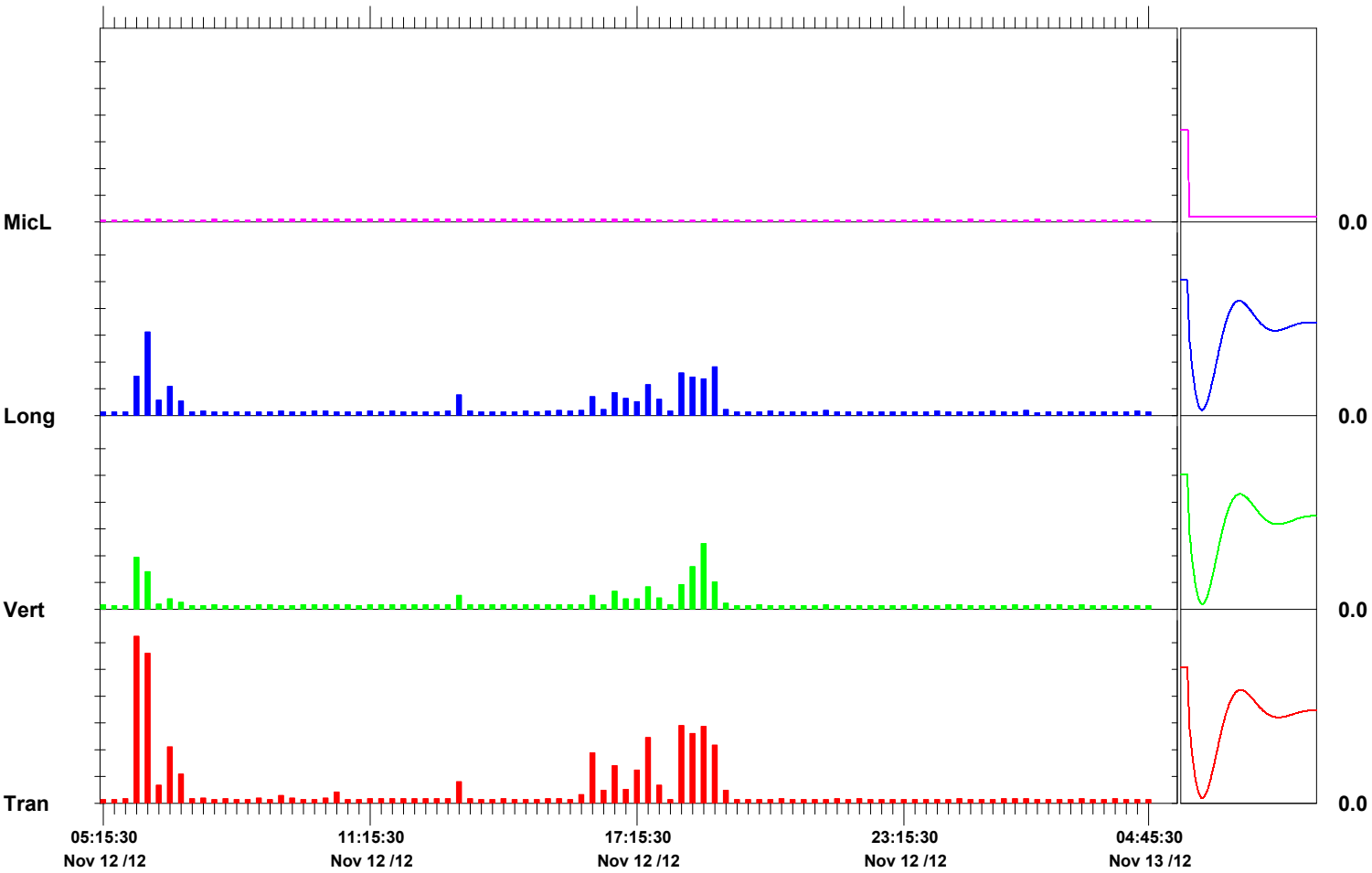
Extended Notes

Post Event Notes

Microphone Linear Weighting
PSPL <88 dB(L) 0.500 pa.(L) on November 12, 2012 at 06:15:30
ZC Freq >100 Hz
Channel Test Check (Freq = 0.0 Hz Amp = 0 mv)

	Tran	Vert	Long	
PPV	3.11	1.22	1.56	mm/s
ZC Freq	85	>100	85	Hz
Date	Nov 12 /12	Nov 12 /12	Nov 12 /12	
Time	06:00:30	18:45:30	06:15:30	
Sensorcheck	Passed	Passed	Passed	
Frequency	7.3	7.4	7.5	Hz
Overswing Ratio	4.0	3.7	3.7	

Peak Vector Sum 3.21 mm/s on November 12, 2012 at 06:00:30



Time Scale: 15 minutes /div **Amplitude Scale:** Geo: 0.500 mm/s/div Mic: 5.00 pa.(L)/div Sensorcheck

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Event Report

Histogram Start Time	09:19:33 November 14, 2012	**Serial Number**	BE10614 V 8.01-8.0 MiniMate Plus
Histogram Finish Time	05:00:28 November 15, 2012	**Battery Level**	6.8 Volts
Number of Intervals	78 at 15 minutes	**Calibration**	July 8, 2011 by Standards & Testing Lab.
Range	Geo :31.7 mm/s	**File Name**	L614EJMP.WL0
Sample Rate	1024sps		
Job Number:	2130		

Notes
Location:
Client:
User Name:
General:

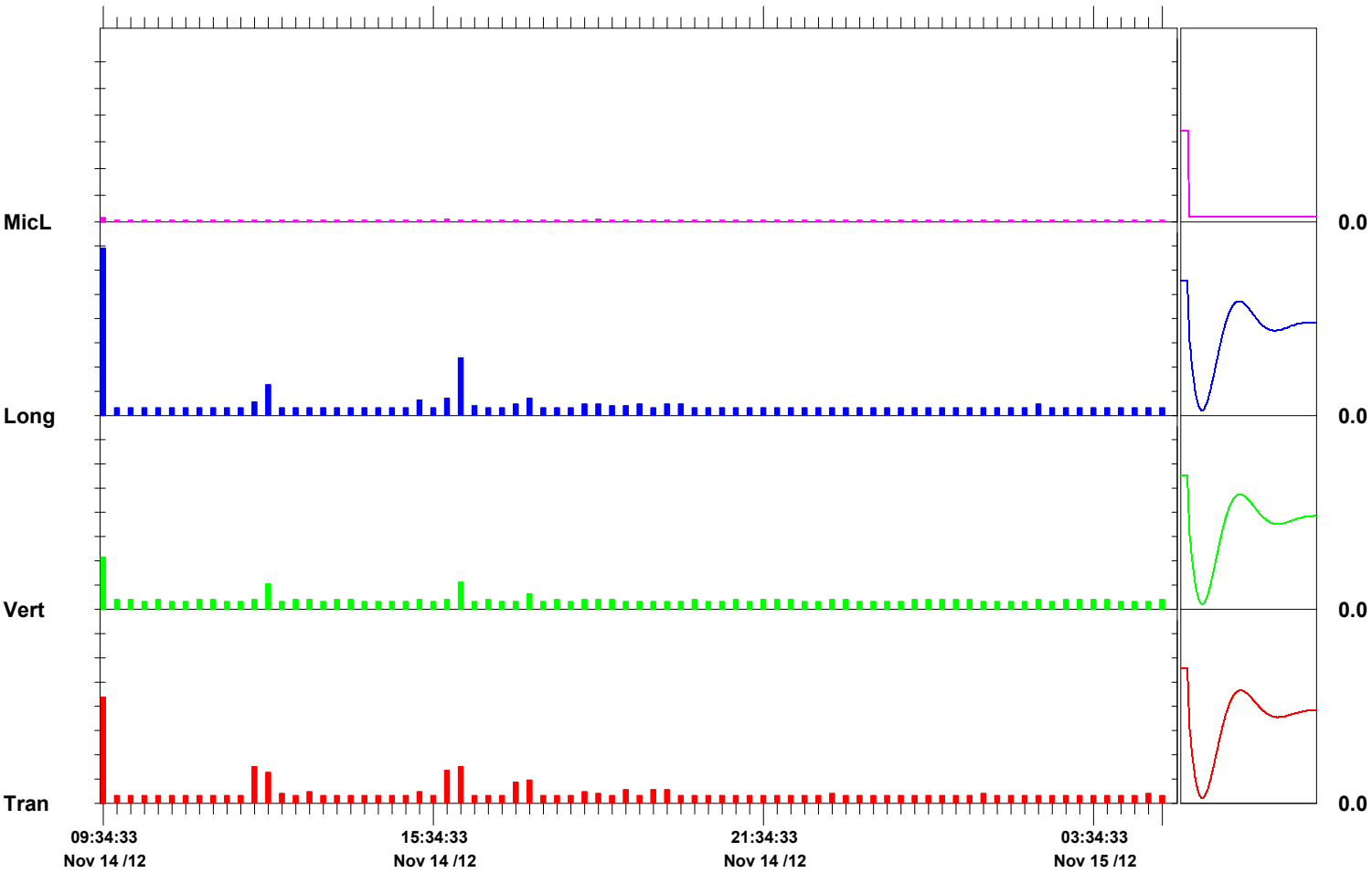
Extended Notes

Post Event Notes

Microphone Linear Weighting
PSPL 91.5 dB(L) 0.750 pa.(L) on November 14, 2012 at 09:34:33
ZC Freq 73 Hz
Channel Test Check (Freq = 0.0 Hz Amp = 0 mv)

	Tran	Vert	Long	
PPV	0.873	0.429	1.38	mm/s
ZC Freq	>100	>100	64	Hz
Date	Nov 14 /12	Nov 14 /12	Nov 14 /12	
Time	09:34:33	09:34:33	09:34:33	
Sensorcheck	Passed	Passed	Passed	
Frequency	7.3	7.4	7.5	Hz
Overswing Ratio	4.1	3.7	3.8	

Peak Vector Sum 1.50 mm/s on November 14, 2012 at 09:34:33



Time Scale: 15 minutes /div **Amplitude Scale:** Geo: 0.200 mm/s/div Mic: 5.00 pa.(L)/div Sensorcheck

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Event Report

Histogram Start Time	05:00:29 December 8, 2012	**Serial Number**	BE10614 V 8.01-8.0 MiniMate Plus
Histogram Finish Time	05:00:28 December 9, 2012	**Battery Level**	6.7 Volts
Number of Intervals	95 at 15 minutes	**Calibration**	July 8, 2011 by Standards & Testing Lab.
Range	Geo :31.7 mm/s	**File Name**	L614EKUT.WT0
Sample Rate	1024sps		
Job Number:	2130		

Notes
Location:
Client:
User Name:
General:

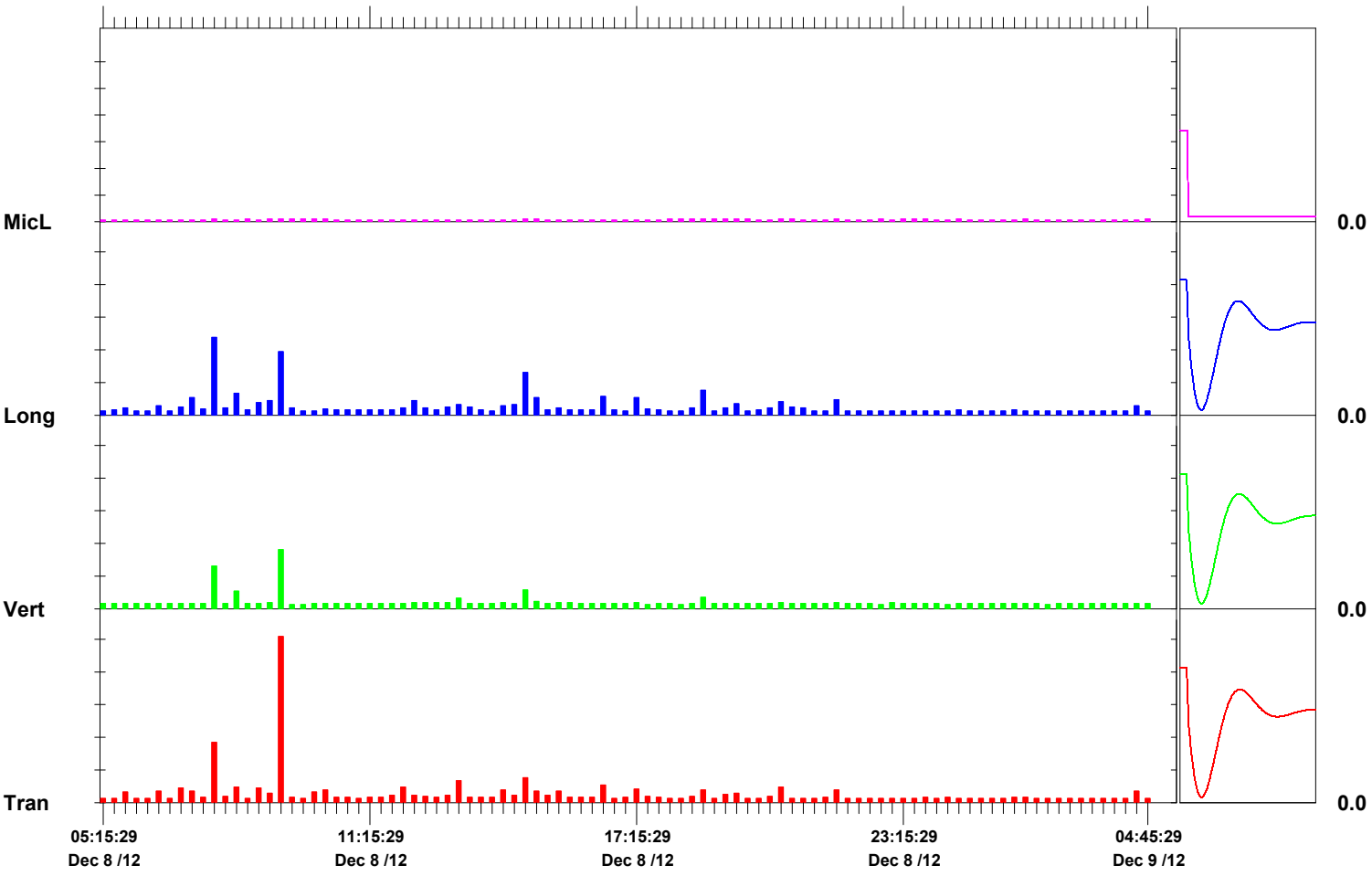
Extended Notes

Post Event Notes

Microphone Linear Weighting
PSPL <88 dB(L) 0.500 pa.(L) on December 8, 2012 at 07:45:29
ZC Freq >100 Hz
Channel Test Check (Freq = 0.0 Hz Amp = 0 mv)

	Tran	Vert	Long	
PPV	2.54	0.905	1.19	mm/s
ZC Freq	73	>100	85	Hz
Date	Dec 8 /12	Dec 8 /12	Dec 8 /12	
Time	09:15:29	09:15:29	07:45:29	
Sensorcheck	Passed	Passed	Passed	
Frequency	7.4	7.4	7.5	Hz
Overswing Ratio	4.0	3.7	3.8	

Peak Vector Sum 2.65 mm/s on December 8, 2012 at 09:15:29



Time Scale: 15 minutes /div **Amplitude Scale:** Geo: 0.500 mm/s/div Mic: 5.00 pa.(L)/div Sensorcheck

Printed: December 11, 2012 (V 8.12 - 8.12) **Format Copyrighted 2006-2007 Instantel, a division of VeriChip Corporation**

Appendix B

Event Report

Histogram Start Time	23:59:28 August 28, 2012	**Serial Number**	BE10608 V 8.01-8.0 MiniMate Plus
Histogram Finish Time	23:59:28 August 29, 2012	**Battery Level**	6.8 Volts
Number of Intervals	96 at 15 minutes	**Calibration**	July 19, 2011 by Standards & Testing Lab.
Range	Geo :31.7 mm/s	**File Name**	L608EFNE.N40
Sample Rate	1024sps		
Job Number:	2130		

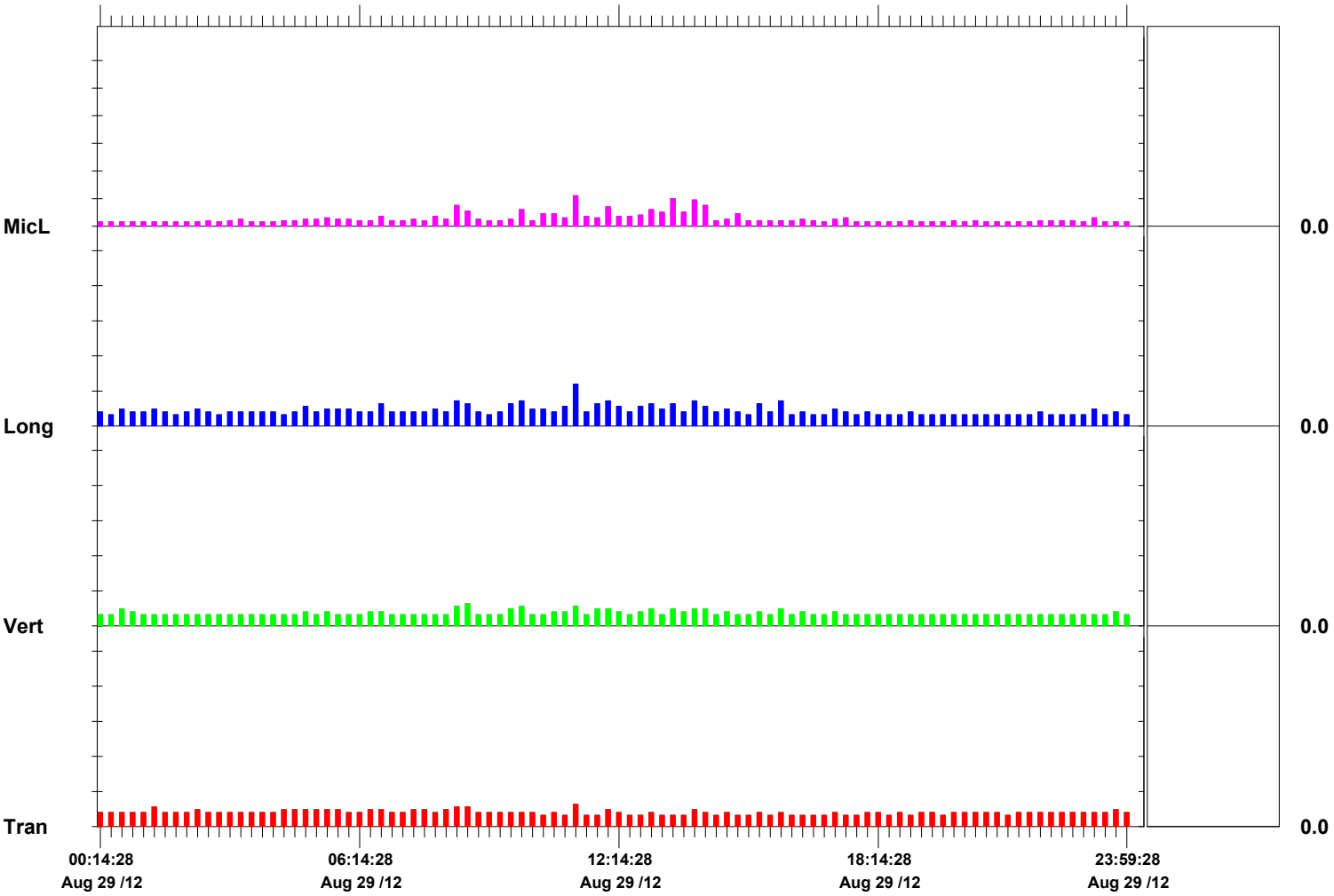
Notes
Location:
Client:
User Name:
General:

Post Event Notes

Microphone Linear Weighting
PSPL 108.8 dB(L) 5.50 pa.(L) on August 29, 2012 at 11:14:28
ZC Freq 64 Hz
Channel Test Disabled

	Tran	Vert	Long	
PPV	0.127	0.127	0.238	mm/s
ZC Freq	32	22	28	Hz
Date	Aug 29 /12	Aug 29 /12	Aug 29 /12	
Time	11:14:28	08:44:28	11:14:28	
Sensorcheck	Disabled	Disabled	Disabled	
Frequency	***	***	***	Hz
Overswing Ratio	***	***	***	

Peak Vector Sum 0.248 mm/s on August 29, 2012 at 11:14:28



Time Scale: 15 minutes /div **Amplitude Scale:** Geo: 0.200 mm/s/div Mic: 5.00 pa.(L)/div Sensorcheck

Printed: December 5, 2012 (V 8.12 - 8.12) **Format Copyrighted 2006-2007 Instantel, a division of VeriChip Corporation**

Event Report

Histogram Start Time	23:59:28 August 29, 2012	**Serial Number**	BE10608 V 8.01-8.0 MiniMate Plus
Histogram Finish Time	23:59:28 August 30, 2012	**Battery Level**	6.8 Volts
Number of Intervals	96 at 15 minutes	**Calibration**	July 19, 2011 by Standards & Testing Lab.
Range	Geo :31.7 mm/s	**File Name**	L608EFP9.B40
Sample Rate	1024sps		
Job Number:	2130		

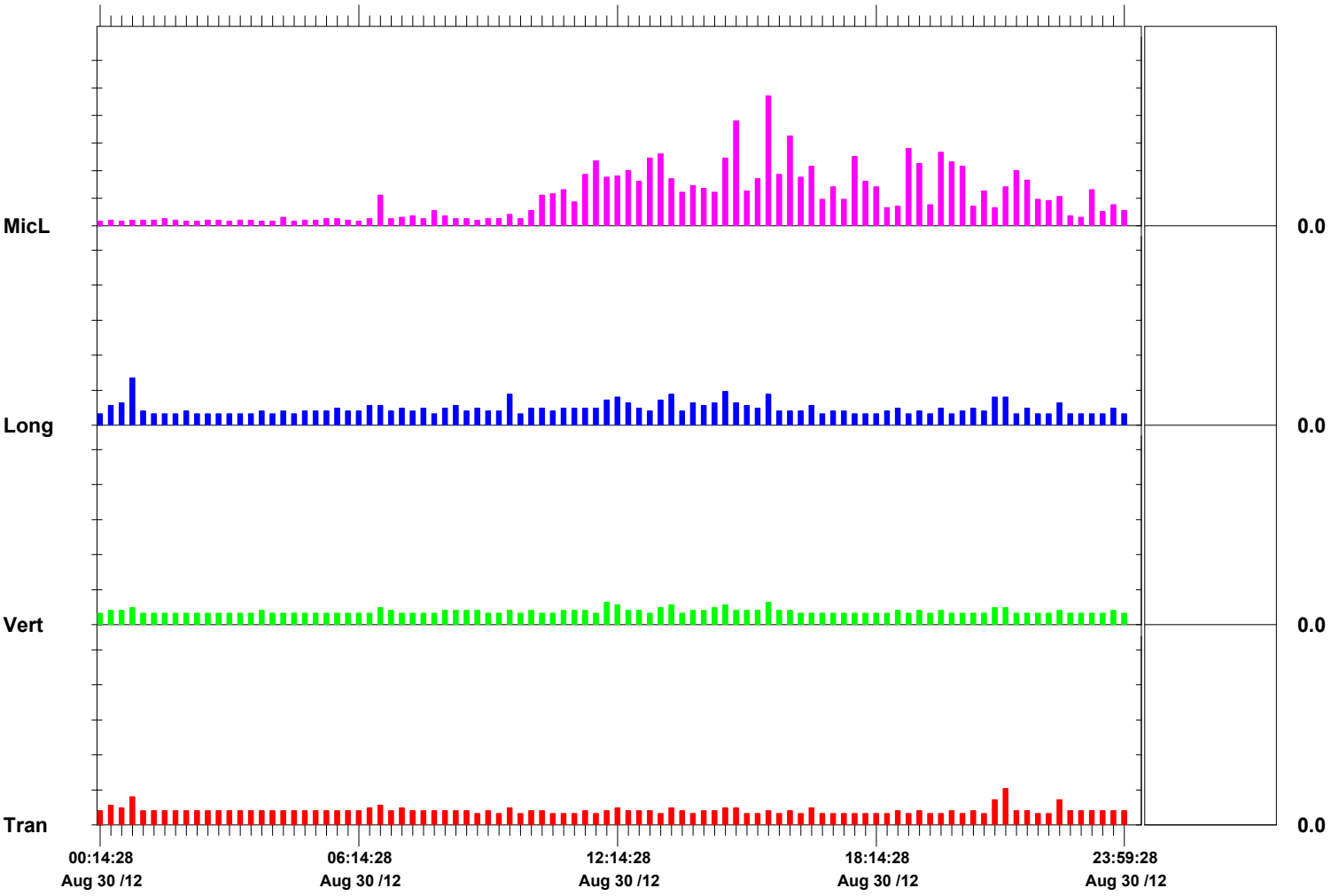
Notes
Location:
Client:
User Name:
General:

Post Event Notes

Microphone Linear Weighting
PSPL 121.4 dB(L) 23.5 pa.(L) on August 30, 2012 at 15:44:28
ZC Freq 9.7 Hz
Channel Test Disabled

	Tran	Vert	Long	
PPV	0.206	0.127	0.270	mm/s
ZC Freq	14	22	12	Hz
Date	Aug 30 /12	Aug 30 /12	Aug 30 /12	
Time	21:14:28	11:59:28	00:59:28	
Sensorcheck	Disabled	Disabled	Disabled	
Frequency	***	***	***	Hz
Overswing Ratio	***	***	***	

Peak Vector Sum 0.290 mm/s on August 30, 2012 at 00:59:28



Time Scale: 15 minutes /div **Amplitude Scale:** Geo: 0.200 mm/s/div Mic: 5.00 pa.(L)/div Sensorcheck

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Event Report

Histogram Start Time	23:59:28 August 30, 2012	**Serial Number**	BE10608 V 8.01-8.0 MiniMate Plus
Histogram Finish Time	23:59:28 August 31, 2012	**Battery Level**	6.8 Volts
Number of Intervals	96 at 15 minutes	**Calibration**	July 19, 2011 by Standards & Testing Lab.
Range	Geo :31.7 mm/s	**File Name**	L608EFR3.Z40
Sample Rate	1024sps		
Job Number:	2130		

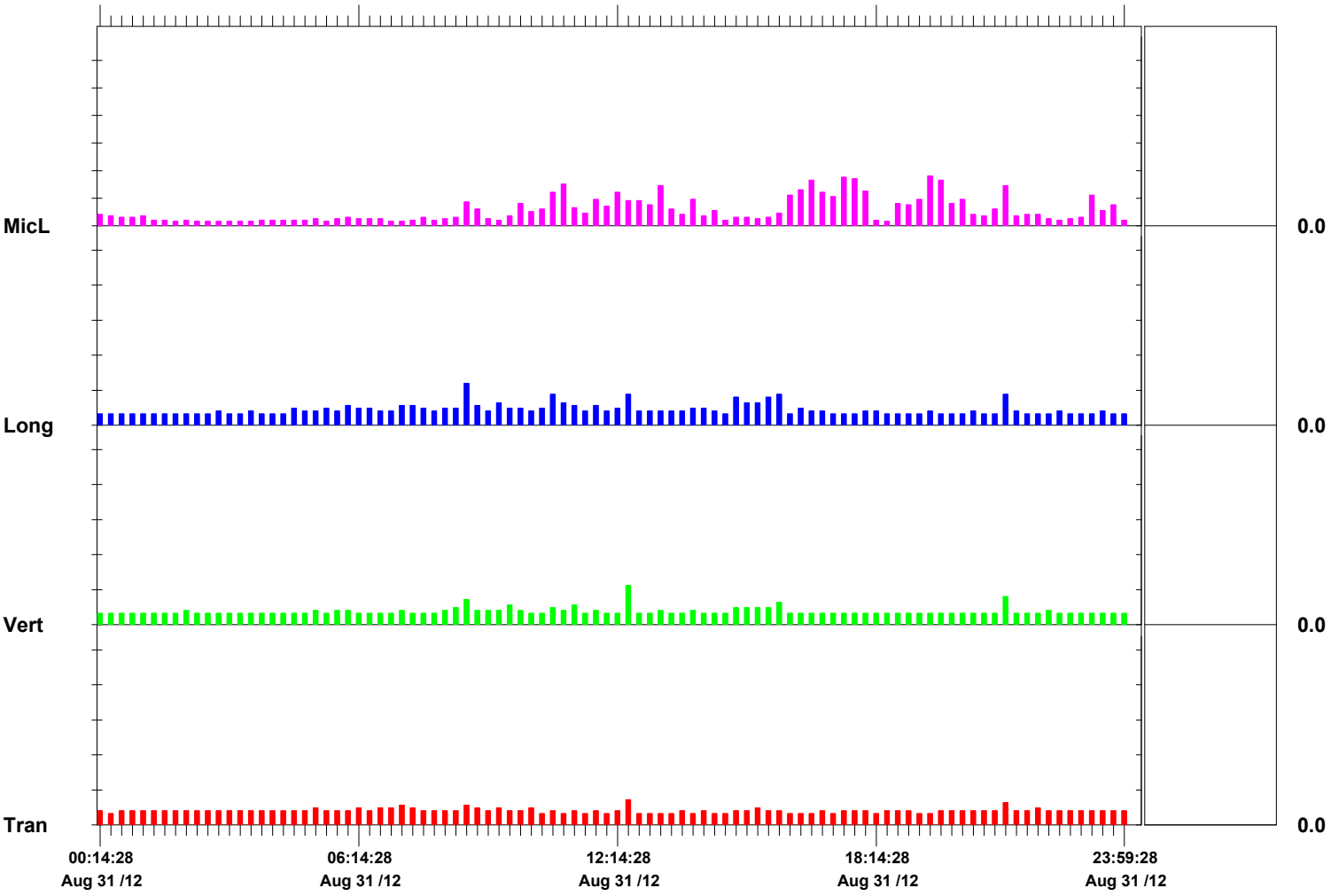
Notes
Location:
Client:
User Name:
General:

Post Event Notes

Microphone Linear Weighting
PSPL 113.1 dB(L) 9.00 pa.(L) on August 31, 2012 at 19:29:28
ZC Freq 11 Hz
Channel Test Disabled

	Tran	Vert	Long	
PPV	0.143	0.222	0.238	mm/s
ZC Freq	23	20	30	Hz
Date	Aug 31 /12	Aug 31 /12	Aug 31 /12	
Time	12:29:28	12:29:28	08:44:28	
Sensorcheck	Disabled	Disabled	Disabled	
Frequency	***	***	***	Hz
Overswing Ratio	***	***	***	

Peak Vector Sum 0.268 mm/s on August 31, 2012 at 08:44:28



Time Scale: 15 minutes /div **Amplitude Scale:** Geo: 0.200 mm/s/div Mic: 5.00 pa.(L)/div Sensorcheck

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Event Report

Histogram Start Time	11:53:47 September 6, 2012	**Serial Number**	BE10608 V 8.01-8.0 MiniMate Plus
Histogram Finish Time	23:59:28 September 6, 2012	**Battery Level**	6.8 Volts
Number of Intervals	48 at 15 minutes	**Calibration**	July 19, 2011 by Standards & Testing Lab.
Range	Geo :31.7 mm/s	**File Name**	L608EG35.1N0
Sample Rate	1024sps		
Job Number:	2130		

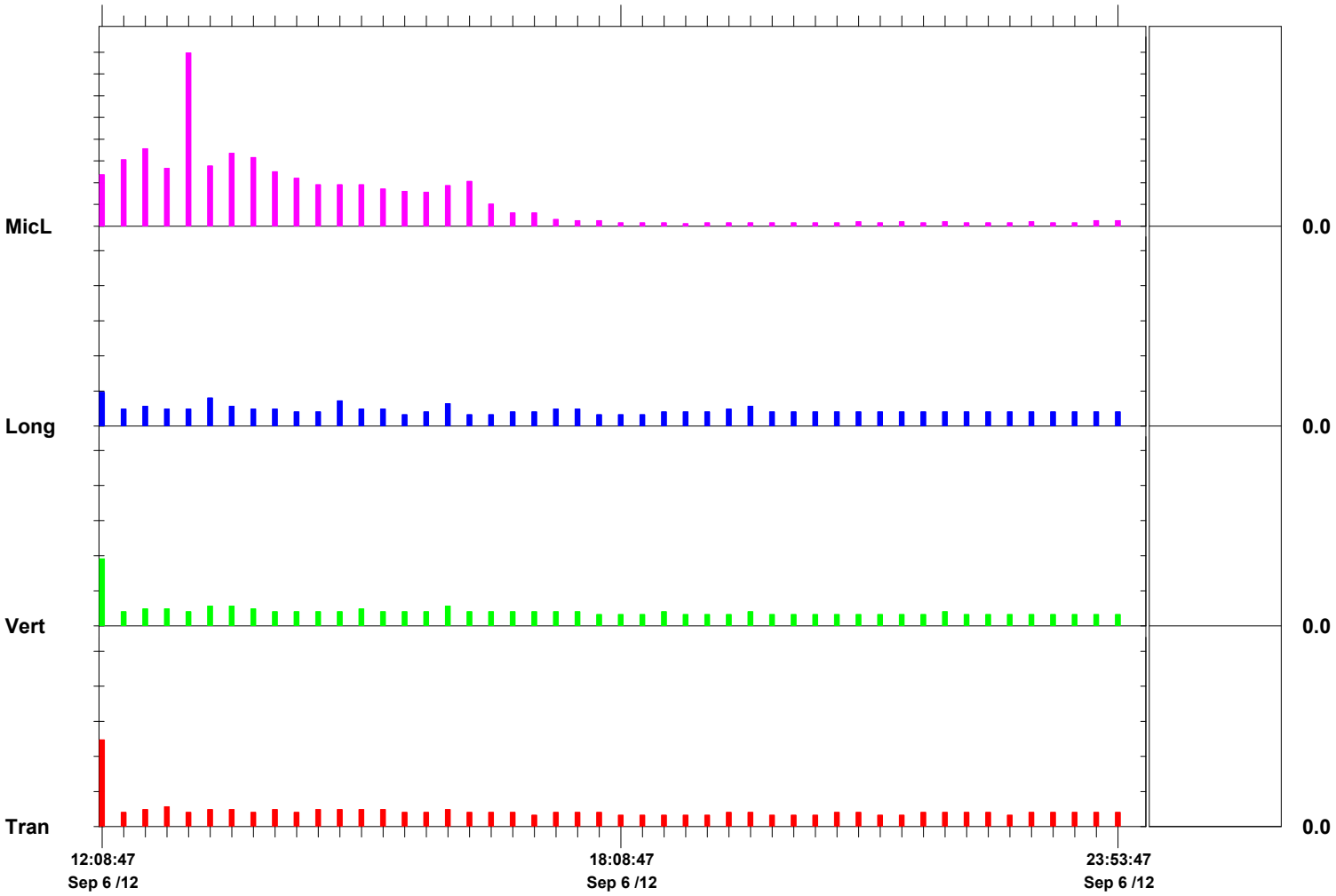
Notes
Location:
Client:
User Name:
General:

Post Event Notes

Microphone Linear Weighting
PSPL 126.0 dB(L) 39.8 pa.(L) on September 6, 2012 at 13:08:47
ZC Freq 4.8 Hz
Channel Test Disabled

	Tran	Vert	Long	
PPV	0.492	0.381	0.190	mm/s
ZC Freq	>100	>100	>100	Hz
Date	Sep 6 /12	Sep 6 /12	Sep 6 /12	
Time	12:08:47	12:08:47	12:08:47	
Sensorcheck	Disabled	Disabled	Disabled	
Frequency	***	***	***	Hz
Overswing Ratio	***	***	***	

Peak Vector Sum 0.611 mm/s on September 6, 2012 at 12:08:47



Time Scale: 15 minutes /div **Amplitude Scale:** Geo: 0.200 mm/s/div Mic: 5.00 pa.(L)/div Sensorcheck

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Event Report

Histogram Start Time	23:59:28 September 19, 2012	**Serial Number**	BE10608 V 8.01-8.0 MiniMate Plus
Histogram Finish Time	12:56:13 September 20, 2012	**Battery Level**	6.8 Volts
Number of Intervals	51 at 15 minutes	**Calibration**	July 19, 2011 by Standards & Testing Lab.
Range	Geo :31.7 mm/s	**File Name**	L608EGS5.B40
Sample Rate	1024sps		
Job Number:	2130		

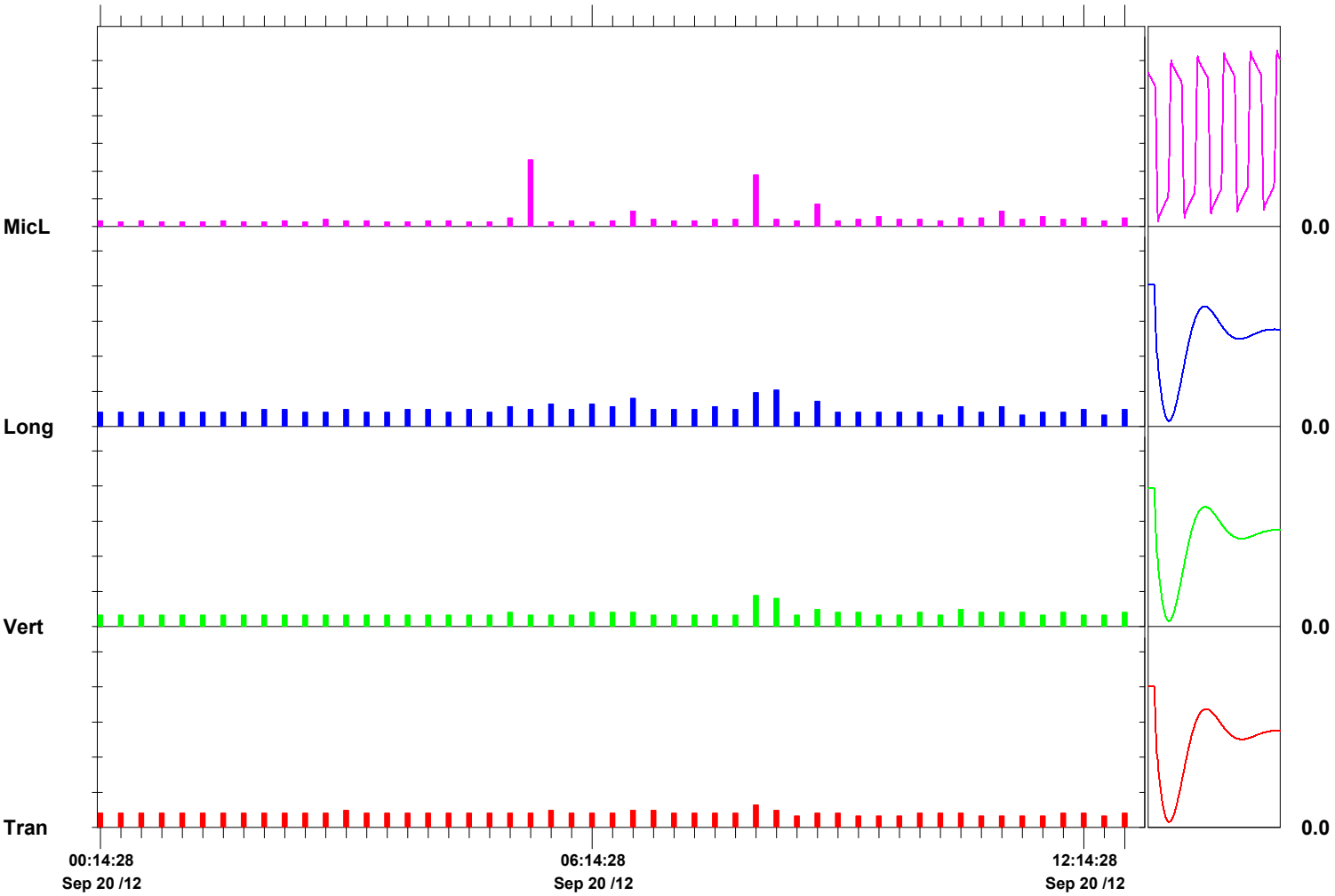
Notes
Location:
Client:
User Name:
General:

Post Event Notes

Microphone Linear Weighting
PSPL 115.6 dB(L) 12.0 pa.(L) on September 20, 2012 at 05:29:28
ZC Freq 9.1 Hz
Channel Test Passed (Freq = 20.1 Hz Amp = 549 mv)

	Tran	Vert	Long	
PPV	0.127	0.175	0.206	mm/s
ZC Freq	20	34	26	Hz
Date	Sep 20 /12	Sep 20 /12	Sep 20 /12	
Time	08:14:28	08:14:28	08:29:28	
Sensorcheck	Passed	Passed	Passed	
Frequency	7.3	7.5	7.5	Hz
Overswing Ratio	3.8	3.6	3.5	

Peak Vector Sum 0.232 mm/s on September 20, 2012 at 08:29:28



Time Scale: 15 minutes /div **Amplitude Scale:** Geo: 0.200 mm/s/div Mic: 5.00 pa.(L)/div Sensorcheck

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Event Report

Histogram Start Time	13:07:16 September 20, 2012	**Serial Number**	BE10608 V 8.01-8.0 MiniMate Plus
Histogram Finish Time	23:59:28 September 20, 2012	**Battery Level**	6.8 Volts
Number of Intervals	43 at 15 minutes	**Calibration**	July 19, 2011 by Standards & Testing Lab.
Range	Geo :31.7 mm/s	**File Name**	L608EGT5.S40
Sample Rate	1024sps		
Job Number:	2130		

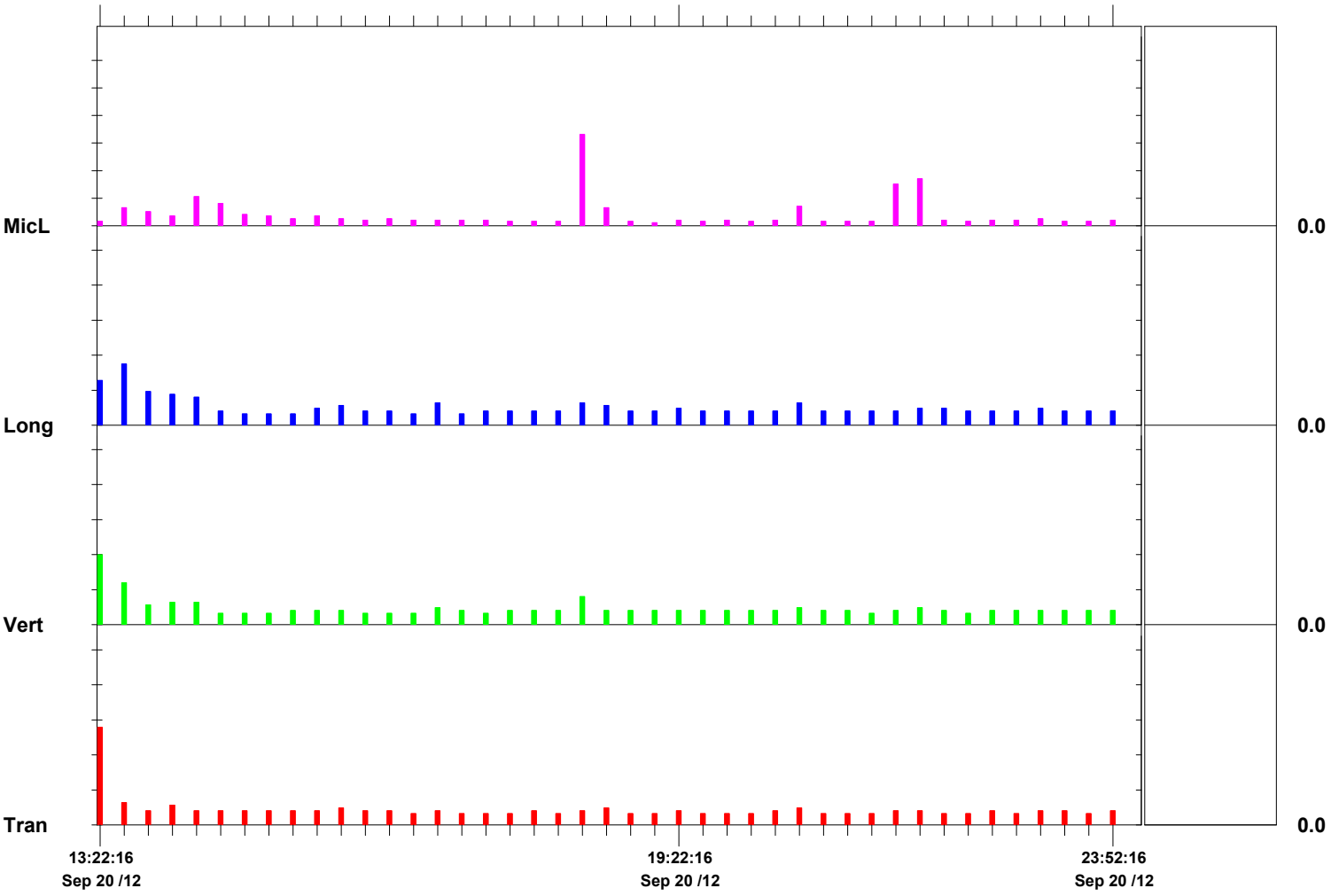
Notes
Location:
Client:
User Name:
General:

Post Event Notes

Microphone Linear Weighting
PSPL 118.3 dB(L) 16.5 pa.(L) on September 20, 2012 at 18:22:16
ZC Freq 73 Hz
Channel Test Disabled

	Tran	Vert	Long	
PPV	0.556	0.397	0.349	mm/s
ZC Freq	>100	>100	30	Hz
Date	Sep 20 /12	Sep 20 /12	Sep 20 /12	
Time	13:22:16	13:22:16	13:37:16	
Sensorcheck	Disabled	Disabled	Disabled	
Frequency	***	***	***	Hz
Overswing Ratio	***	***	***	

Peak Vector Sum 0.683 mm/s on September 20, 2012 at 13:22:16



Time Scale: 15 minutes /div **Amplitude Scale:** Geo: 0.200 mm/s/div Mic: 5.00 pa.(L)/div Sensorcheck

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Event Report

Histogram Start Time	10:30:11 October 17, 2012	**Serial Number**	BE10608 V 8.01-8.0 MiniMate Plus
Histogram Finish Time	09:12:52 October 31, 2012	**Battery Level**	6.8 Volts
Number of Intervals	1338 at 15 minutes	**Calibration**	July 19, 2011 by Standards & Testing Lab.
Range	Geo :31.7 mm/s	**File Name**	L608EI6Y.IB0
Sample Rate	1024sps		
Job Number:	1		

Notes
Location:
Client:
User Name:
General:

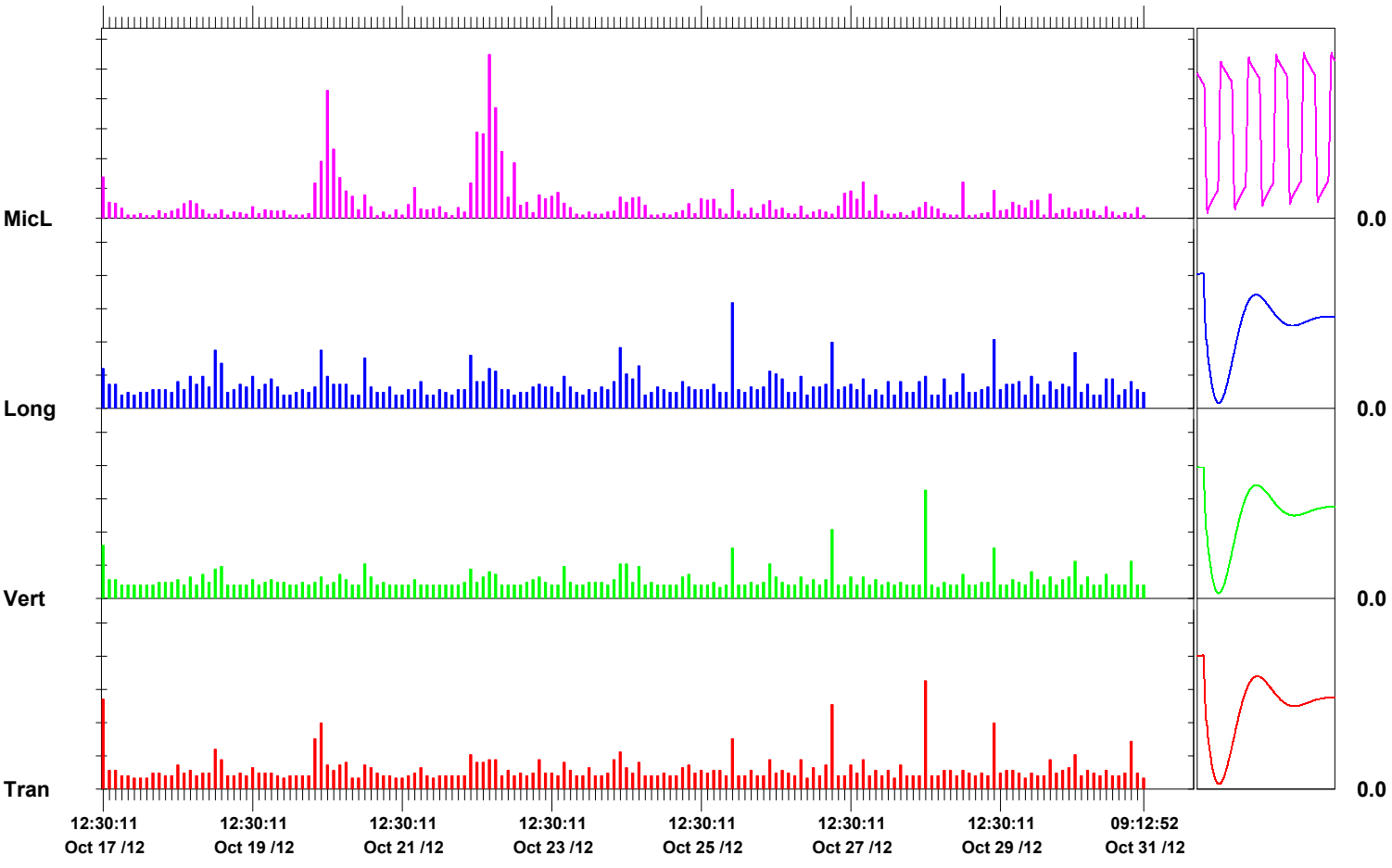
Extended Notes
Offset correction event recorded with all channels at 1x gain.

Post Event Notes

Microphone Linear Weighting
PSPL 128.7 dB(L) 54.8 pa.(L) on October 22, 2012 at 16:15:11
ZC Freq 7.8 Hz
Channel Test Passed (Freq = 20.1 Hz Amp = 486 mv)

	Tran	Vert	Long	
PPV	0.651	0.651	0.635	mm/s
ZC Freq	>100	>100	28	Hz
Date	Oct 28 /12	Oct 28 /12	Oct 25 /12	
Time	11:00:11	11:00:11	21:45:11	
Sensorcheck	Passed	Passed	Passed	
Frequency	7.4	7.6	7.6	Hz
Overswing Ratio	3.7	3.6	3.5	

Peak Vector Sum 0.920 mm/s on October 28, 2012 at 11:00:11



Time Scale: 2 hours /div **Amplitude Scale:** Geo: 0.200 mm/s/div Mic: 10.00 pa.(L)/div Sensorcheck

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Event Report

Histogram Start Time	09:22:20 October 31, 2012	**Serial Number**	BE10608 V 8.01-8.0 MiniMate Plus
Histogram Finish Time	09:36:09 November 14, 2012	**Battery Level**	6.8 Volts
Number of Intervals	1344 at 15 minutes	**Calibration**	July 19, 2011 by Standards & Testing Lab.
Range	Geo :31.7 mm/s	**File Name**	L608EIWS.P80
Sample Rate	1024sps		
Job Number:	1		

Notes
Location:
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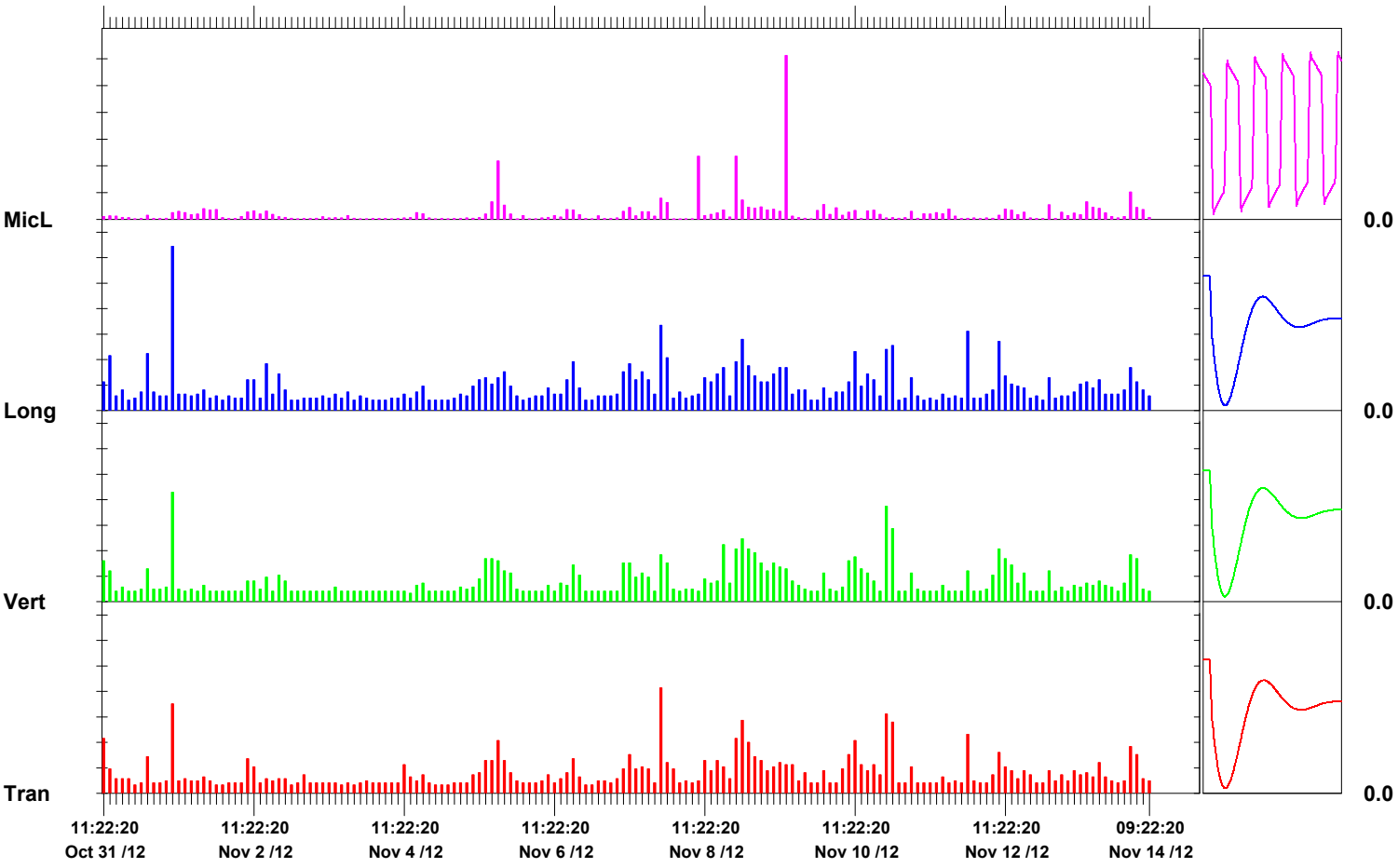
Extended Notes
Offset correction event recorded with all channels at 1x gain.

Post Event Notes

Microphone Linear Weighting
PSPL 143.7 dB(L) 306 pa.(L) on November 9, 2012 at 12:22:20
ZC Freq 6.3 Hz
Channel Test Passed (Freq = 20.1 Hz Amp = 544 mv)

	Tran	Vert	Long	
PPV	0.825	0.857	1.29	mm/s
ZC Freq	>100	28	27	Hz
Date	Nov 7 /12	Nov 1 /12	Nov 1 /12	
Time	20:37:20	08:22:20	08:22:20	
Sensorcheck	Passed	Passed	Passed	
Frequency	7.3	7.5	7.5	Hz
Overswing Ratio	3.7	3.6	3.6	

Peak Vector Sum 1.37 mm/s on November 1, 2012 at 08:22:20



Time Scale: 2 hours /div **Amplitude Scale:** Geo: 0.200 mm/s/div Mic: 50.0 pa.(L)/div Sensorcheck

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Event Report

Histogram Start Time	09:43:06 November 14, 2012	**Serial Number**	BE10608 V 8.01-8.0 MiniMate Plus
Histogram Finish Time	09:29:40 November 28, 2012	**Battery Level**	6.8 Volts
Number of Intervals	1343 at 15 minutes	**Calibration**	July 19, 2011 by Standards & Testing Lab.
Range	Geo :31.7 mm/s	**File Name**	L608EJMQ.ZU0
Sample Rate	1024sps		
Job Number:	1		

Notes
Location:
Client:
User Name:
General:

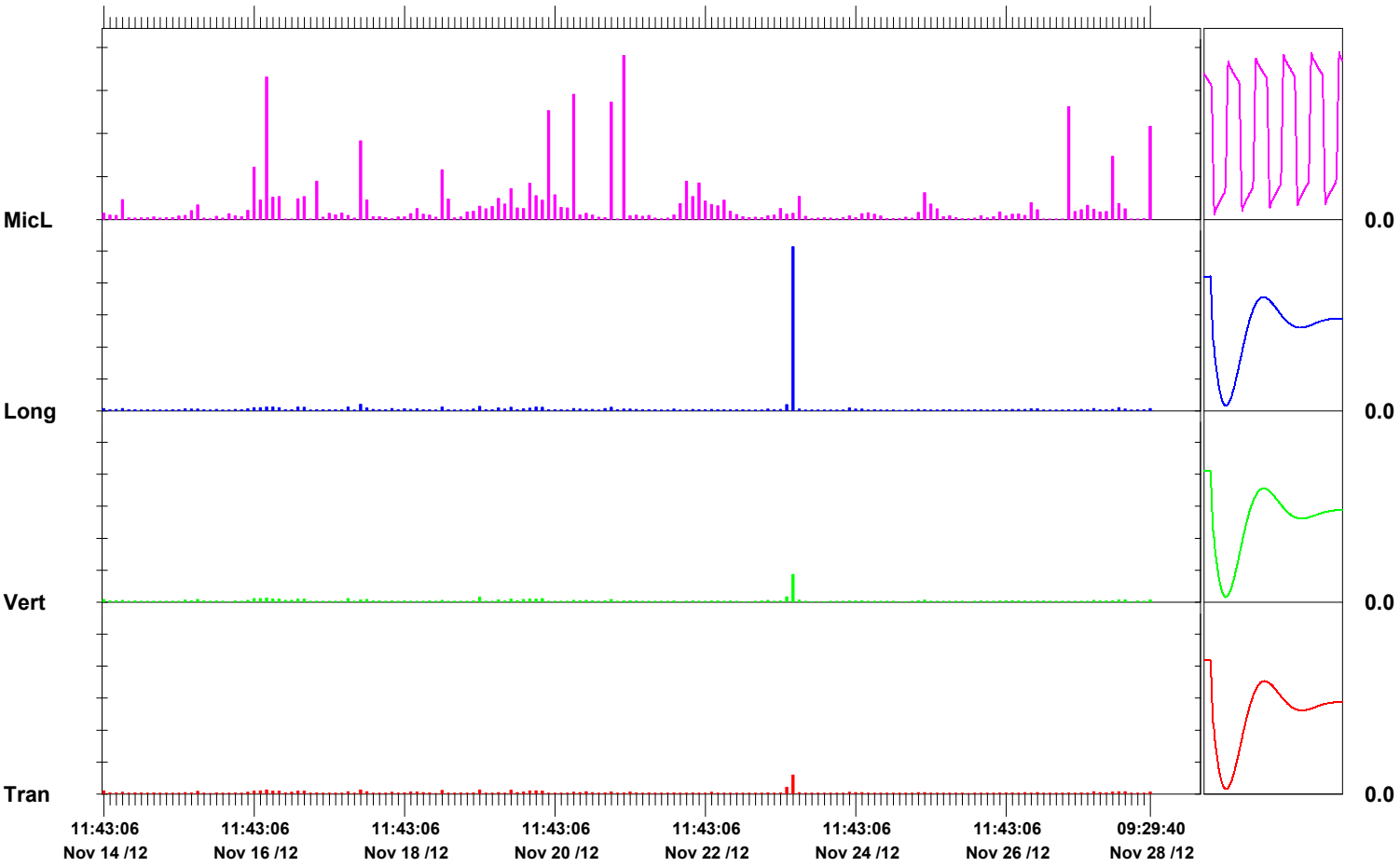
Extended Notes
Offset correction event recorded with all channels at 1x gain.

Post Event Notes

Microphone Linear Weighting
PSPL 139.6 dB(L) 190 pa.(L) on November 21, 2012 at 08:43:06
ZC Freq 6.0 Hz
Channel Test Passed (Freq = 20.1 Hz Amp = 573 mv)

	Tran	Vert	Long	
PPV	2.94	4.29	25.6	mm/s
ZC Freq	>100	43	57	Hz
Date	Nov 23 /12	Nov 23 /12	Nov 23 /12	
Time	15:43:06	15:43:06	15:43:06	
Sensorcheck	Passed	Passed	Passed	
Frequency	7.3	7.5	7.5	Hz
Overswing Ratio	3.7	3.6	3.6	

Peak Vector Sum 26.0 mm/s on November 23, 2012 at 15:43:06



Time Scale: 2 hours /div **Amplitude Scale:** Geo: 5.00 mm/s/div Mic: 50.0 pa.(L)/div Sensorcheck

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Event Report

Histogram Start Time	14:20:58 December 7, 2012	**Serial Number**	BE10608 V 8.01-8.0 MiniMate Plus
Histogram Finish Time	09:24:00 December 11, 2012	**Battery Level**	6.8 Volts
Number of Intervals	364 at 15 minutes	**Calibration**	July 19, 2011 by Standards & Testing Lab.
Range	Geo :31.7 mm/s	**File Name**	L608EKTP.6Y0
Sample Rate	1024sps		
Job Number:	1		

Notes
Location:
Client:
User Name:
General:

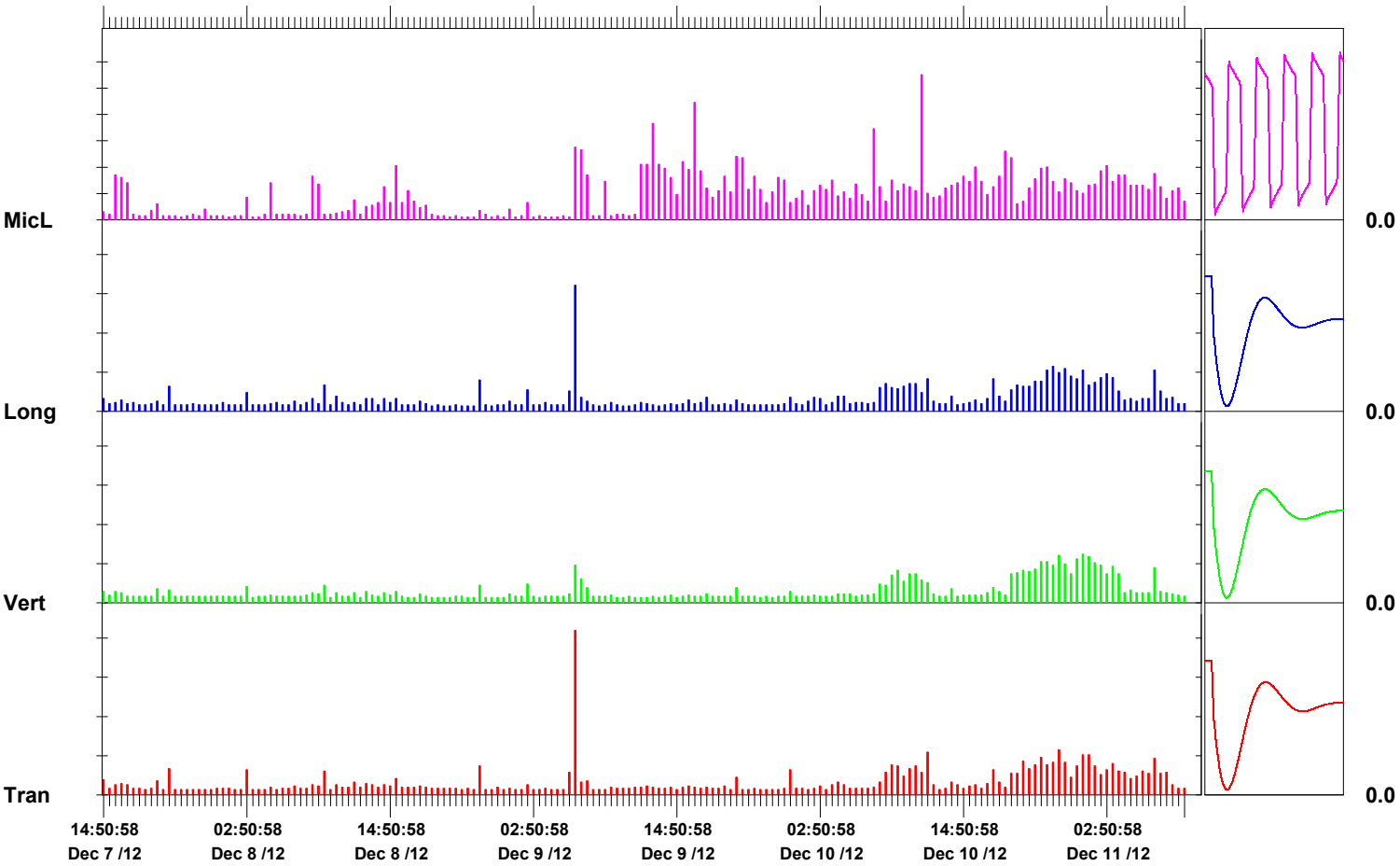
Extended Notes
Offset correction event recorded with all channels at 1x gain.

Post Event Notes

Microphone Linear Weighting
PSPL 122.8 dB(L) 27.5 pa.(L) on December 10, 2012 at 11:20:58
ZC Freq 5.8 Hz
Channel Test Passed (Freq = 20.1 Hz Amp = 570 mv)

	Tran	Vert	Long	
PPV	2.10	0.619	1.60	mm/s
ZC Freq	>100	24	>100	Hz
Date	Dec 9 /12	Dec 11 /12	Dec 9 /12	
Time	06:20:58	00:50:58	06:20:58	
Sensorcheck	Passed	Passed	Passed	
Frequency	7.4	7.5	7.5	Hz
Overswing Ratio	3.8	3.7	3.7	

Peak Vector Sum 2.25 mm/s on December 9, 2012 at 06:20:58



Time Scale: 30 minutes /div **Amplitude Scale:** Geo: 0.500 mm/s/div Mic: 5.00 pa.(L)/div Sensorcheck

Printed: December 11, 2012 (V 8.12 - 8.12) **Format Copyrighted 2006-2007 Instantel, a division of VeriChip Corporation**

APPENDIX 9
Floodpath Condition Report 2012

Centennial Mandalong Mine Floodpath Condition Report 2012

For the Period 1 January 2012 to 31 December 2012

Owned & Operated by Centennial Mandalong
ABN 74101 508 892
(dated February 2013)



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	Author:	Jeff Dunwoodie
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	G Summerhayes	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 F3 Freeway 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.

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 mined beneath by longwall panel twelve and thirteen in 2012 and previously subsided longwall panels one to eleven, identifying the effects of subsidence on the floodpaths. The pre-mining condition of the floodpaths above longwall panels fourteen and fifteen is also documented in this report.

1.3 Predicated Changes to Streams and Flooding Regime

Longwall panels twelve and thirteen were mined beneath Stockton Creek in 2012. In this area the longwall panel is mined beneath the middle 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 metres to 25 metres and typical channel depths of 1.0 metres to 2.0 metres (Hughes Trueman 2004).

The creek meanders considerably through these areas and as such a length of approximately 800 m and 560 m was undermined by longwall panels 12 and 13. The maximum predicted subsidence in the vicinity of Stockton Creek longwall panels 12 and 13 is approximately 651mm & 249mm with a predicted maximum differential subsidence (from the chain pillar to the centre of the longwall) of approximately 643mm and 96 mm. Umwelt (2009) in the flood model reported that this equated to a predicted grade change along these reaches of Stockton Creek of 0.26 % and 0.16 % over longwall panels 12 and 13.

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 28 & 29 June 2012 and 17 and 18 December 2012.

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 Four 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 Panel Fourteen and Fifteen

3.1.1 Pre-mining Survey Assessment

Monitoring points 50 & 51 (Appendix 3) are located above Maingate fourteen and are typical of the stream reach above longwall panel 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). Longwall panel 14 is expected to mine beneath Stockton Creek in the first half of 2013 and subsidence related changes will be assessed in the June and December 2013 inspections.

3.2 Stockton Creek (Main Tributary) Longwall Panel Twelve and Thirteen

3.2.1 Pre-mining Survey Assessment

Monitoring points 46 & 47 presented in Appendix 3 above Maingate twelve are typical of the stream reach above longwall panel 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 consists for 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) Longwall panel 12 is expected to mine beneath Stockton Creek is the first half of 2012 and subsidence related changes will be assessed in the July 2012 inspections.

Monitoring points 48 & 49 (Appendix 3) are located above Maingate thirteen and are typical of the stream reach above longwall panel 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 post-mining survey in December 2012 observed minor flows above longwall panel 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 panel eleven. Evidence of subsidence induced soil cracking or additional erosion on the stream's banks or bed were not observed at this monitoring point following mining. The vegetation communities, Redgum Rough-bark Apple Forest (Hunter Eco 2008) and pasture species remained unchanged following mining.

3.2.3 Impact Assessment

Maximum subsidence above Longwall 12 was 456 mm recorded in October 2012 and maximum differential subsidence 321 mm 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.

Maximum subsidence above Longwall 13 was 338 mm recorded in October 2012 and maximum differential subsidence 338 mm was measured between the creek above the Maingate 13 and the center of the Longwall 13. Maximum change in stream grade of 0.25 % was recorded above Longwall 13. Stockton Creek has average pre-mining stream grades up to 0.31% along these reaches. It is expected that the 0.25% stream grade change will reduce with the extraction of Longwall 14 and the settlement of the intervening chain pillar, that typically subsides between 0.1m to 0.15m.

No visible evidence of cracking or erosion from subsidence was observed during the post-mining surveys in 2012.

There was no evidence during the 2012 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.

3.3 Stockton Creek (Main Tributary) Longwall Panel Eleven

3.3.1 Pre-mining Survey Assessment

Monitoring point 44 presented in Appendix 3 above Maingate eleven is typical of the stream reach above longwall panel 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 prevent 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 panel eleven. Evidence of subsidence induced soil cracking or additional erosion on the stream's banks or bed were not observed at this monitoring point following mining. The vegetation communities, Redgum Rough-bark Apple Forest (Hunter Eco 2008) and pasture species remained unchanged following mining.

3.1.3 Impact Assessment

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 panel. 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 2012.

There was no evidence during the 2012 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.

Remnant ponding was evident on a Centennial property above longwall panel 11 in 2011 and 2012. The ponding is located on an area of Redgum Rough-bark Apple Forest and pasture. To date no dieback of the vegetation community has occurred and an ecologist is monitoring the area to assess the effects on ponding on this vegetation community. Meetings have been held with the tenant occupying the property to discuss the works required to remediate the remnant ponding area. At present due, to limited impact from ponding, remediation works are being assessed and may be considered if required by the owner.

3.1 Stockton Creek (Main Tributary) Longwall Panels Seven to Ten

3.1.1 Pre-mining Survey Assessment

Monitoring points 27 and 35 presented in Appendix 3 above Maingates seven to ten are typical of the stream reach above longwall panels eight to ten. 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 eight is monitored at points 30 and 31 consisting of undefined or less than 1 m high banks. The stream reach above longwalls nine and ten observed at monitoring Points 41 to 43 (Maingates nine and ten) 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 panels eight to ten due to rainfall events at the time (refer to photos of monitoring points 27 to 43 in Appendix 3). 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 panels eight to ten. Evidence of subsidence induced soil cracking or additional erosion on the stream's banks or bed were not observed at these monitoring points following mining in 2011 or 2012.

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 2011 and 2012.

3.1.3 Impact Assessment

While there has been no subsidence monitoring along Stockton Creek over Longwalls 1 to 10 during 2012, subsidence monitoring over the major crosslines and centerlines have shown that subsidence has been stable up to Longwall 10. Only minor movements of less than 30mm have been recorded over Longwall 11.

Subsidence above longwall panels eight and nine is stable with 452mm & 439mm recorded in September 2011. Subsidence above longwall panel ten 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 seven, eight and nine. 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 2012.

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 panel seven, eight and nine when taking into consideration the average bank heights of up to 0.5 -2 m. There was no evidence during the 2012 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 2012 inspections on the flood plain in a limited area above longwall panels seven to nine situated on an existing low lying area of Centennial property. The area consists of exotic pasture species primarily used for horse grazing.

The Mine applied to install sub-surface drainage in these areas in November 2010 when initially identified. Meetings were held with the NSW Office of Water in 2011 to progress the applications for a controlled works permit to excavate near the creek bank. No response to the applications has been received from NSW Office of Water to date.

3.2 Stockton Creek (Main Tributary) Longwall Panel Four to Six

3.2.1 Pre-mining Survey Assessment

The results of pre-mining surveys undertaken in 2007 above longwall panel six indicate that the 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 3 are typical of baseline conditions for this reach above longwall panel six, 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 panels four and five was undertaken in April 2007. The survey indicated that above longwall panel five Stockton Creek is characterised as, shown in the photos of monitoring points 4 and 5 (refer to Appendix 3) with a wider channel between 15-20 m and bank heights of 3-4 m. The bank condition at point four 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 four and five resulting in stock ruts and bank erosion. The bank condition at monitoring point five 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 panel four recorded the stream condition at photographic monitoring points six and seven (refer to Appendix 3). 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 meter from the bed and well vegetated above this level. Pre-mining surveys at monitoring points six and seven found some evidence of limited bank erosion along sections with incised banks.

The floodplain above longwall panel six has been extensively cleared and consists predominately of pasture areas. At monitoring point three 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 panels four and five typically forms a pool sequence during low rainfall periods and the stream bed condition is similar to the reach above longwall panel six consisting of coarse sand and gravel. Stock access above longwall panel five 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 3, the streams condition in June and December 2012 were similar to compared 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 3, identified in the pre-mining surveys continued in 2012 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 and 2012 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 panels four and five. 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 panel six was evident in the 2012 surveys. No evidence of subsidence induced soil cracking or additional erosion on the stream's banks or bed were observed at these points in 2012.

The vegetation communities, Redgum Rough-bark Apple Forest (Hunter Eco 2008) and pasture species remained unchanged with some limited regrowth observed in 2012. Similar to pre-mining conditions, a high level of groundcover and riparian species were found in 2012 above longwall panel four, predominately consisting of pasture and sedge species at monitoring points six and seven (refer to Appendix 3). The presence of riparian species above longwall panel four compared to the fewer recorded species above longwall panel five is largely a result of restricted stock access along this stream reach.

3.2.3 Impact Assessment

No additional subsidence occurred on longwall panels four to six in 2011 with the maximum subsidence recorded in 2009 remaining unchanged at 797 mm, 627 mm, & 257 mm as shown in the graph of the subsidence results in Appendix Four. As discussed in the 2009 flood path report, these subsidence levels

resulted in maximum changes to stream grades of 0.54%, 0.23%, and 0.02% between the edge of Maingate pillars and the centre of longwall panels six, five and four. 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 panels six to four where unchanged in 2012 and are all below the anomalous trigger values in the UMEMP (refer to table 1), requiring investigations into stream impacts or remedial works.. The 2012 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 three and in similar condition to that recorded prior to mining.

3.3 Stockton Creek (Main Tributary) – Longwall Panel One to Three

3.3.1 Pre-mining Survey Assessment

The condition of Stockton Creek was recorded at photographic monitoring point's seven to twelve as shown in Appendix 3. 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 panels one to three 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 panels one to three as, recorded in the photos of monitoring points 8 to 12 (refer to Appendix 3). Further post-mining surveys conducted in 2012 recorded as, shown in these photos, similar stream conditions to those found prior to mining with no observable change in channel widths or bank heights. Some limited pre-mining erosion observed along incised banks had not further eroded following the high flow events in December 2007 and no further bank erosion was evident in 2012. No evidence of subsidence induced soil cracking or additional erosion on the stream's banks or bed was observed at these points in 2012.

The vegetation communities, Redgum Rough-bark Apple Forest (Hunter Eco 2008) and pasture species remained unchanged following mining in 2012. Similar to pre-mining conditions, a high level of groundcover and riparian species were found in 2012 above longwall panels one to three, predominately consisting of larger Eucalyptus and sedge species. The restriction of stock along the stream reaches above longwall panels one to three 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

No additional subsidence occurred in 2012 and the maximum subsidence levels remained unchanged at 200 mm and 233 mm 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 panels. The 2012 surveys did not find evidence subsidence had caused bank erosion or a requirement for channel realignment as, the stream reach above longwall panels one to three remained stable and in similar condition to that recorded prior to mining. The subsidence, stream grade and condition changes on Stockton Creek above longwall panels two and three 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 Panels two to six

3.4.1 Pre-mining Survey Assessment

A tributary of Stockton Creek positioned above longwall panels two to six as shown in the Plan MG 10687 flows into Stockton Creek. The tributary is characterised by photographic monitoring points 13 to 20 as shown in Appendix 3. 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 (as shown in photographic monitoring points 13, 19 & 20). The stream widens to an undefined channel with a flow path between 20-30 m wide (as show in photographic monitoring points 16, 17 and 18). The tributary is well vegetated and displays little to no erosion along the sections above the longwall panels two to six. 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 panel one 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. In 2012 minor stream flows and pooled water were observed due to the rainfall events in early 2012.

3.4.3 Impact Assessment

Subsidence levels of up to 659 mm and 661 mm were remained unchanged in 2012 above longwall panel six and five. Maximum stream grade changes of up to 0.4 % and 1.5 % resulted on longwall panels five and six. 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 panel five (point 16) in June 2012 due to a rainfall events with some minor changes from pasture to riparian species evident. 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 Panels Four to Six

3.5.1 Pre-mining Survey Assessment

Although outside the defined floodpath area the tributary located at the foothills to the Watagan Mountains and draining into Stockton Creek above longwall panels four to six 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 3) 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 or 2012 due to access not being granted by landowners. Access to monitor on these properties was restricted in 2011 and 2012 however; 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 panels four and five. Pre-mining stream condition above longwall panels seven to ten 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 2012 recorded some further minor erosion of stream banks along these stream sections likely to be caused by a combination of stock access exposing soils and concentrated flows scouring the banks. Areas of subsidence induced remnant ponding were also identified.

The subsidence levels above longwall panels three to six remained unchanged in 2012. The stream condition in 2012 above longwall panels one to three and six, 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 panels four and five in Stockton Creek has 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 identified prior to mining, were observed in June 2008 to be a result of the concentrated flows on the opposing bank causing further erosion.

In addition to areas identified in previous reports, remnant ponding was evident on a Centennial property above longwall panel 11 in 2011. The ponding is located on an area of Redgum Rough-bark Apple Forest and pasture. To date no dieback of the vegetation community has occurred and an ecologist is monitoring the area to assess the effects on ponding on this vegetation community. Meetings have been held with the tenant occupying the property to discuss the works required to remediate the remnant ponding area. At present due to limited impacts remediation works are being assessed and may be considered if required. Discussions with NSW Office of Water were held in 2011 in relation to the Mine's application for controlled works permits to undertaken excavations to alleviate ponding on Centennial owned properties. To date no response has been received from NSW Office of Water on the application.

The maximum subsidence levels recorded in 2012 on longwall panels eleven to thirteen are within the predicted range, with the changes in stream grade above these panels similar to pre-existing grades occurring on Stockton creek. 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 panel's eleven, twelve and thirteen 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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- 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 1 -
Figure 1.1 100 year ARI storm event – maximum flood depths pre mining landform & Photographic Location Points (Plan MG10687)

1	354964	6334427
2	355018	6334409
3	355095	6334552
4	355076	6334700
5	355225	6334723
6	355308	6334724
7	355364	6334826
8	355356	6334943
9	355444	6335029
10	355466	6335047
11	355587	6335080
12	355712	6335200
13	354634	6334936
14	354763	6335022
15	354826	6335019
16	354894	6335072
17	354955	6335127
18	355135	6335221
19	355295	6335247
20	355315	6335205
21	354202	6336409
22	354253	6336539
23	354033	6336530
24	354033	6336530
25	354099	6336547
26	353927	6336565
27	354683	6334522
28	354591	6334553
29	354639	6334488
30	354537	6334371
31	354508	6334315
32	354477	6333750
34	353996	6334224
35	353973	6334389
36	354453	6334304
37	354543	6334452
39	354662	6334477
41	354370	6334250
42	354393	6334122
43	353979	6334420
44	353866	6334501
45	353544	6334562
46	353219	6334787
47	353207	6334717
48	352983	6334780
49	352943	6334714
50	352594	6335026
51	352479	6335079

Monthly Progress Key

- January
- February
- March
- April
- May
- June
- July
- August
- September
- October
- November
- December

Major Creek

Minor Creek

LOCATION	MANDALONG
SEAM	WEST WALLARAH
DRAWN	PJS 16/07/07
CHECKED	
APPROVED	
SCALE	N.T.S.

Centennial Mandalong

PHOTOGRAPHIC MONITORING LOCATIONS

CONTRACT No.	
PLOTFILE No.	
A3	MG 10687
DRAWING REVISION	Rev4 28/02/13

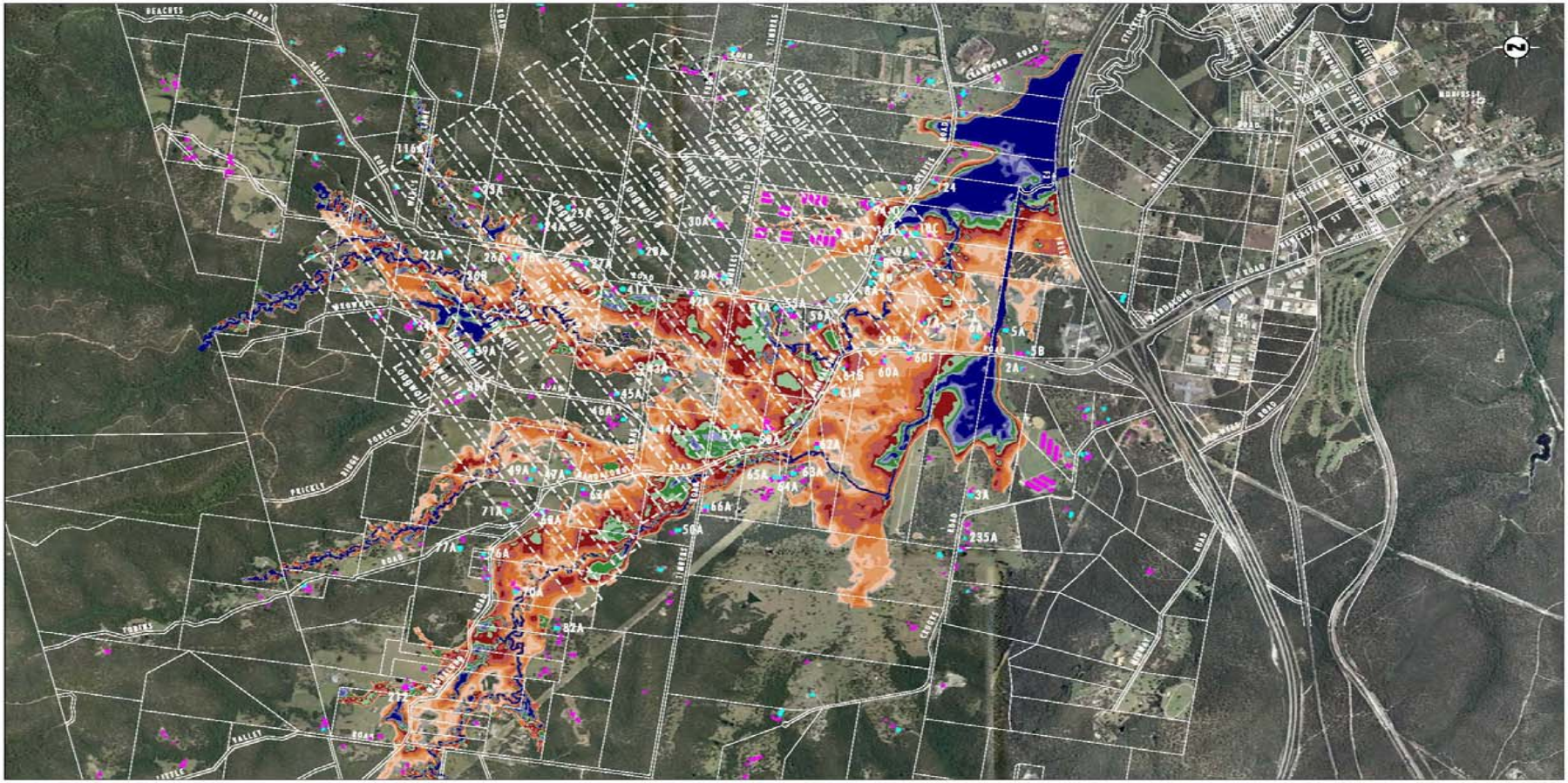
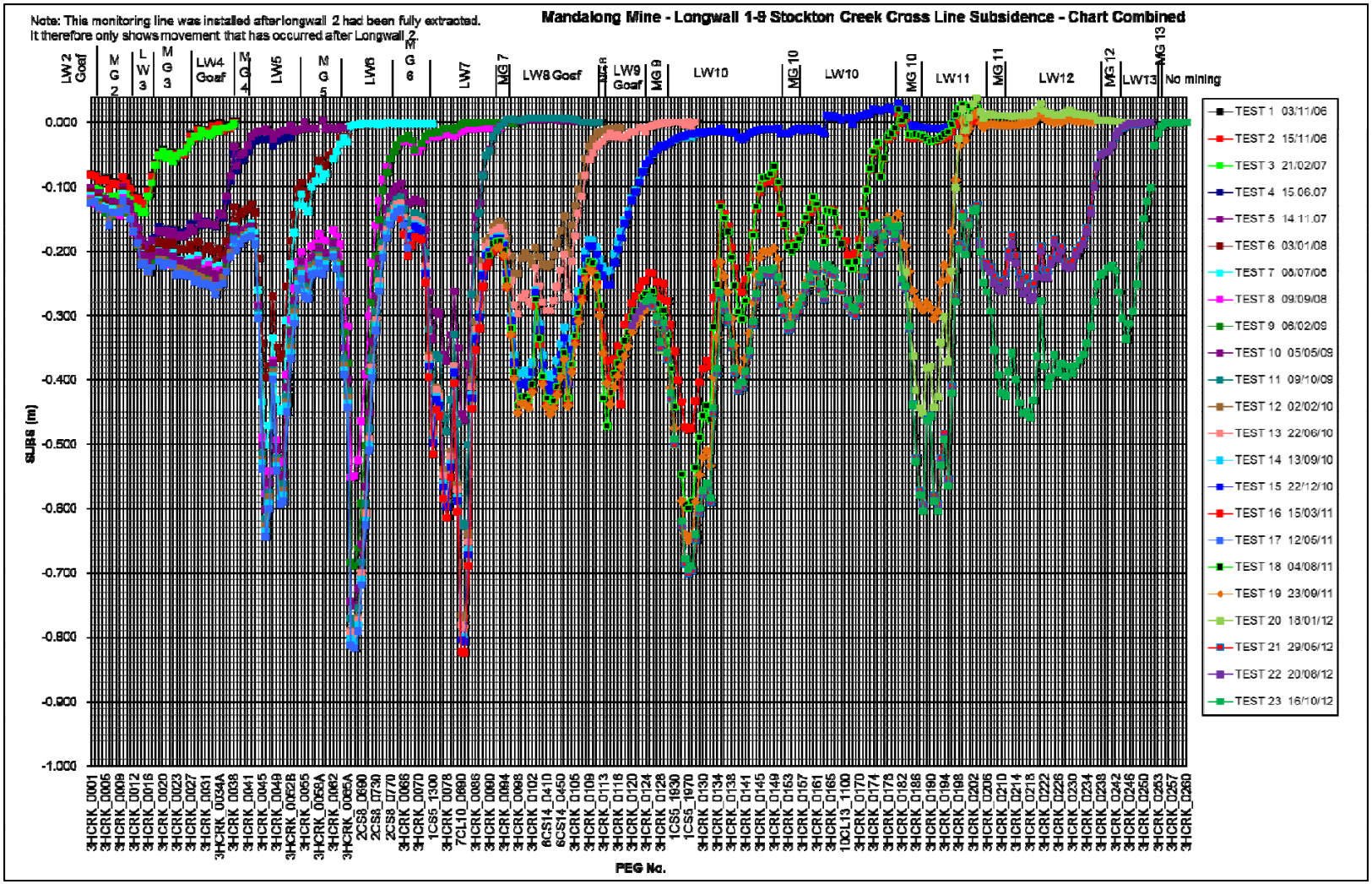


FIGURE 1

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

APPENDIX 2
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 1-8 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
0.000
-0.100
-0.200
-0.300
-0.400
-0.500
-0.600
-0.700
-0.800
-0.900
-1.000
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 06/07/08
TEST 8 09/09/08
TEST 9 08/02/09
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 3
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



PT1 - MG6 1 HD Stockton Creek December 2011



PT1 - MG6 1 HD Stockton Creek June 2012



PT1 - MG6 1 HD Stockton Creek December 2012



PT2 – MG6 2 HD Stockton Creek April 2007



PT2 – MG6 2HD Stockton Creek December 2007



PT2 – MG6 2HD Stockton Creek June 2008



PT2 – MG6 2HD Stockton Creek December 2008



PT2 – MG6 2HD Stockton Creek June 2009



PT2 – MG6 2HD Stockton Creek December 2009



PT2 – MG6 2HD Stockton Creek December 2010



PT2 – MG6 2HD Stockton Creek June 2011



PT2 – MG6 2HD Stockton Creek December 2011



PT2 – MG6 2HD Stockton Creek June 2012



PT2 – MG6 2HD Stockton Creek December 2012



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



PT3 – MG5 1HD Stockton Creek June 2010



PT3 – MG5 1HD Stockton Creek December 2010



PT3 – MG5 1HD Stockton Creek June 2011



PT3 – MG5 1HD Stockton Creek December 2011



PT3 – MG5 1HD Stockton Creek June 2012



PT3 – MG5 1HD Stockton Creek December 2012



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



PT4 – MG5 2HD Stock Creek December 2009



PT – 4 MG5 2HD Stock Creek June 2010



PT – 4 MG5 2HD Stock Creek December 2010



PT – 4 MG5 2HD Stock Creek June 2011



PT – 4 MG5 2HD Stock Creek December 2011



PT – 4 MG5 2HD Stock Creek June 2012



PT – 4 MG5 2HD Stock Creek December 2012



PT5 – MG4 1HD Stockton Creek April 2007



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



PT5 – MG4 1HD Stockton Creek December 2007



PT5 – MG4 1HD Stockton Creek June 2008



PT5 – MG4 1HD Stockton Creek December 2008



PT5 – MG4 1HD Stockton Creek June 2009



PT5 – MG4 1HD Stockton Creek December 2009



PT5 – MG4 1HD Stockton Creek June 2010



PT5 – MG4 1HD Stockton Creek December 2010



PT5 – MG4 1HD Stockton Creek June 2011



PT5 – MG4 1HD Stockton Creek December 2011



PT5 – MG4 1HD Stockton Creek June 2012



PT5 – MG4 1HD Stockton Creek December 2012



PT6 – MG4 2HD Stockton Creek April 2007



PT6 – MG4 2HD Stockton Creek December 2007



PT6 – MG4 2HD Stockton Creek June 2008



Pt6 – MG4 2HD Stockton Creek December 2008



PT6 – MG4 2HD Stockton Creek June 2009



PT6 – MG4 2HD Stockton Creek December 2009



PT6 – MG4 2HD Stockton Creek June 2010



PT6 – MG4 2HD Stockton Creek December 2010



PT6 – MG4 2HD Stockton Creek June 2011



PT6 – MG4 2HD Stockton Creek December 2011



PT6 – MG4 2HD Stockton Creek June 2012



PT6 – MG4 2HD Stockton Creek December 2012



PT7 – MH3 1HD Stockton Creek April 2007



PT7 – MG3 1HD Stockton Creek December 2007



PT7 – MG3 1HD Stockton Creek June 2008



PT7 – MG3 1HD Stockton Creek December 2008



PT7 – MG3 1HD Stockton Creek June 2009



PT7 – MG3 1HD Stockton Creek December 2009



PT7 – MG3 1HD Stockton Creek June 2010



PT7 – MG3 1HD Stockton Creek December 2010



PT7 – MG3 1HD Stockton Creek June 2011



PT7 – MG3 1HD Stockton Creek December 2011



PT7 – MG3 1HD Stockton Creek June 2012



PT7 – MG3 1HD Stockton Creek December 2012



PT8 – MG3 2HD Stockton Creek April 2007



PT8 – MG3 2HD Stockton Creek December 2007



PT8 – MG3 2HD Stockton Creek June 2008



PT8 – MG3 2HD Stockton Creek December 2008



PT8 – MG3 2HD Stockton Creek June 2009



PT8 – MG3 2HD Stockton Creek December 2009



PT8 – MG3 2HD Stockton Creek June 2010



PT8 – MG3 2HD Stockton Creek December 2010



PT8- MG3 2HD Stockton Creek June 2011



PT8- MG3 2HD Stockton Creek December 2011



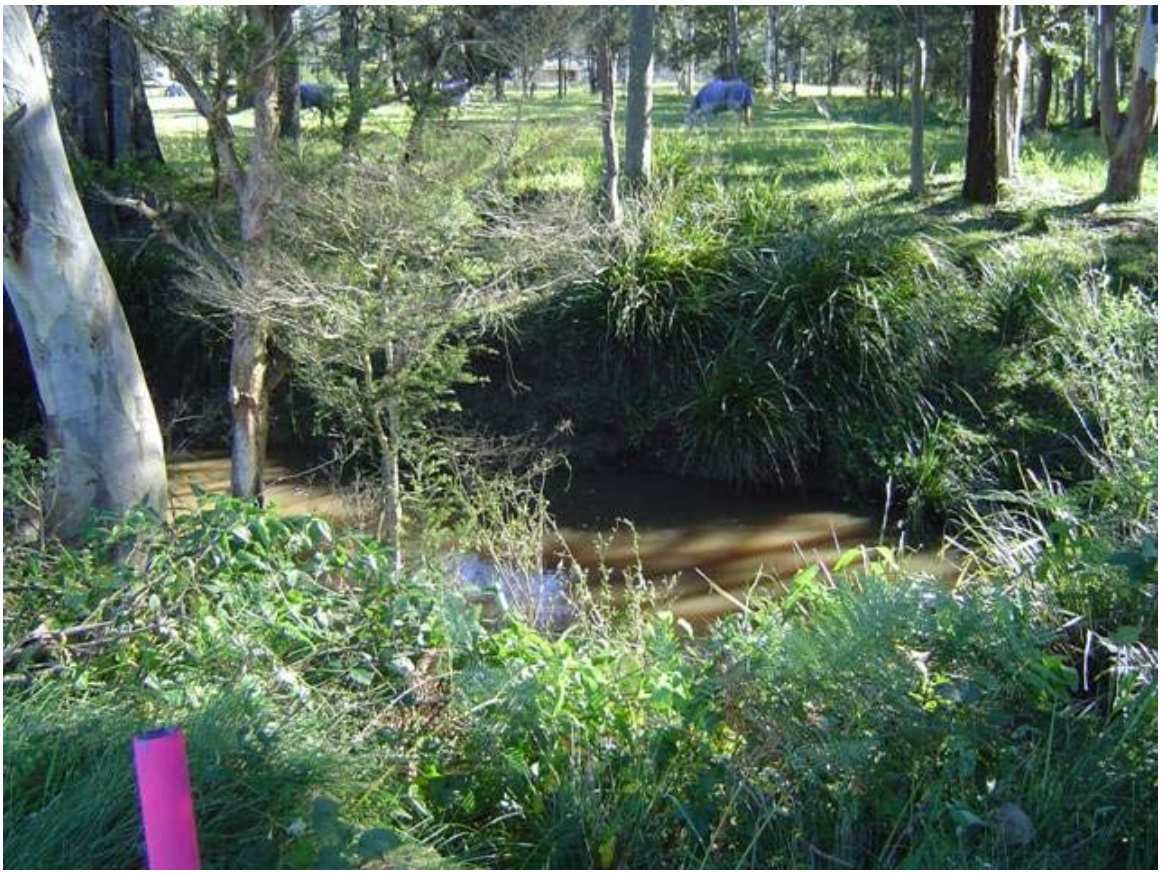
PT8- MG3 2HD Stockton Creek June 2012



PT8- MG3 2HD Stockton Creek December 2012



PT9 – MG2 1HD Stockton Creek April 2007



PT9 – MG2 1HD Stock Creek June 14th 2007



PT9 – MG2 1HD Stockton Creek December 2007



PT9 – MG2 1HD Stockton Creek June 2008



PT9 – MG2 1HD Stockton Creek December 2008



PT9 – MG2 1HD Stockton Creek June 2009



PT9 – MG2 1HD Stockton Creek December 2009



PT9 – MG2 1HD Stockton Creek June 2010



PT9 – MG2 1HD Stockton Creek December 2010



PT9-MG2 1HD Stockton Creek June 2011



PT9-MG2 1HD Stockton Creek December 2011



PT9-MG2 1HD Stockton Creek June 2012



PT9-MG2 1HD Stockton Creek December 2012



PT10 – MG2 2HD Stockton Creek June 2007



PT10 – MG2 2HD Stockton Creek December 2007



PT10 – MG2 2HD Stockton Creek June 2008



PT10 – MG2 2HD Stockton Creek December 2008



PT10 – MG2 2HD Stockton Creek June 2009



PT10 – MG2 2HD Stockton Creek December 2009



PT10 – MG2 2HD Stockton Creek June 2010



PT10 – MG2 2HD Stockton Creek December 2010



PT10- MG2 2HD Stockton Creek June 2011



PT10- MG2 2HD Stockton Creek December 2011



PT10- MG2 2HD Stockton Creek June 2012



PT10- MG2 2HD Stockton Creek December 2012



PT11 – MG1 1HD Stockton Creek April 2007



PT11 – MG1 1HD Stockton Creek December 2007



PT11 – MG1 1HD Stockton Creek June 2008



PT11 – MG1 1HD Stockton Creek December 2008



PT11 – MG1 1HD Stockton Creek June 2009



PT11 – MG1 1HD Stockton Creek December 2009



PT11 – MG1 1HD Stockton Creek June 2010



PT11 – MG1 1HD Stockton Creek December 2010



PT11- MG1 1HD Stockton Creek June 2011



PT11 – MG1 1HD Stockton Creek December 2011



PT11 – MG1 1HD Stockton Creek June 2012



PT11 – MG1 1HD Stockton Creek December 2012



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



PT12 – Flank St Creek December 2008



PT12 – Flank St Creek June 2009



PT12 – Flank St Creek December 2009



PT12 – Flank St Creek June 2010



PT12 – Flank St Creek December 2010



PT12- Flank St Creek June 2011



PT12 – Flank St Creek December 2011



PT12 – Flank St Creek June 2012



PT12 – Flank St Creek December 2012



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



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



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



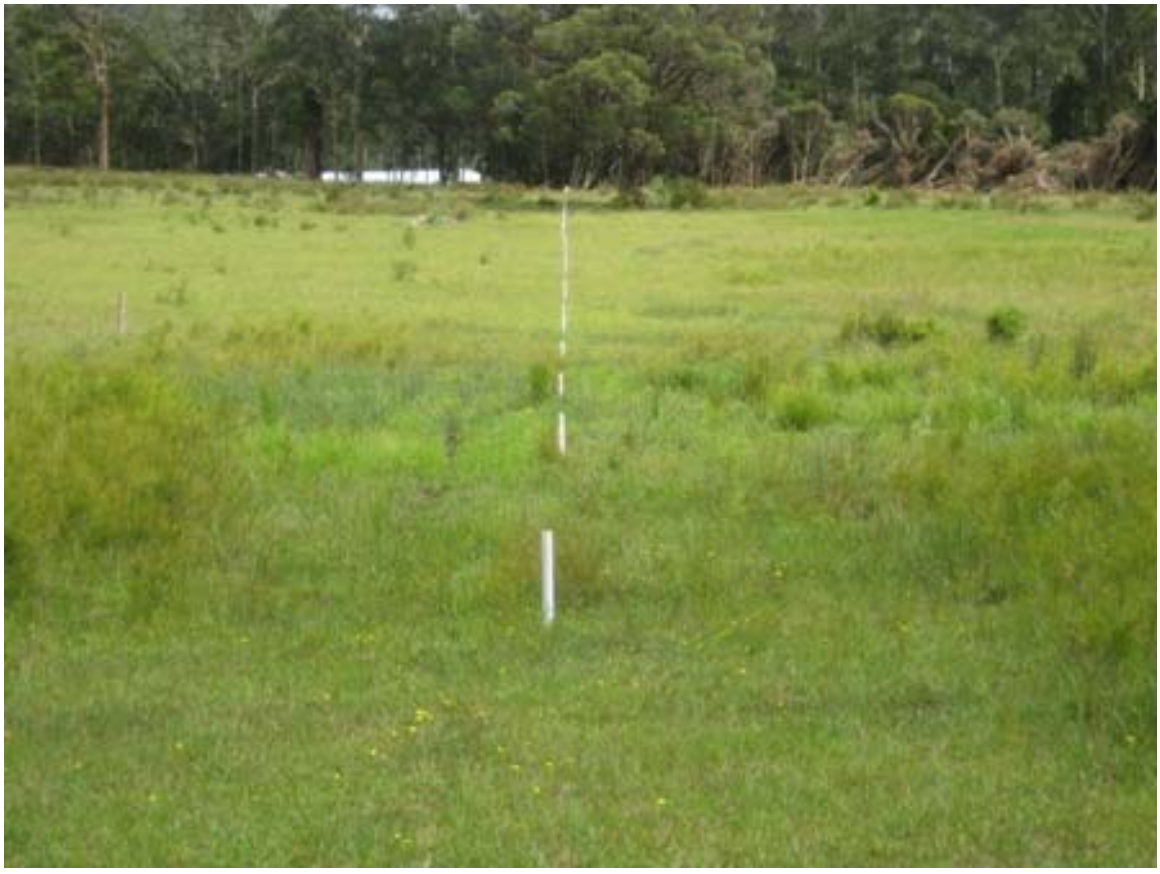
PT16 – Stockton Creek –CL April 2007



PT16 - St Creek CL December 2007



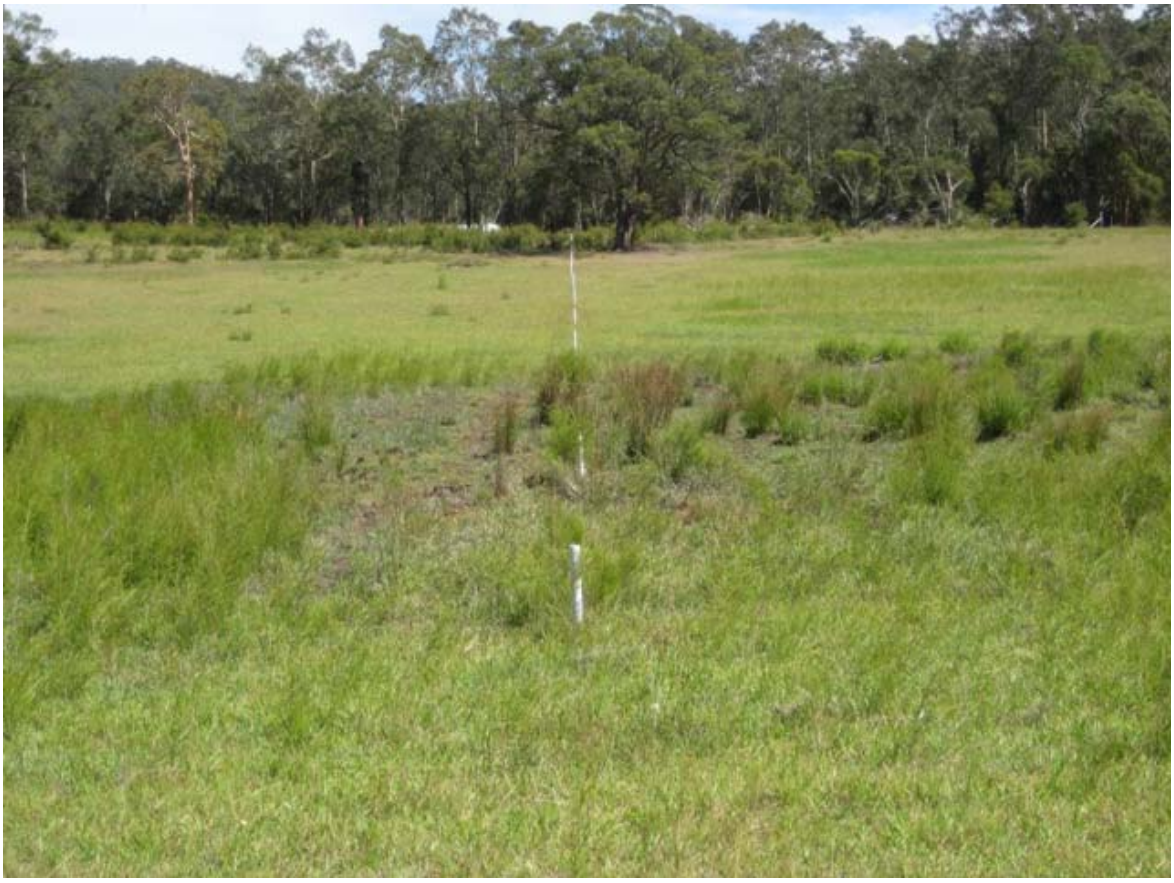
PT16 - St Creek CL June 2008



PT16 - St Creek CL December 2008



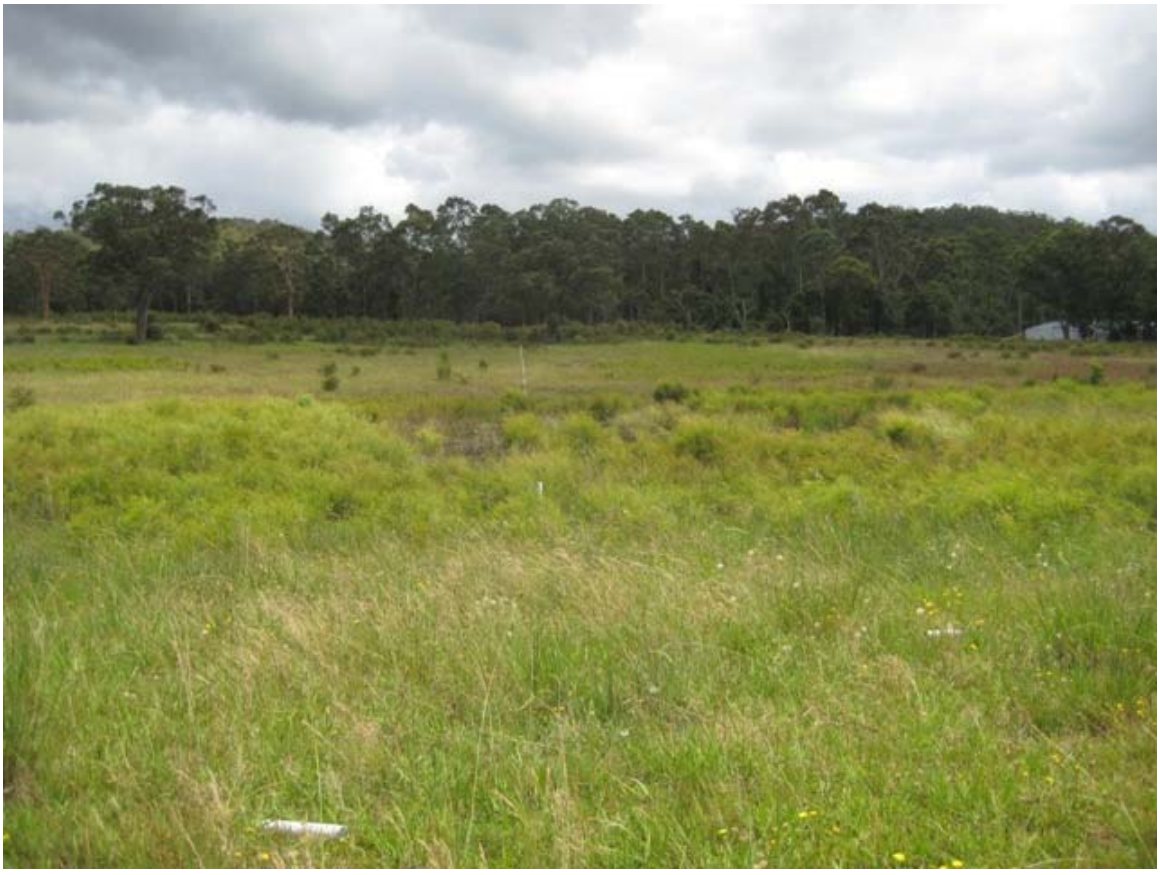
PT16 - St Creek CL June 2009



PT16 - St Creek CL December 2009



PT16 - St Creek CL June 2010



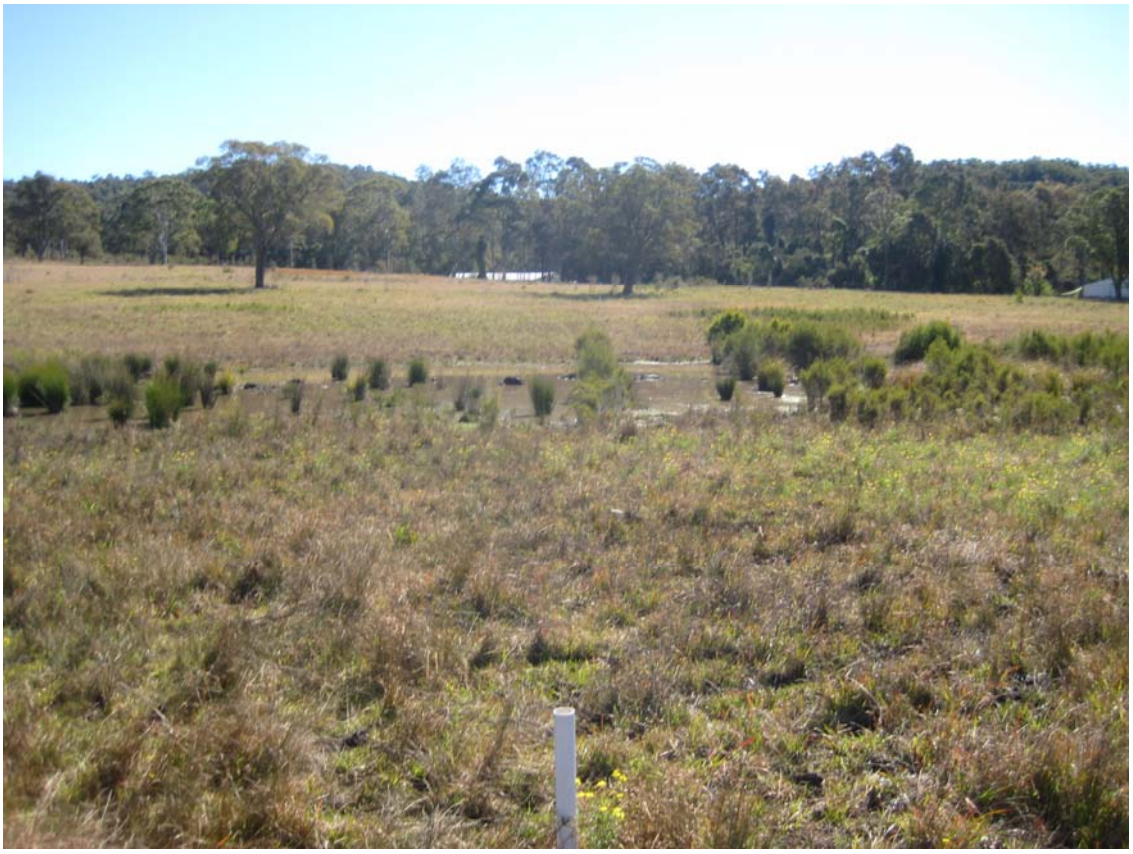
PT16 - St Creek CL December 2010



PT16 – St Creek CL June 2011



PT16 – St Creek CL December 2011



PT16 – St Creek CL June 2012



PT16 – St Creek CL December 2012



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



PT17 MG4 2HD St Creek December 2010



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



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 14th2007



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



PT19 MG2 1HD St Creek June 2011



PT19 MG2 1HD St Creek December 2011



PT19 MG2 1HD St Creek June 2012



PT19 MG2 1HD St Creek December 2012



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



PT20 MG2 2HD Stockton Creek December 2008



PT20 MG2 2HD Stockton Creek June 2009



PT20 MG2 2HD Stockton Creek December 2009



PT20 MG2 2HD Stockton Creek December 2010



PT20 MG2 2HD Stockton Creek June 2011



PT20 MG2 2HD Stockton Creek December 2011



PT20 MG2 2HD Stockton Creek June 2012



PT20 MG2 2HD Stockton Creek December 2012



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



PT 27 – MG7 2HD Stockton Creek June 2011



PT 27 – MG7 2HD Stockton Creek December 2011



PT 27 – MG7 2HD Stockton Creek June 2012



PT 27 – MG7 2HD Stockton Creek December 2012



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



PT 28 – MG7 1HD (a) Stockton Creek June 2009



PT 28 – MG7 1HD (a) Stockton Creek December 2009



PT 28 – MG7 1HD (a) Stockton Creek June 2010



PT 28 – MG7 1HD (a) Stockton Creek December 2010



PT 28 – MG7 1HD (a) Stockton Creek December 2011



PT 28 – MG7 1HD (a) Stockton Creek June 2012



PT 28 – MG7 1HD (a) Stockton Creek December 2012



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



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



PT29 – MG7 1HD (b) Tributary Stockton Creek June 2011



PT29 – MG7 1HD (b) Tributary Stockton Creek December 2011



PT29 – MG7 1HD (b) Tributary Stockton Creek June 2012



PT29 – MG7 1HD (b) Tributary Stockton Creek December 2012



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



PT30 – MG8 2HD Stockton Creek December 2010



PT30 – MG8 2HD Stockton Creek June 2011



PT30 – MG8 2HD Stockton Creek December 2011



PT30 – MG8 2HD Stockton Creek June 2012



PT30 – MG8 2HD Stockton Creek December 2012



PT31 – MG8 1HD Stockton Creek December 2008



PT31 – MG8 1HD Stockton Creek June 2009



PT31 – MG8 1HD Stockton Creek December 2009



PT31 – MG8 1HD Stockton Creek June 2010



PT31 – MG8 1HD Stockton Creek December 2010



PT31 – MG8 1HD Stockton Creek June 2011



PT31 – MG8 1HD Stockton Creek December 2011



PT31 – MG8 1HD Stockton Creek June 2012



PT31 – MG8 1HD Stockton Creek December 2012



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



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



PT41 – MG9 1HD Stockton Creek December 2012



PT42 – MG9 2HD Stockton Creek December 2009



PT42 – MG9 2HD Stockton Creek June 2010



PT42 – MG9 2HD Stockton Creek December 2010



PT42 – MG9 2HD Stockton Creek June 2011



PT42 – MG9 2HD Stockton Creek December 2011



PT42 – MG9 2HD Stockton Creek June 2012



PT42 – MG9 2HD Stockton Creek December 2012



PT43 – MG10 2HD Stockton Creek December 2009



PT43 – MG10 2HD Stockton Creek December 2010



PT43 – MG10 2HD Stockton Creek June 2011



PT43 – MG10 2HD Stockton Creek December 2011



PT43 – MG10 2HD Stockton Creek June 2012



PT43 – MG10 2HD Stockton Creek December 2012



PT44 – MG10 1HD Stockton Creek December 2009



PT44 – MG11 1HD Stockton Creek December 2010



PT44- MG11 1HD Stockton Creek June 2011



PT44- MG11 1HD Stockton Creek June 2012



PT44- MG11 1HD Stockton Creek December 2012



PT45 – MG11 1HD Stockton Creek December 2010



PT45 – MG11 1HD Stockton Creek June 2011



PT45 – MG11 1HD Stockton Creek December 2011



PT45 – MG11 1HD Stockton Creek June 2012



PT45 – MG11 1HD Stockton Creek December 2012



PT46 – MG12 1HD Stockton Creek June 2011



PT46 – MG12 1HD Stockton Creek December 2011



PT46 – MG12 1HD Stockton Creek June 2012



PT46 – MG12 1HD Stockton Creek December 2012



PT47 MG12 2HD Stockton Creek June 2011



PT47 MG12 2HD Stockton Creek December 2011



PT47 MG12 2HD Stockton Creek June 2012



PT47 MG12 2HD Stockton Creek December 2012



PT48 – MG13 1HD Stockton Creek December 2011



PT48 – MG13 1HD Stockton Creek June 2012



PT48 – MG13 1HD Stockton Creek December 2012



PT49 – MG13 2HD Stockton Creek December 2011



PT49 – MG13 2HD Stockton Creek June 2012



PT49 – MG13 2HD Stockton Creek December 2012



PT50 – MG14 Stockton Creek December 2012



PT51 – MG14 Stockton Creek December 2012

APPENDIX 4
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)	28/6/13	Stockton Crk (Main Reach)	Turbid / low flow	none	Pool	none	none	none	90
1	354964, 6334427	MG6 1 heading	Stockton Crk (South Arm)	17/12/13	Stockton Crk (Main Reach)	Turbid / low flow	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	None	None	90

									m from bed			
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
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- Est 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- Est Bank	NA-no subsidence	None	95
3	355095, 6334552	MG5 1 hd	Stockton Crk (South	10/12/07	Stockton Crk (Main	Visibly turbid/high	Yes West Bank	Run	Yes- Est Bank	NA-no subsidence	None	95

			Arm)		Reach)	flow						
3	355095, 6334552	MG5 1 hd	Stockton Crk (South Arm)	09/06/08	Stockton Crk (Main Reach)	Visibly turbid/moderate flow	none	Run	Yes- Est 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- Est 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- Est 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- Est 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- Est 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- Est 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- Est 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
4	355095, 6334553	MG5 2hg	Stockton Crk (South Arm)	07/12/11	Stockton Crk (Main Reach)	Minor flow	none	Pool	Yes- Est 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	None	None	90

									from Bank Top			
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
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/modera te 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
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
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
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
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/modera te 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
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	28/06/10	Stockton Crk (Main	Visibly turbid/no flow	none	Pooled	Minor at base of	None	None	95

			Arm)		Reach)				bank			
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/modera te 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
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
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	11/12/08	Stockton Crk (Main Reach)	Visibly turbid/high flow	Yes overflow	Pooled	Minor erosion (cattle)	NA (no subsidence)	None	90

			Crk (Mid Arm))									
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 (Stockton Creek)	28/6/12	Stockton Crk (Main Reach)	visibly turbid/minor flow	Yes overflow	Pooled	none	None	None	90
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
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
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
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
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
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
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
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

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 -	13/12/08		Visibly turbid/no flow	n/a	Pooled	n/a	None	None	n/a

			Vandenburg Property Refer No. 108)									
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,	MG5, 1hd	Drainage	30/04/07		Visibly	n/a	Pooled	n/a	None	None	80

	633 6565		Line (Rear Vizzer Property Refer No. 109)			turbid/no flow						
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 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	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	Visibly turbid/ no flow	none	Pooled	None - (stock access)	none	None	90

					width 0.5m							
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 No. 54)	07/12/10	Stockton Crk (Main Reach) bank height 1m and width 0.5m	Visibly turbid/minor 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)	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/modera te 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/modera te 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
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 - stagnant	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	dry	none	Pooled - stagnant	incised near bed - (stock access)	none	minor	60

					width 2m							
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 - stagnant	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 - stagnant	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 width 2m	dry	none	none	incised near bed - (stock access)	none	minor	100
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	dry	none	Pooled - riffle sequence u/s	banks incised <0.5 m from bed - (stock	none	minor	80

					width 3-4m				access)			
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

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 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)	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	visibly turbid/moderate flow	none	pooled	banks incised <1 -2 m from bed - (stock	none	minor	80

					width 8-10m				access)			
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
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 Creek)	No water	None	None	None	Minor erosion	none	80
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
37	354543, 6334452	LW 8 Centre	Stockton Creek (Centennial Property Ref No. 55)	16/06/09	Paddock containing billabong	Pooled Water (Billabong)	None	Pooled - stagnant	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 - stagnant	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
42	354392, 6334122,	MG9, 2 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
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	Visibly turbid/minor flow	None	run	none	none	none	90

					3m							
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/modera te flow	None	run	none	none	none	100
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
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	dry	None	None	None	None-pre mining	None-pre mining	80

					10 m							
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

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, width 2-3 m	Pooled/visibly turbid/ no flow	none	pooled	incised 1m at bed	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	Visibly turbid/minor flow	none	pooled	incised 1m at from top bank	none pre-mining	none pre-mining	70

					15 m							
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
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
48	352983, 6334780	Mg13, 1hd	Stockton Creek (Ref No. 26)	08/12/11	Stockton Creek (Main Reach) Bank height 4 m, width 5.10m	Visibly turbid/modera te flow	none	pooled (run d/S)	some soil erosion exposed banks	none pre-mining	none pre-mining	50
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
49	352943, 6334714	Mg13, 2hd	Stockton Creek (Ref No. 39)	08/12/11	Stockton Creek (Main Reach) Bank height 3 m, width	Visibly turbid/modera te flow	none	pooled	some soil erosion exposed banks	none pre-mining	none pre-mining	50

					11 m							
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/modera te flow	none	pooled	some soil erosion exposed banks	none	none	800
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
50	**352594, 6335026**	Mg14	Stockton Creek (Ref No. 22)	18/12/12	Stockton Creek (Main Reach) Bank height 3 m, width 5 m	Turbid / now flow	none	Pooled	none	none – pre mining	None – prep mining	80
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

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 2012
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 2012

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 2012
Abbreviations NYT Not Yet Triggered

Condition No	Condition	Status 20BL169424					
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 :- m) Details of the work set out in the attached form "A" (must be completed by a driller); n) A plan showing accurately the location of the work, in relation to portion and property boundary; o) A one litre water sample for all licences other than those from stock, domestic, test bores and farming purpose; p) 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:- g) Inserting the appropriate length(s) of casing to a depth sufficient to exclude the saline or polluted water from the work. h) 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	The volume of groundwater extracted from the works authorised by this license for stock and/or domestic purpose shall not exceed 365 megalitres in any period of 12 months commencing 1 July.	Complied (212 ML extracted in 2012)					

Condition No	Condition	Status 20BL169424					
6	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					
7	The licensee shall within three months of being called upon by the Department to do so, install to the satisfaction of the Department in respect to the location, type and construction and measurement of the quantity of water extracted from the work. The monitoring equipment consisting of a measuring weir or weirs with automatic recorder, or levels of the dethridge type, or such other class or meter or means of measuring as approved by the Department. The appliance(s) shall be in good working order and condition. A record of all water extracted from the work shall be kept and supplied to the department upon request. The licensee when requested must supply test certificates as to the accuracy of the appliance furnished by the manufacturer or by some person duly qualified.	NYT					
8	a) The holder of the licence must comply with groundwater containment methods in accordance with the approved water management plan, identified as 'schedule A" and attached to this licence, and b) A copy of the approved water management plan, is retained in the Newcastle office of the Department of Infrastructure, Planning and Natural Resources	Complied					
9	The authorised work shall not be used for the discharge of polluted water into a river or lake, otherwise than in accordance with the conditions of a licence granted under the Protection of the Environment Operations Act 1997. A copy of the licence to discharge is to be provided to the department of Infrastructure, Planning and Natural Resources.	Complied					

Note: status as 31 December 2012
Abbreviations: NYT Not Yet Triggered

APPENDIX 11
AEMR Photos 2012

Plate One: Rehabilitated Direct Grass Seeded Area and Perimeter Drain at the Delta Entry Site.



Plate Two: Rehabilitated Direct Tree Seeded Area Delta Entry Site.



Plate Three: Trapezoidal Road Edge Drain 413 Conveyor



Plate Four: Moran's Creek Rehabilitation Direct Seeding Area



Plate Five: Moran's Creek Tube Stock Planted Area



Plate Six: New Oil Water Separator at the Cooranbong Services Site installed in 2012.



Plate Seven: De-Silting of the Cooranbong 5ML Dam in 2012



Plate Eight: New Sediment Control Wall installed in the Cooranbong 5ML Dam in 2012.



APPENDIX 12
Wetlands Monitoring Report

Centennial Coal



Mandalong Wetlands

Monitoring Report

Centennial Mandalong

May 2012

HUNTER ECO

Centennial Coal
Environment Matters

Executive Summary

Conditions of Consent for the Centennial Mandalong underground coalmine 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 are control sites unaffected by subsidence and five are within the subsidence area. This report presents the results from monitoring in May 2012 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.

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.

Similarity analysis has shown that the monitoring transects include three habitat types: dry, margin and aquatic. The location of these habitats has remained the same for each wetland since April 2009. A feature of the floristic content of the aquatic habitat has been a high level of variation between monitoring occasions.

Wetland 8 has been subject to subsidence for over 12 months as of May 2012 and there is no detectable impact. Wetland 6 is located over the pillars between longwalls 11 and 12. As of May 2012 both of these longwalls have been subsided. So far, it appears that increased rainfall has had the greatest impact on Wetland 6.

Evidence is accumulating that feral deer are having a negative impact on aquatic habitat for some wetlands.

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Centennial Coal Mandalong Underground Coalmine Wetlands Monitoring Report May 2012

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. The mining process is longwall mining and at completion of coal extraction the longwall void is collapsed. This collapse results in subsidence of the overburden that is ultimately transmitted to the surface to varying degrees. 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. The degree of impact at the surface is dependent on a number of factors, mainly the depth of the longwall below the surface and the physical structure and composition of the overburden.

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 (Driscoll 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 (Driscoll 2009b) which described the status of the wetlands prior to any subsidence having occurred. The current report provides data and analysis from the seventh 6-monthly monitoring of the 8 wetlands since baseline monitoring. The data for the baseline report were recorded prior to any subsidence having occurred at any of the 5 wetlands within the subsidence impact area. As of May 2012 subsidence had been completed for longwall panels 11 and 12 (**Figure 1**). Wetland 6, being located directly over a pillar between panels 11 and 12, now has the potential to be impacted by subsidence.

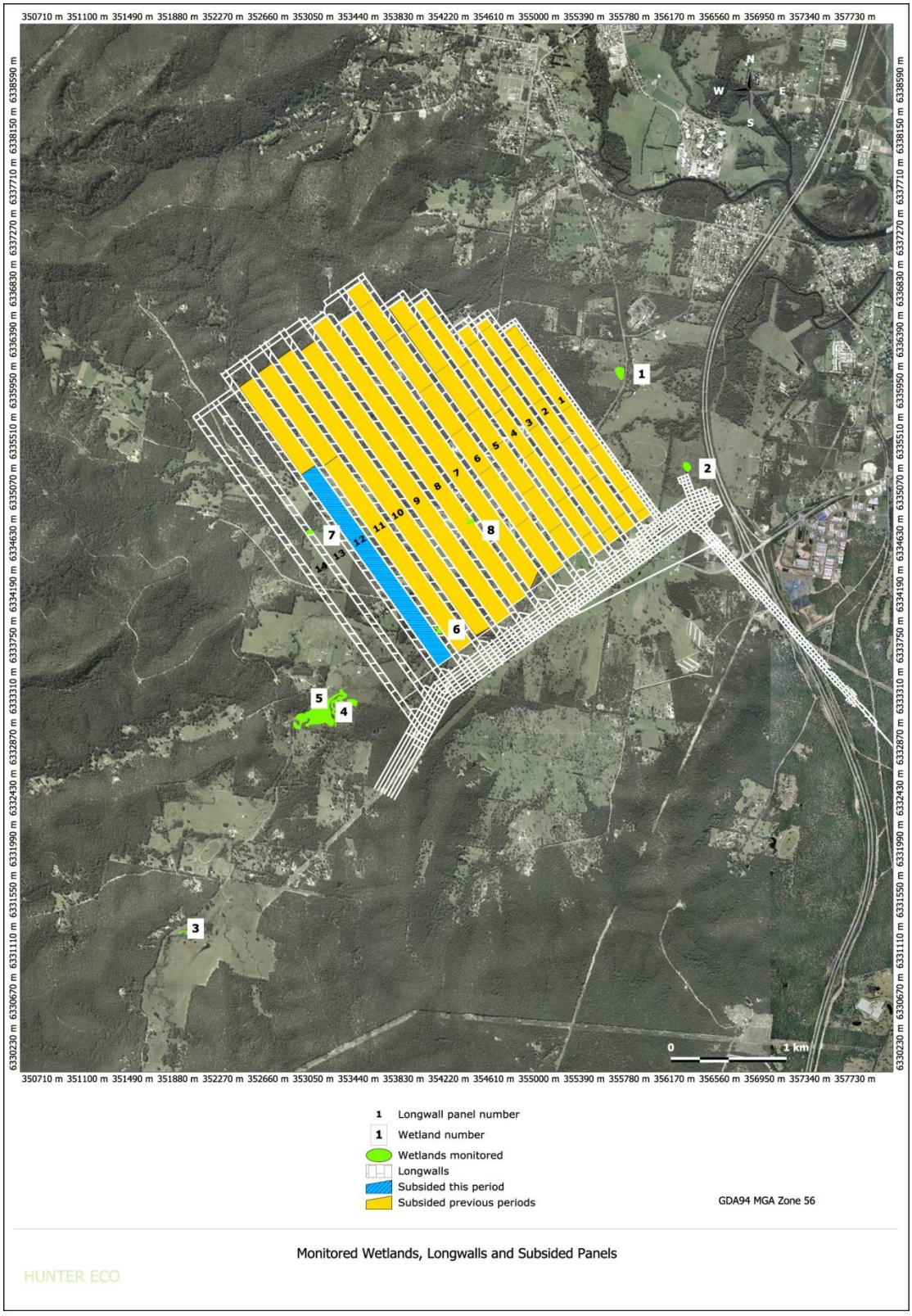


Figure 1 Monitored wetlands, longwalls and subsided panels

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). While the dry and margin habitat was distinguishable for individual wetlands, across all wetlands, at the similarity level where aquatic habitat was separately clustered, dry and margin habitats tended to merge. 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.

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, EC, salinity 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.

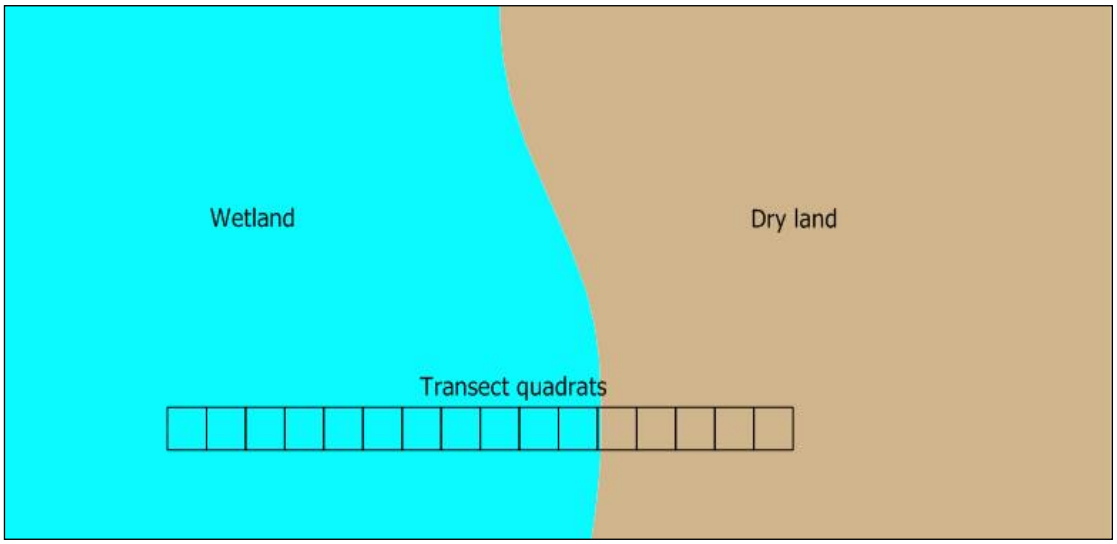


Figure 2 Schematic of a sampling transect.

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

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.

Split Moving Window (SMW)

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.

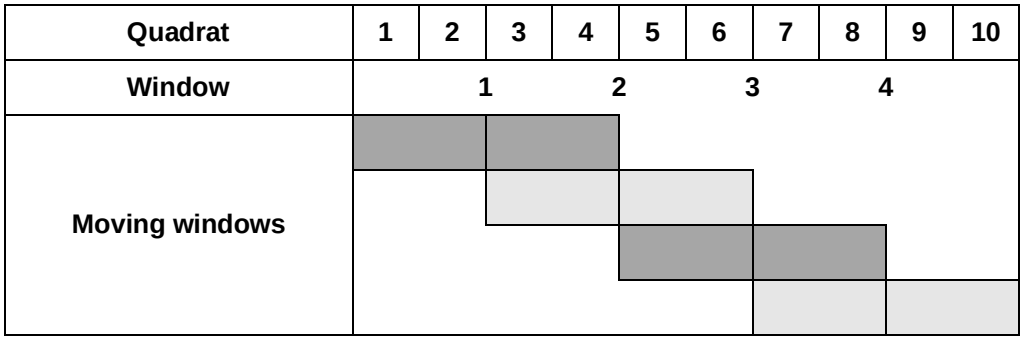


Figure 3 Schematic for SMW analysis using a window of four quadrats.

Multi-dimensional Scaling (MDS)

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 normalised data. Several stages of data transformation are available (e.g. Square Root, 4^{th} 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.

Biodiversity

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 8 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 normalised, 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.

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).

Statistical analysis was also conducted to determine levels of similarity/dissimilarity of the overall species composition and abundance across time in the Aquatic habitat of each wetland. This analysis was accomplished using the ANOSIM function in Primer 6, analogous to a standard analysis of variance (ANOVA) test. Variables were time (the six monitoring periods) and species abundance data with replicates being the individual quadrats that passed across the Aquatic habitat. The hypothesis tested was there was no difference in habitat between the six years. A global significance test was conducted which, if significant, was followed by post hoc tests to determine which monitoring occasions were the same or different.

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 22nd and 23rd May 2012. 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 111 species (**Appendix 1)**. **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.

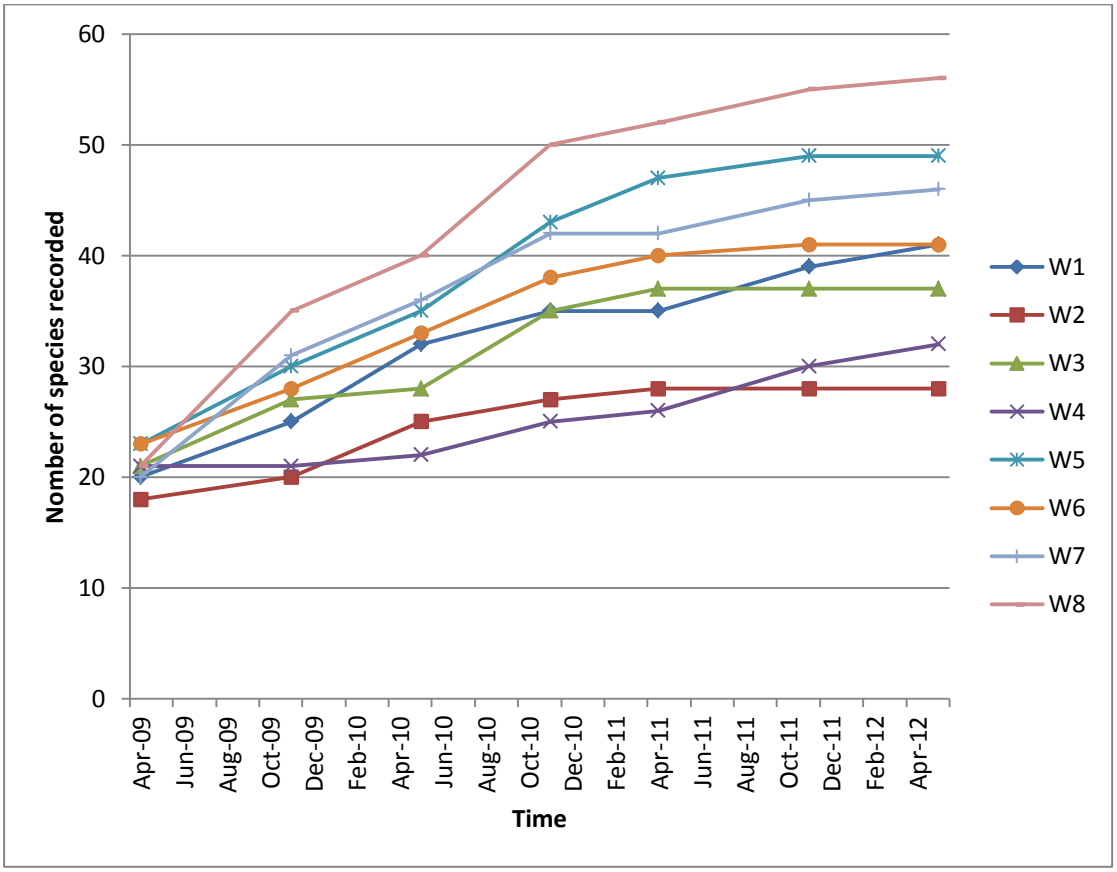


Figure 4 Cumulative species for each wetland transect over time

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 weed species to native species. **Figure 5** shows plots with trendlines, of the proportion of weed species to total species recorded on each monitoring occasion.

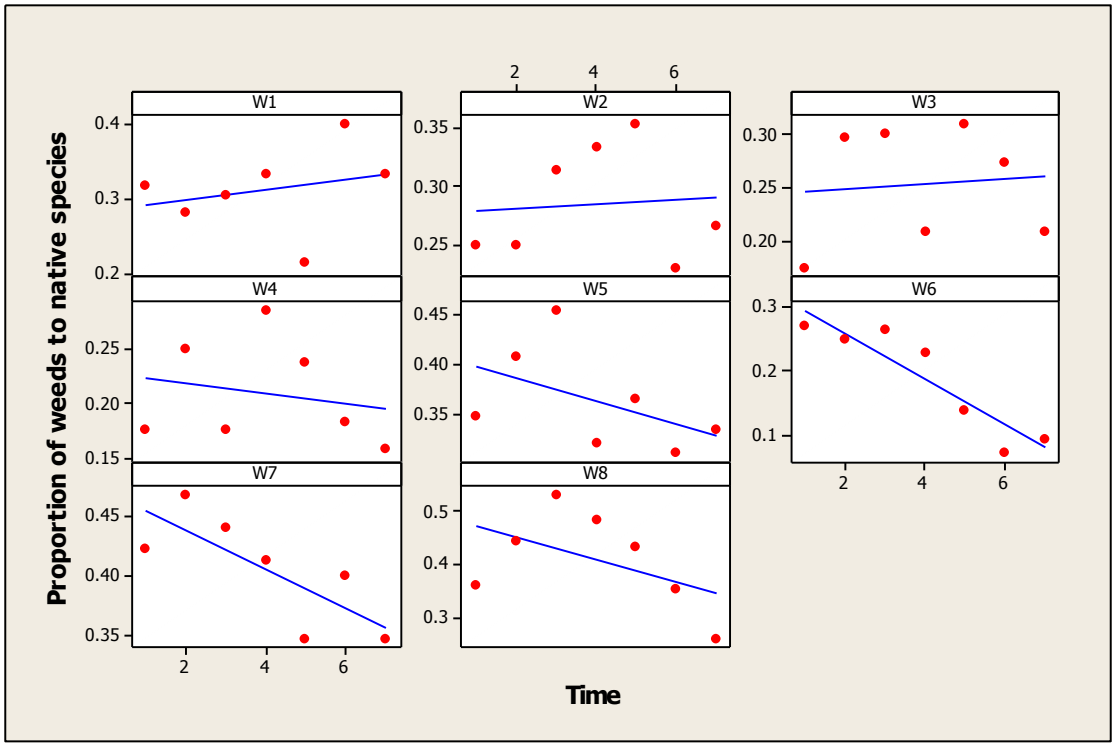


Figure 5 The proportion of weed species to total species in each wetland and each monitoring occasion

Table 3 Regression results for the ratio of weeds to native species and time

Wetland	r^2	F-value	Significance (*p*-value)
W1	0.08	(1,5) 0.41	0.550
W2	0.07	(1,5) 0.04	0.857
W3	0.09	(1,5) 0.04	0.842
W4	0.04	(1,5) 0.23	0.652
W5	0.23	(1,5) 1.49	0.276
W6	0.86	(1,5) 29.76	**0.003**
W7	0.60	(1,5) 7.65	**0.040**
W8	0.08	(1,5) 1.55	0.268

To determine whether the trendlines shown in **Figure 5** were significant, a least squares regression was conducted (**Table 3**). The regression shows that the trendlines were significant for Wetlands 6 and 7 ($p < 0.05$) meaning that for both of these wetlands, the proportion of weeds to native species has been decreasing over time. 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.

This analysis has dealt with diversity of weed species. For example, in five weed species, whether there was only one plant of each species or many more, there would still only be five weed species present. Section 5.6 below looks at the actual abundance of weed species along with native species in relation to habitat type.

5.2 Water levels and rainfall

All wetlands had abundant water on this monitoring occasion. **Figure 5** shows the percentage of each transect that contained water on each monitoring occasion.

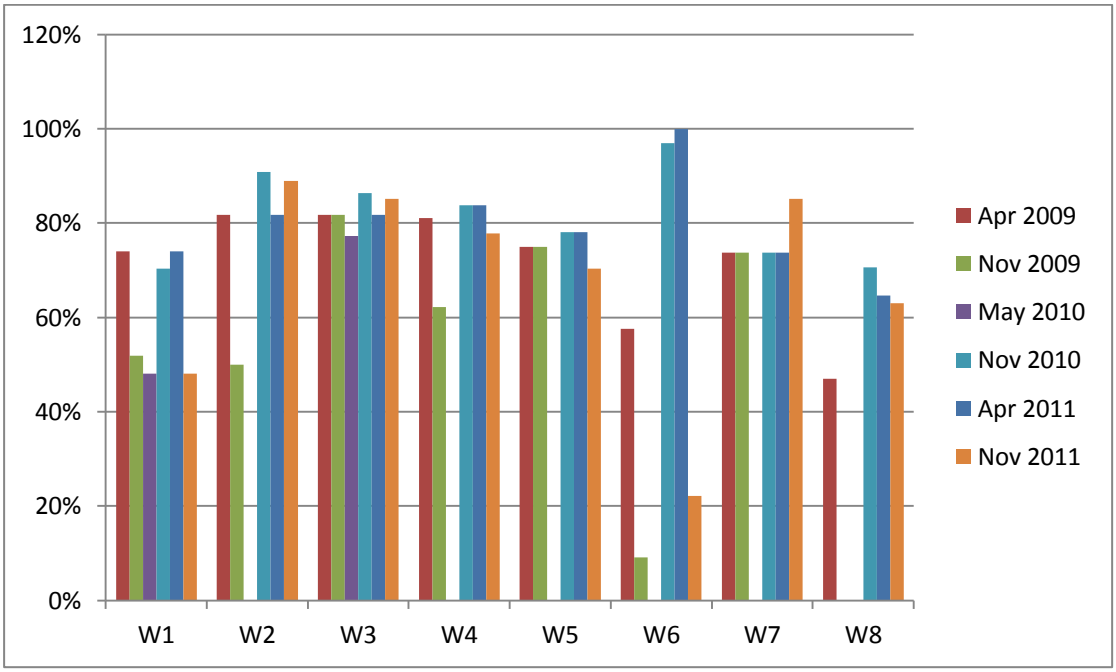


Figure 5 The percentage of each transect containing water on each monitoring occasion

Water level in wetlands will primarily be a function of recent rainfall runoff from the immediate catchment. **Figure 6** shows monthly rainfall recorded at the Centennial Mandalong automatic weather station (AWS) since January 2009.

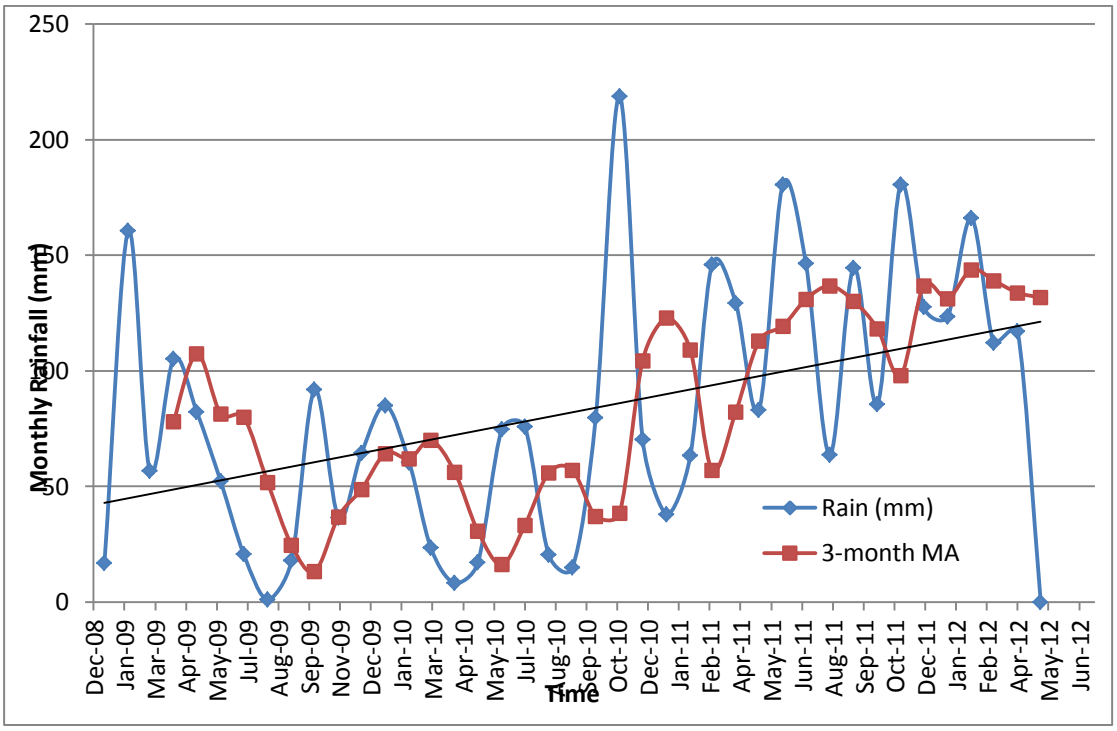


Figure 6 Monthly rainfall at Mandalong for 2009 to 2011
3-month MA is a 3-month moving average

5.3 Habitat transitions

As previously reported, the monitoring transects can be divided into dry, margin, and aquatic habitat based on the grouping of species combinations. The location of change points between each of these habitat types, along each monitoring transect, has been determined using the results of the split moving window plot and MDS ordination.

The purpose of this wetland monitoring program is to determine whether subsidence has an impact on wetlands within the subsidence zone. In this context, the most important transition to monitor is that of aquatic habitat. The impact of subsidence and tilt on a wetland could show up as a permanent change in the extent of the wetland water holding boundary. **Section 5.2** shows that the location of the actual water edge is a consequence of recent rainfall so would not be a useful indicator for showing any change in the net amount of water in the wetland. However, any permanent change would ultimately be expressed in the composition of plant species recorded along a transect with the transition to aquatic habitat permanently being shifted either in or out. To monitor this, the April 2009 baseline position of the aquatic boundary has been set at zero for each

transect and the shift from this base position has been plotted and will continue to be followed over time.

Figure 7 shows the changes that have occurred so far. A positive value means that the aquatic edge has moved towards the start of the transect (expanded) and a negative value means that it has moved away (contracted). It should be noted that these measurements are accurate to one metre i.e. the transect quadrat in which free water first occurs. Greater precision is not possible because the actual edge is ambiguous, depending on the slope of the ground into water and the amount of vegetation and stock trampling.

Wetland 8 is of particular interest because it has been subjected to subsidence for over 12 months. **Figure 7** showed a slight contraction of aquatic habitat in November 2011 with no change in May 2012. Subsidence monitoring shows that this wetland has been subject to about 0.40 m of subsidence with a small amount of tilt to the west and it is difficult to see how the subsidence would result in a contraction of the aquatic wetland edge.

At the western (start) end of the Wetland 8 transect there is a dense group of *Casuarina glauca* trees growing on a wide low mound of soil. This soil mound is acting as a barrier to any expansion of this wetland directly along the line of the monitoring transect. From general observation, it appears that there has been expansion of free water to the west and south west; see Section 6 below for further discussion.

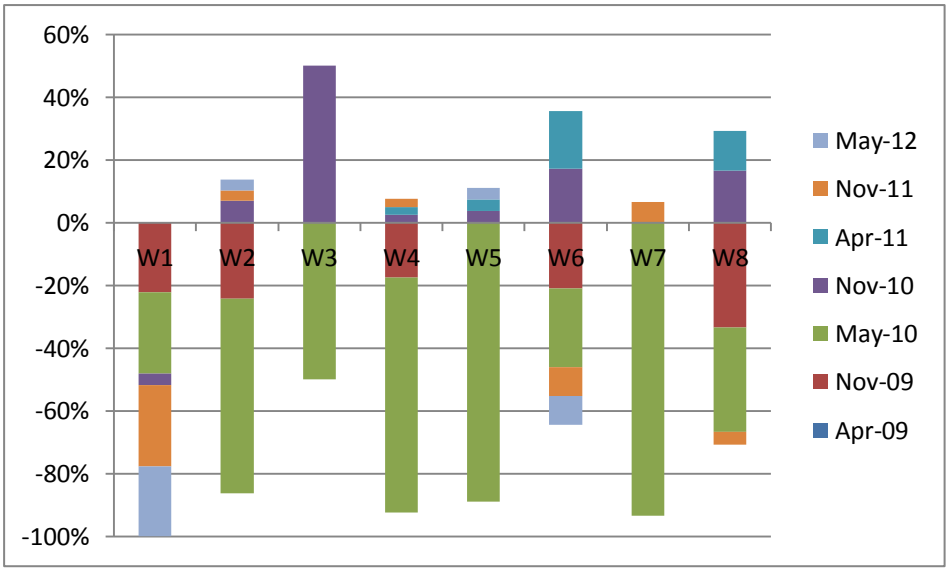


Figure 7 Movement of the aquatic habitat boundary in relation to the April 2009 baseline set as zero

5.4 Individual wetland detail

The following sections provide details for each wetland. Each section shows a plot of the Split Moving Window analysis and the MDS analysis. Tables of the raw individual species abundance data are also provided; refer back to **Table 2** for the meaning of abundance scores.

5.4.1 Wetland 1

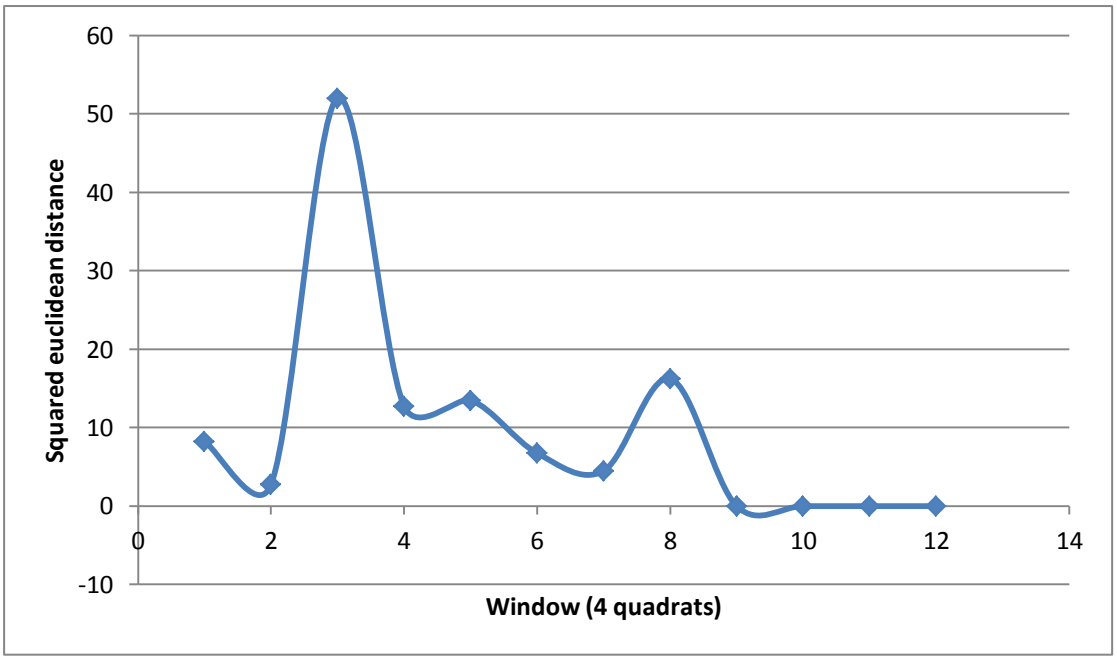


Figure 8 SMW plot for Wetland 1

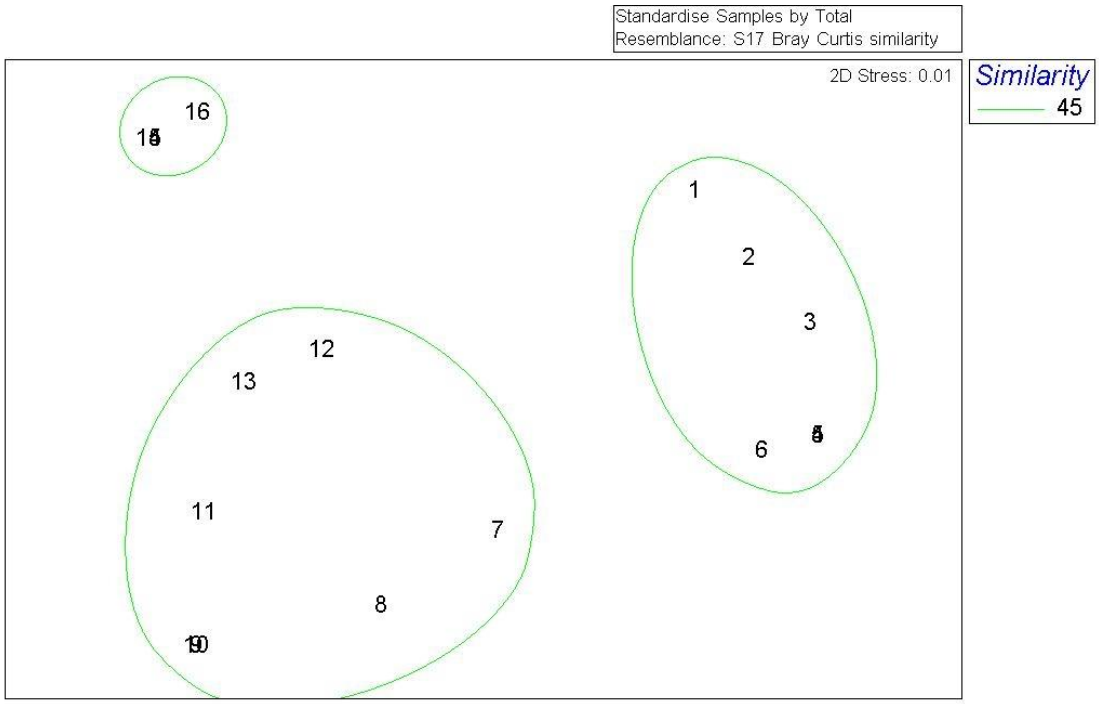


Figure 9 MDS plot for Wetland 1

Table 4 Wetland 1 abundance data

(Arrows show SMW transitions; shading shows MDS groups.)

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**																										
Asteraceae	*Aster subulatus**	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
Poaceae	*Axonopus fissifolius**	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
Azollaceae	*Azolla pinnata*	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	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	2	4	4	4	5	3	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Cynodon dactylon**	4	5	5	6	6	6	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyperaceae	*Cyperus polystachyos*	3	4	4	1	1	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyperaceae	*Isolepis inundata*	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
Juncaceae	*Juncus cognatus**	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
Juncaceae	*Juncus polyanthemos*	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
Juncaceae	*Juncus usitatus*	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Paspalum distichum*	0	0	0	0	0	0	4	6	6	6	5	3	4	0	0	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										

Aquatic vegetation was the most sparse recorded so far with no vegetation from 22 m to the end of the transect.

5.4.2 Wetland 2

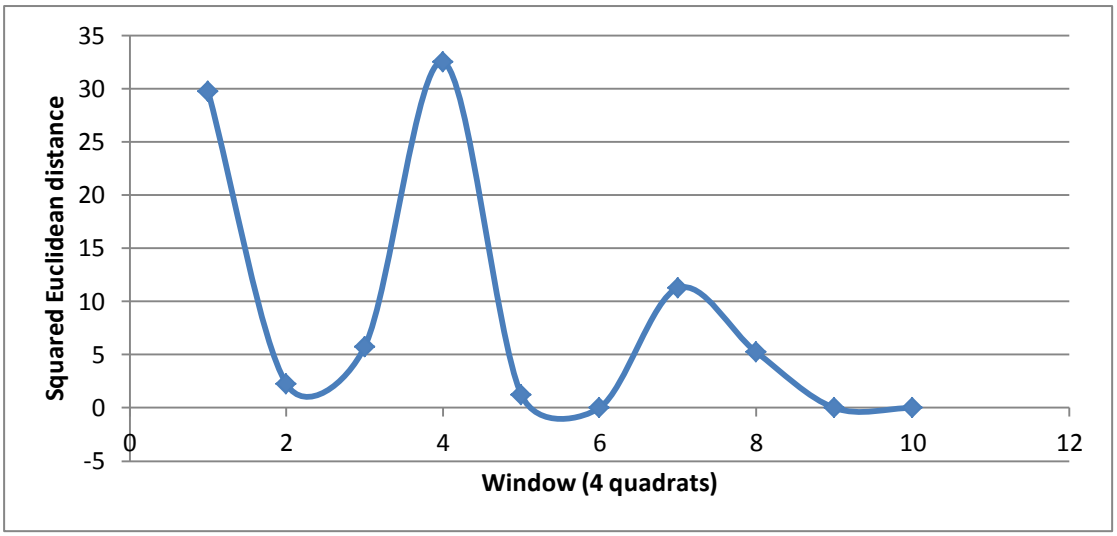


Figure 10 SMW plot for Wetland 2

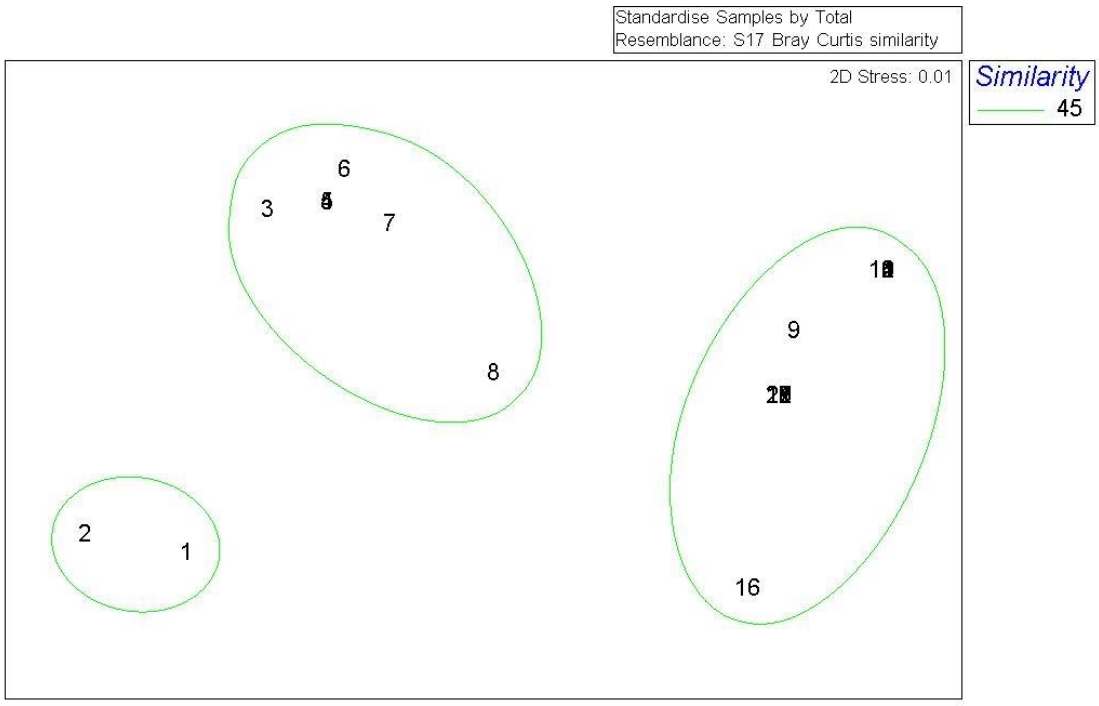


Figure 11 MDS plot for Wetland 2

Table 5 Wetland 2 abundance data

(Arrows show SMW transitions; shading shows MDS groups.)

Wetland 2	Transect quadrat number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	22	16	17	18	19	20	21
Family	Species	Abundance Scores																					
Poaceae	*Axonopus fissifolius**	3	2	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	1	1	5	5	5	5	5	5	5	3	5	5	5	5	5	5
Cyperaceae	*Carex appressa*	2	1	5	6	6	5	5	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Apiaceae	*Centella asiatica*	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Cynodon dactylon**	1	0	0	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	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0
Apiaceae	*Hydrocotyle tripartita*	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncaceae	*Juncus polyanthemos*	0	1	0	0	0	0	0	0	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	0	1	2	2	3	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Plantaginaceae	*Plantago lanceolata**	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	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ricciaceae	*Ricciocarpus natans*	0	0	0	0	0	0	0	1	1	0	0	0	0	0	3	2	3	3	3	3	3	3
Rosaceae	*Rubus discolor**	2	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	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0
		DRY		MARGIN						AQUATIC													

The water surface was covered with dense (about 1 cm thick) *Spirodela polyrhiza*, a small floating Duck Weed and the floating fern *Azolla pinnata*. None of the threatened *Maundia triglochinoides* that were so dominant in April 2009 was present. A game camera was set up at this wetland and as the image shows, deer were recorded in the wetland itself; probably Red Deer. The game camera also captured a number of water birds using the wetland. The most common was Black Duck along with Black Swan, Purple Swamp Hen and young, and Little Black Cormorant.

5.4.3 Wetland 3

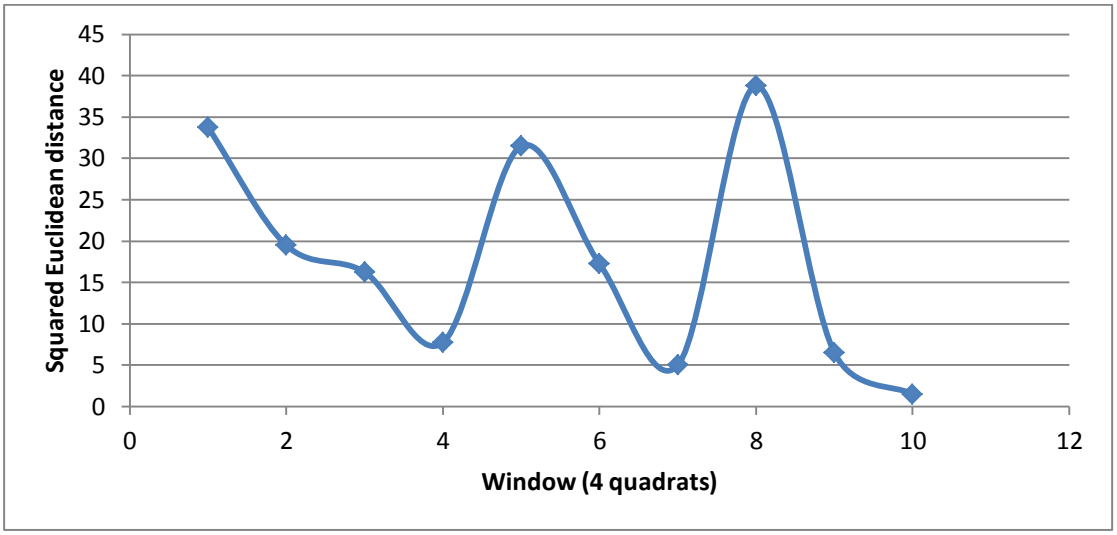


Figure 12 SMW plot for Wetland 3

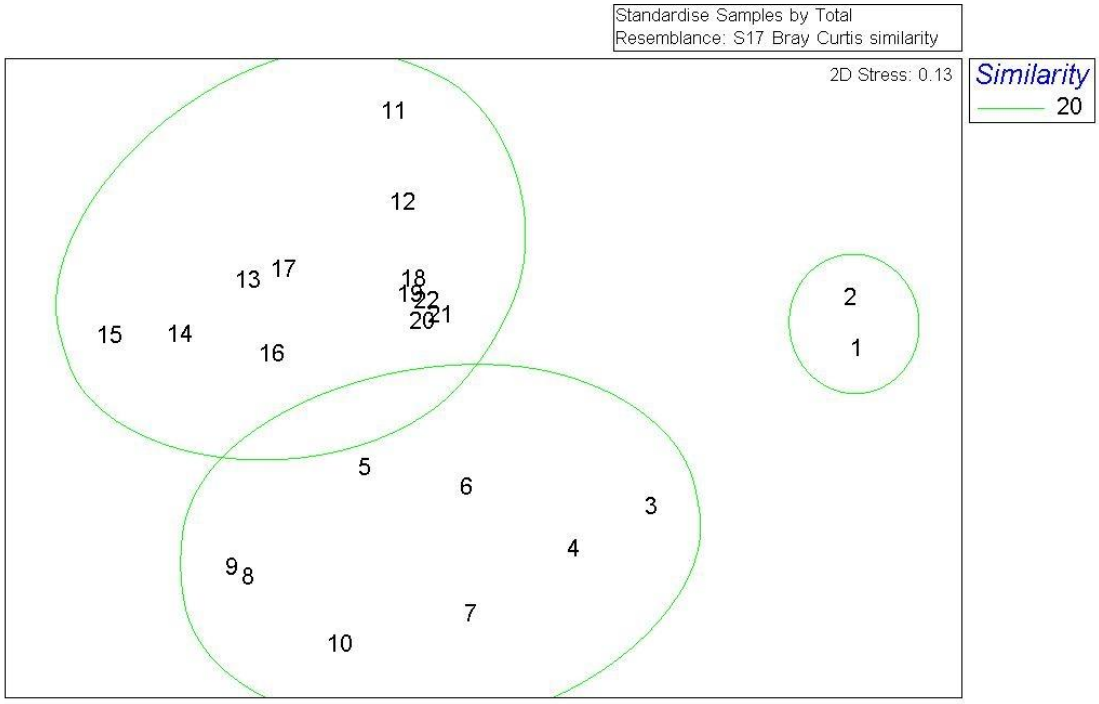


Figure 13 MDS plot for Wetland 3

Table 6 Wetland 3 abundance data
(Arrows show SMW transitions; shading shows MDS groups.)

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	5	2	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	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyperaceae	*Carex appressa*	0	0	2	4	0	2	5	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0
Poaceae	*Cynodon dactylon**	1	3	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	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyperaceae	*Cyperus polystachyos*	1	1	0	1	0	0	0	0	0	0	1	1	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	2	2	0	0	0	3	4	5	5	4	0	0	0	0	0
Cyperaceae	*Fimbristylis dichotoma*	1	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	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncaceae	*Juncus polyanthemos*	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Onagraceae	*Ludwigia peploides subsp. montevidensis*	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	1	0	0	0	0	0	0
Poaceae	*Panicum obseptum*	0	0	0	0	0	0	1	4	4	1	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Paspalum dilatatum**	1	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	2	1	0	0	0	0	1	5	4	2	1	4	4	5	4	3	2	3
Polygonaceae	*Persicaria praetermissa*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0
Polygonaceae	*Persicaria strigosa*	0	0	1	2	5	2	3	4	3	4	0	1	1	0	0	2	1	2	2	3	2	2
Phylidraceae	*Philydrum lanuginosum*	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	4	6	5	6	6	6
Potamogetonaceae	*Potamogeton octandrus*	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0
Lobeliaceae	*Pratia purpurascens*	0	1	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ranunculaceae	*Ranunculus inundatus*	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Sacciolepis indica*	1	0	1	0	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	0	0	1	2	2	0	0	0	0	0	0	0	0	0
Juncaginaceae	*Triglochin microtuberosa*	0	0	0	0	1	2	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
		DRY	MARGIN/AQUATIC MIX																				

There is a dense layer of decomposing vegetation in this wetland that is providing suitable growing conditions for a variety of species such that the margin and aquatic habitat have become merged even though there is deep water (>1 m).

5.4.4 Wetland 4

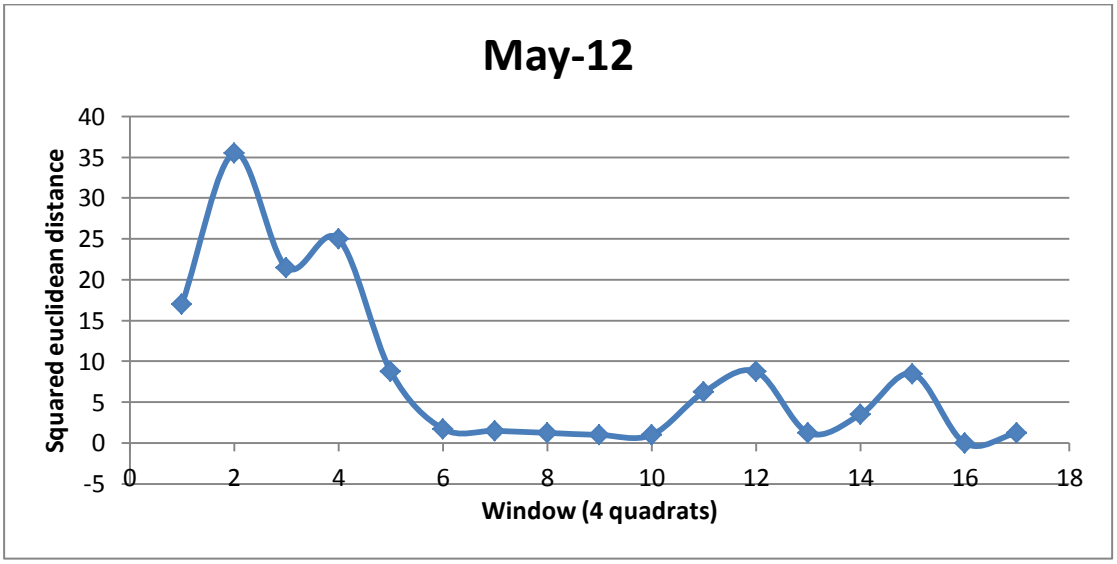


Figure 14 SMW plot for Wetland 4

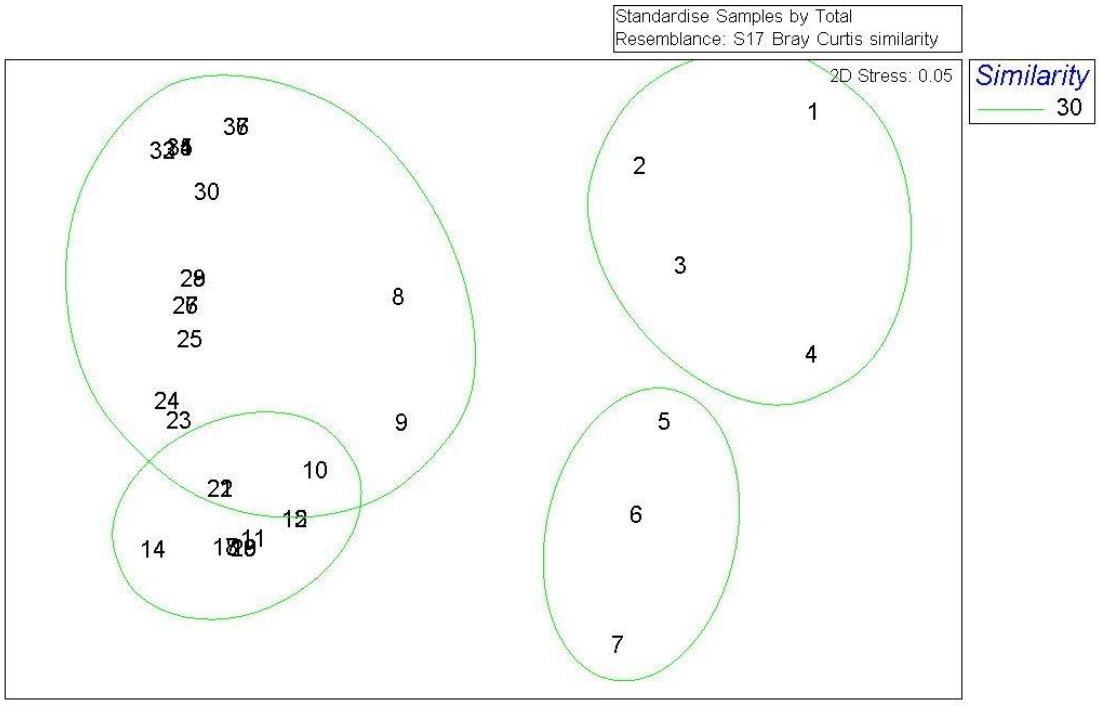


Figure 15 MDS plot for Wetland 4

Table 7 Wetland 4 abundance data

(Arrows show SMW transitions; shading shows MDS groups.)

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																																				
Poaceae	*Axonopus fissifolius**	0	1	1	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
Cyperaceae	*Carex appressa*	0	0	1	1	3	6	6	4	4	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	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
Poaceae	*Cynodon dactylon**	6	6	5	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	0	0	0
Cyperaceae	*Cyperus polystachyos*	1	2	2	1	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	0	0	0	0	0	0
Poaceae	*Eragrostis alveiformis*	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	2	2
Cyperaceae	*Fimbristylis dichotoma*	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	0
Goodeniaceae	*Goodenia stelligera*	0	0	0	0	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	0	0	0	0	0	0
Apiaceae	*Hydrocotyle laxiflora*	0	0	1	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	0	0	0
Juncaceae	*Juncus cognatus**	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	0	0	0	0	0
Juncaceae	*Juncus polyanthemos*	0	1	2	0	0	2	0	0	0	0	0	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
Juncaceae	*Juncus prismatocarpus*	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	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	1	1	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Juncaginaceae	*Maundia triglochinoides*	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	1	1	0	0	1	1	1	1
Haloragaceae	*Myriophyllum crispatum*	0	0	0	0	0	0	0	5	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	3	3	4	4	5	6	6	6	6	6	6	6
Poaceae	*Paspalum distichum*	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polygonaceae	*Persicaria praetermissa*	0	0	0	0	0	0	0	2	4	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	5	4	4	4	4	1	0	0	0	0	0	0	0
Potamogetonaceae	*Potamogeton octandrus*	0	0	0	0	0	0	0	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
Ranunculaceae	*Ranunculus inundatus*	0	0	0	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
		DRY				MARGIN			AQUATIC																														

Aquatic vegetation was still well below April 2009 levels.

5.4.5 Wetland 5

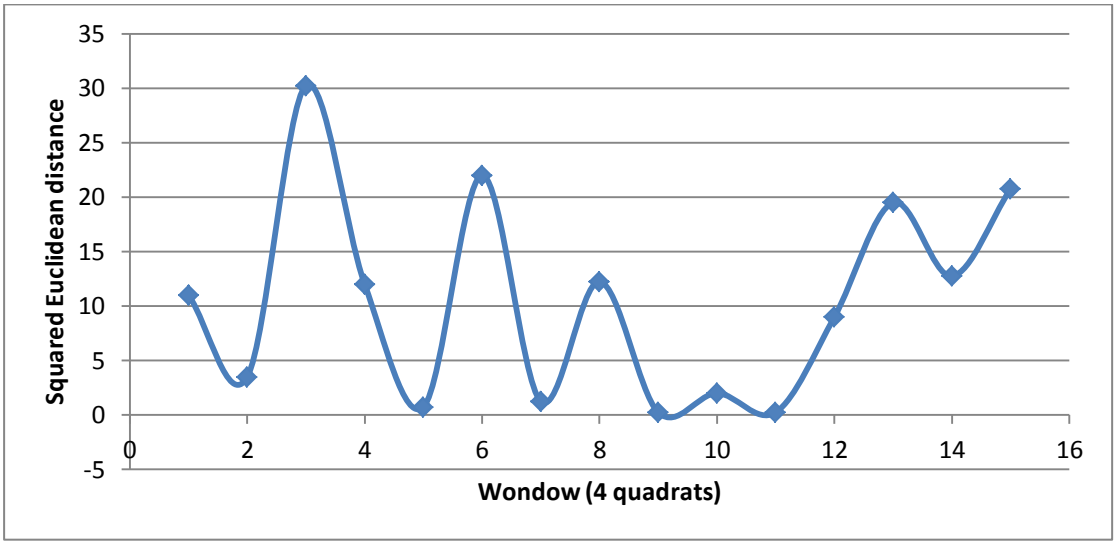


Figure 16 SMW plot for Wetland 5

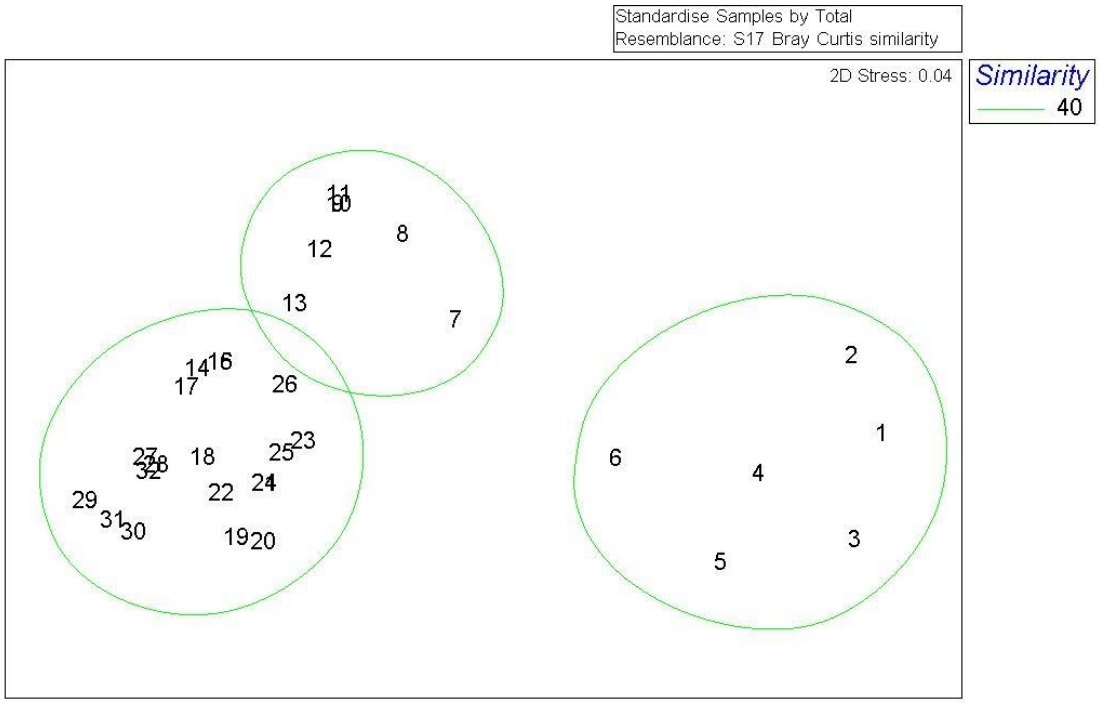


Figure 17 MDS plot for Wetland 5

Table 8 Wetland 5 abundance data

(Arrows show SMW transitions; shading shows MDS groups)

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	*Axonopus fissifolius**	3	4	2	4	5	4	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	0	0	1	1	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	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**	2	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
Cyperaceae	*Cyperus polystachyos*	0	0	2	3	3	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
Cyperaceae	*Fimbristylis dichotoma*	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	*Isolepis prolifera**	0	0	0	0	0	0	1	4	5	5	6	4	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncaceae	*Juncus cognatus**	1	0	1	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 polyanthemos*	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
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	0	0	0	0	0	0	0	0	2	4	4	3	3	3	3	3	1	1	1	1	2	2	1
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	0	0	1	2	4	4	5	5	4	3	2	2	4	2	2	2	2	4	4	4	5	5	5
Poaceae	*Panicum bisulcatum*	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
Poaceae	*Paspalum dilatatum**	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
Poaceae	*Paspalum distichum*	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	0
Polygonaceae	*Persicaria praetermissa*	0	0	0	0	0	1	6	5	5	5	4	5	4	3	4	5	3	2	1	1	2	2	4	2	3	4	1	1	0	0	0	1
Phylidraceae	*Philydrum lanuginosum*	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	0	0	0	0
Lobeliaceae	*Pratia purpurascens*	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
Ranunculaceae	*Ranunculus inundatus*	0	0	0	0	0	1	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
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
Poaceae	*Sacciolepis indica*	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	0
Asteraceae	*Senecio madagascariensis**	0	0	0	0	1	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
Poaceae	*Sporobolus africanus**	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
Asteraceae	*Taraxacum officinale**	1	1	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	0	0	0
Cyperaceae	*Tetraria capillaris*	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
Juncaginaceae	*Triglochin microtuberosa*	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	0
		DRY						MARGIN							AQUATIC																		

The weed *Isolepis prolifera* is spreading further into the aquatic habitat. Aquatic species were still in low abundance compared with April 2009.

5.4.6 Wetland 6

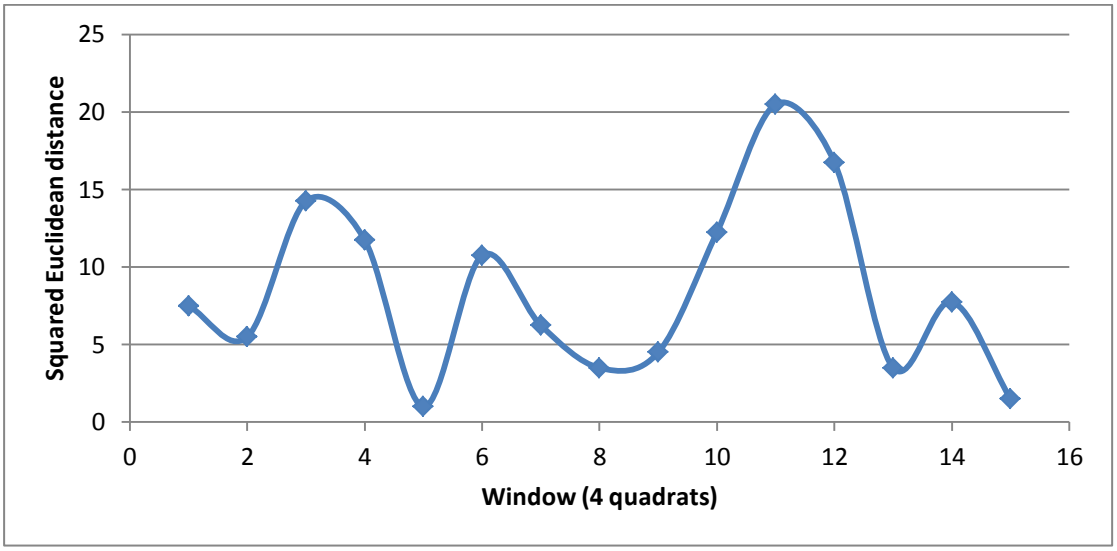


Figure 18 SMW plot for Wetland 6

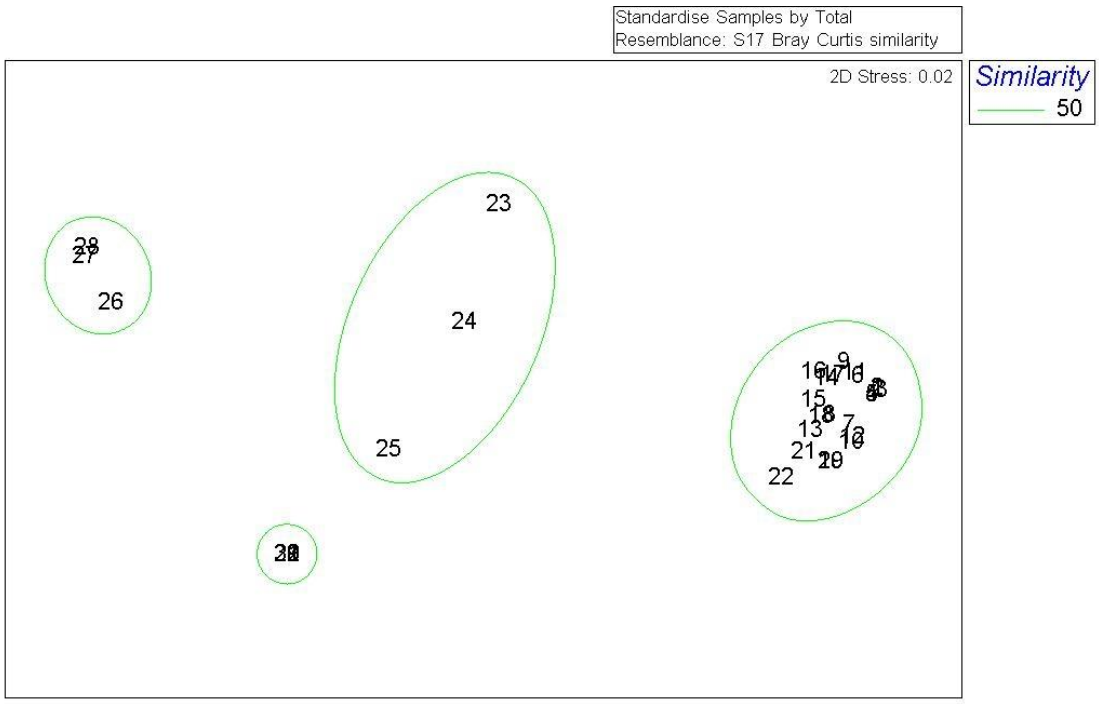


Figure 19 MDS plot for Wetland 6

Table 9 Wetland 6 abundance data

(Arrows show SMW transitions; shading shows MDS groups)

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**																																
Cyperaceae	*Carex appressa*	0	0	0	0	0	0	2	2	0	2	0	2	3	0	1	0	0	2	3	3	3	3	0	0	0	0	0	0	0	0	0	0	0
Cyperaceae	*Carex gaudichaudiana*	6	6	6	6	6	5	5	4	4	4	4	5	4	4	4	3	4	4	3	3	3	3	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	0	0	0	0	3	5	4	0	0	0	0	0
Apiaceae	*Hydrocotyle bonariensis**	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncaceae	*Juncus polyanthemos*	0	0	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	0
Haloragaceae	*Myriophyllum crispatum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0
Poaceae	*Paspalum distichum*	0	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
Polygonaceae	*Persicaria decipiens*	2	2	2	2	2	3	2	3	4	1	3	1	3	3	3	3	4	3	1	1	2	1	1	1	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	1	1	4	2	1	0	0	0	0	0	0	0	0
Ranunculaceae	*Ranunculus inundatus*	0	0	0	1	1	0	0	0	0	0	0	1	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncaginaceae	*Triglochin procera*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	1	1	1	1	1	1
		MARGIN																						AQUATIC										

The dry habitat has now been replaced by margin habitat species as a consequence of persistent increased rainfall. No stock grazing has occurred along the transect for almost a year and the ground cover is tall and dense. Deer have been recorded regularly through this wetland. See **Appendix 2**.

5.4.7 Wetland 7

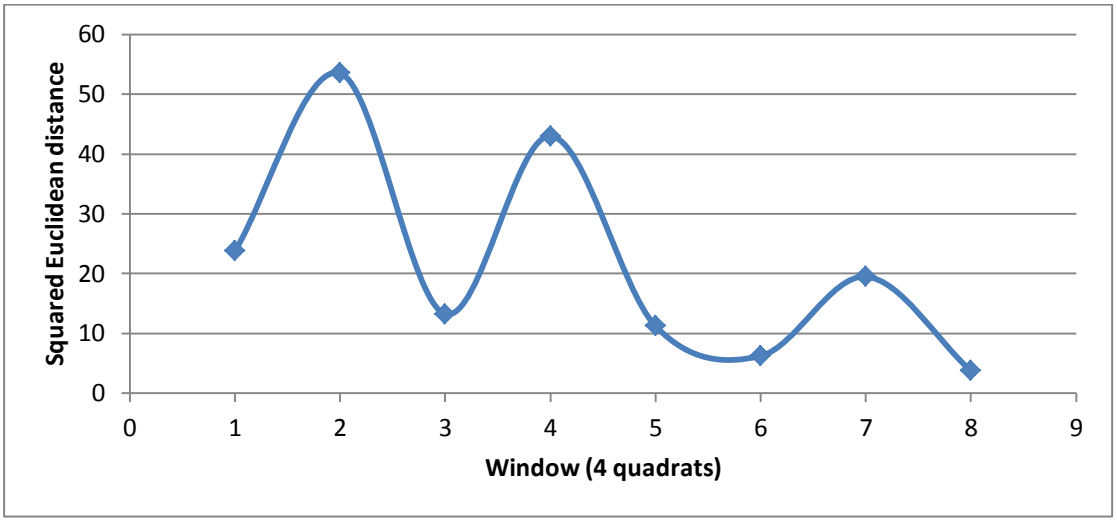


Figure 20 SMW plot for Wetland 7

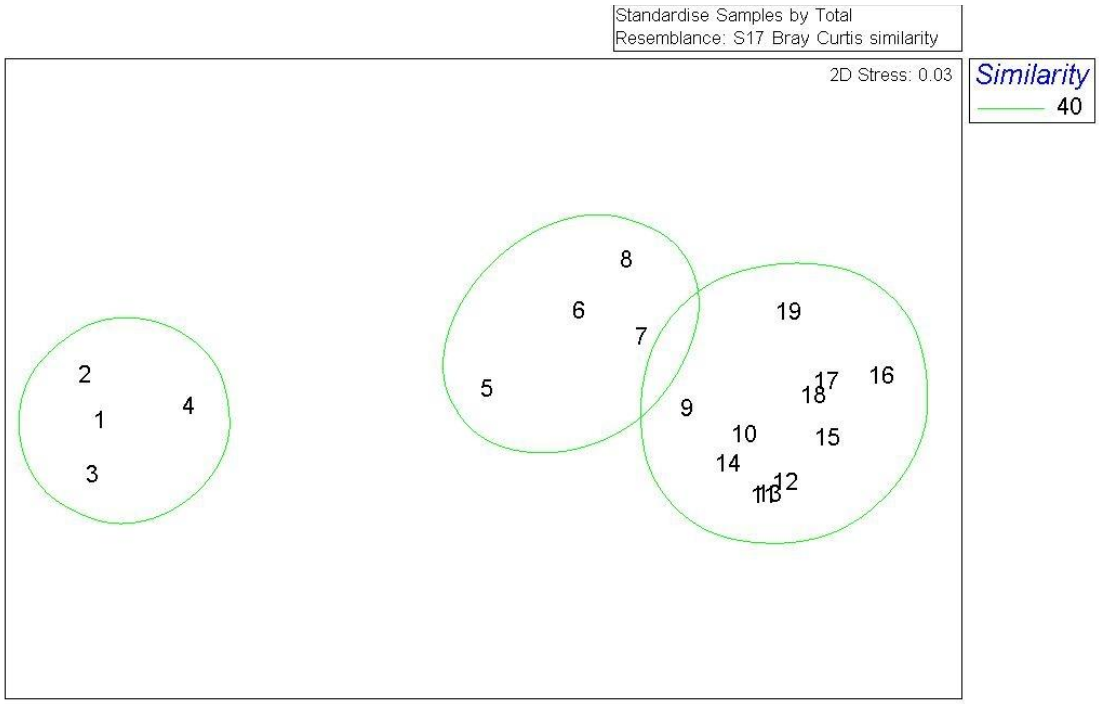


Figure 21 MDS plot for Wetland 7

Table 10 Wetland 7 abundance data

(Arrows show SMW transitions; shading shows MDS groups)

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	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Axonopus fissifolius**	6	6	6	5	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	2	2	3	2	3	3	4	4	3	4	3
Apiaceae	*Centella asiatica*	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyperaceae	*Cyperus haspan subsp. haspan*	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyperaceae	*Cyperus polystachyos*	1	1	1	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyperaceae	*Cyperus sesquiflorus**	1	1	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	0	0	0	0	2	0	0	1	4	3	2	3
Juncaceae	*Juncus polyanthemos*	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Juncaceae	*Juncus prismatocarpus*	0	0	0	0	1	1	0	0	1	1	1	1	1	1	0	0	0	0	0
Onagraceae	*Ludwigia peploides subsp. montevidensis*	0	0	0	0	1	0	1	1	0	1	0	1	2	1	1	0	0	0	0
Haloragaceae	*Myriophyllum crispatum*	0	0	0	0	2	5	5	6	4	2	0	0	0	1	1	1	2	2	4
Poaceae	*Paspalum dilatatum**	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Paspalum distichum*	0	0	0	0	1	4	2	2	2	2	3	4	3	4	1	1	1	2	3
Polygonaceae	*Persicaria praetermissa*	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	2
Phylidraceae	*Philydrum lanuginosum*	0	0	0	0	0	0	2	0	5	5	4	4	4	3	4	1	3	3	0
Plantaginaceae	*Plantago lanceolata**	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Potamogetonaceae	*Potamogeton octandrus*	0	0	0	0	3	3	1	0	1	0	0	0	0	0	0	0	0	0	0
Ranunculaceae	*Ranunculus inundatus*	0	0	0	0	2	1	1	1	1	0	0	0	0	0	0	0	0	0	0
Polygonaceae	*Rumex sp**	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Asteraceae	*Senecio madagascariensis**	2	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Setaria sphacelata**	0	0	0	2	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncaginaceae	*Triglochin microtuberosa*	0	0	0	0	0	0	1	1	1	0	1	0	0	1	0	0	0	0	0
		DRY				M	AQUATIC													

This wetland is much the same as on previous monitoring occasions. *Philydrum lanuginosum* dominated the aquatic habitat.

5.4.8 Wetland 8

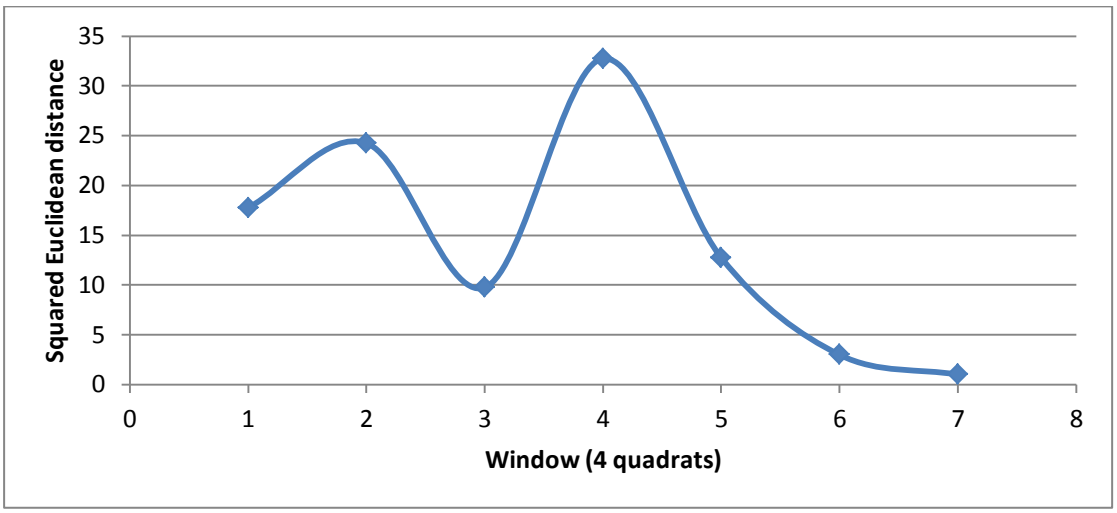


Figure 22 SMW plot for Wetland 8

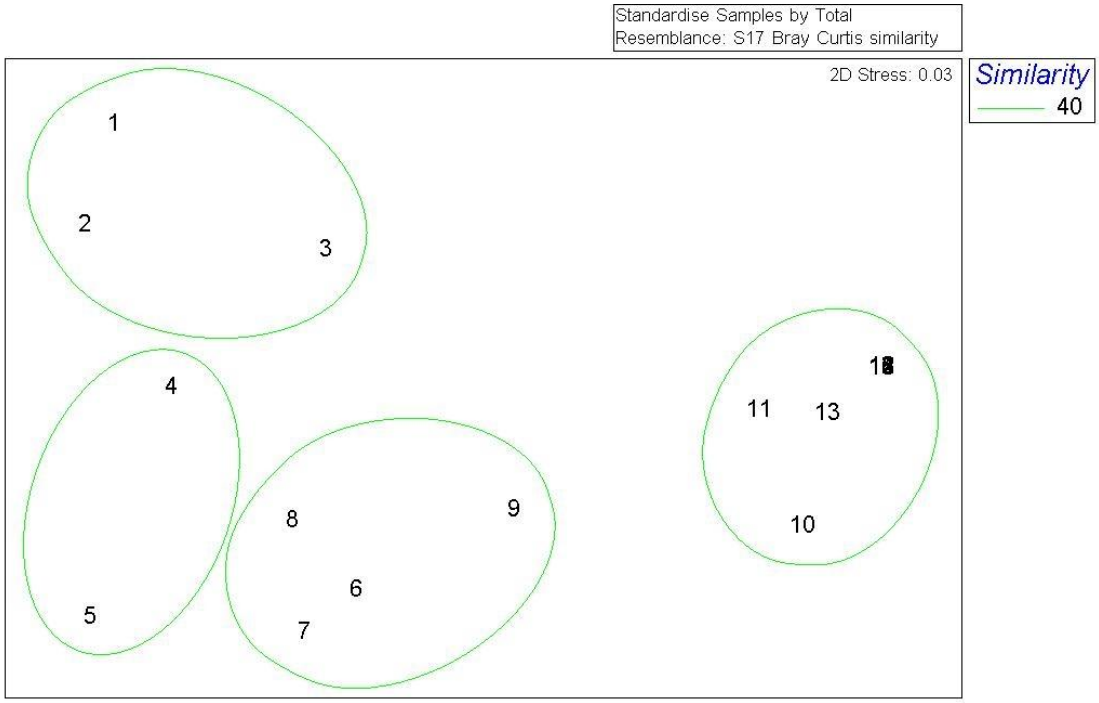


Figure 23 MDS plot for Wetland 8

Table 11 Wetland 8 abundance data

(Arrows show SMW transitions; shading shows MDS groups.)

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**																
Poaceae	*Axonopus fissifolius**	3	1	3	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Azollaceae	*Azolla pinnata*	0	0	0	0	0	0	0	0	3	4	6	6	6	6	6	6	6
Cyperaceae	*Carex appressa*	0	1	1	3	6	4	4	3	2	0	0	0	0	0	0	0	0
Casuarinaceae	*Casuarina glauca*	1	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Apiaceae	*Centella asiatica*	1	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Cyperaceae	*Cyperus flavidus*	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Asteraceae	*Euchiton sphaericus*	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Juncaceae	*Juncus polyanthemos*	0	0	0	0	0	1	0	0	1	2	3	0	1	0	0	0	0
Juncaginaceae	*Juncus usitatus*	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fabaceae (Faboideae)	*Lotus corniculatus**	0	0	0	0	1	1	1	2	1	0	0	0	0	0	0	0	0
Onagraceae	*Ludwigia peploides subsp. montevidensis*	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
Oxalidaceae	*Oxalis sp.*	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Paspalum dilatatum**	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Poaceae	*Paspalum distichum*	0	0	0	0	0	0	0	0	2	2	1	0	0	0	0	0	0
Polygonaceae	*Persicaria praetermissa*	0	0	0	0	0	1	2	1	0	0	0	0	0	0	0	0	0
Plantaginaceae	*Plantago lanceolata**	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lobeliaceae	*Pratia purpurascens*	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Ranunculaceae	*Ranunculus inundatus*	0	0	1	1	0	3	3	3	3	0	1	0	0	0	0	0	0
Asteraceae	*Senecio madagascariensis**	3	2	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Setaria gracilis**	1	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	0	0	0	0	3	3	3	3	3	3	3
Fabaceae (Faboideae)	*Trifolium repens*	1	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	1	1	1	1	1	1
		DRY			MARGIN					AQUATIC								

The aquatic habitat was dominated by the floating fern *Azolla pinnata*. The dry and margin habitats were as for previous monitoring occasions.

5.5 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 six sampling events since and including April 2009.

The **Margalef Richness Index** (d) is a measure of the number of species present for a given number of individuals.

The **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 used to determine whether the variation in diversity over time was significant. Results are shown in **Figures 24 to 31**. All data were significant at 99.9%, indicated by ***. Time is shown in abbreviated years 09, 10, 11 and 12. There was no aquatic vegetation in Wetland 1 in May 2012 so the plots for that wetland are from November 2011.

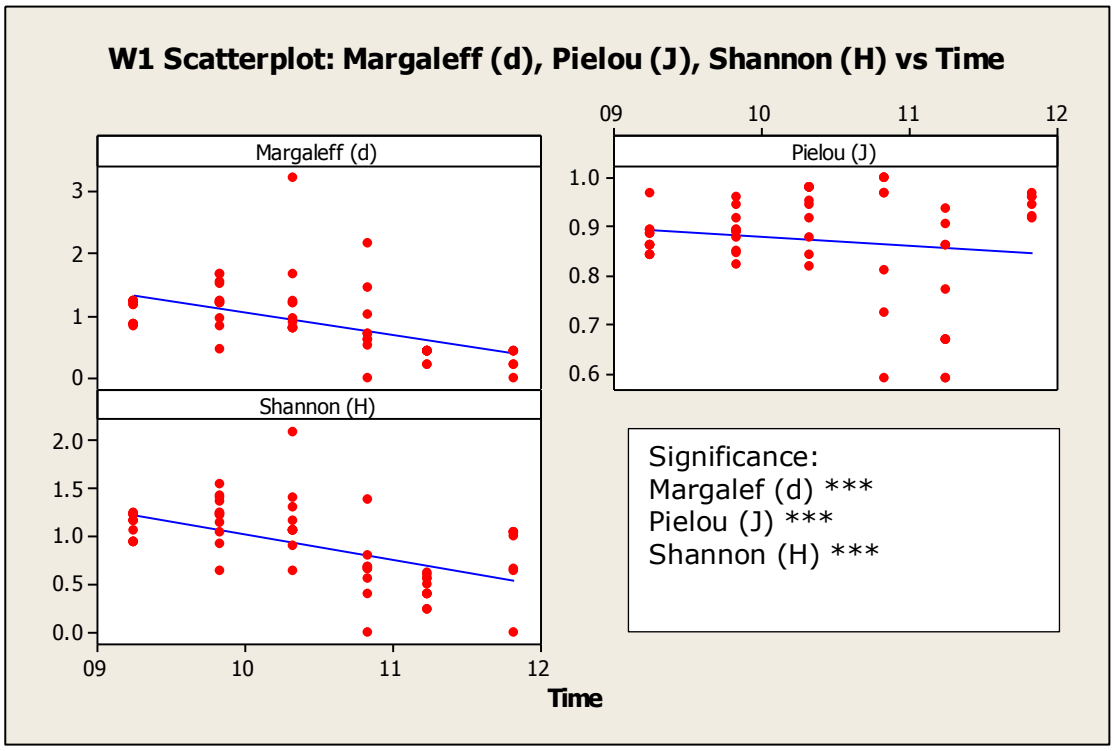


Figure 24 Wetland 1 plots showing the trend of the three diversity indices for aquatic habitat over the six monitoring occasions

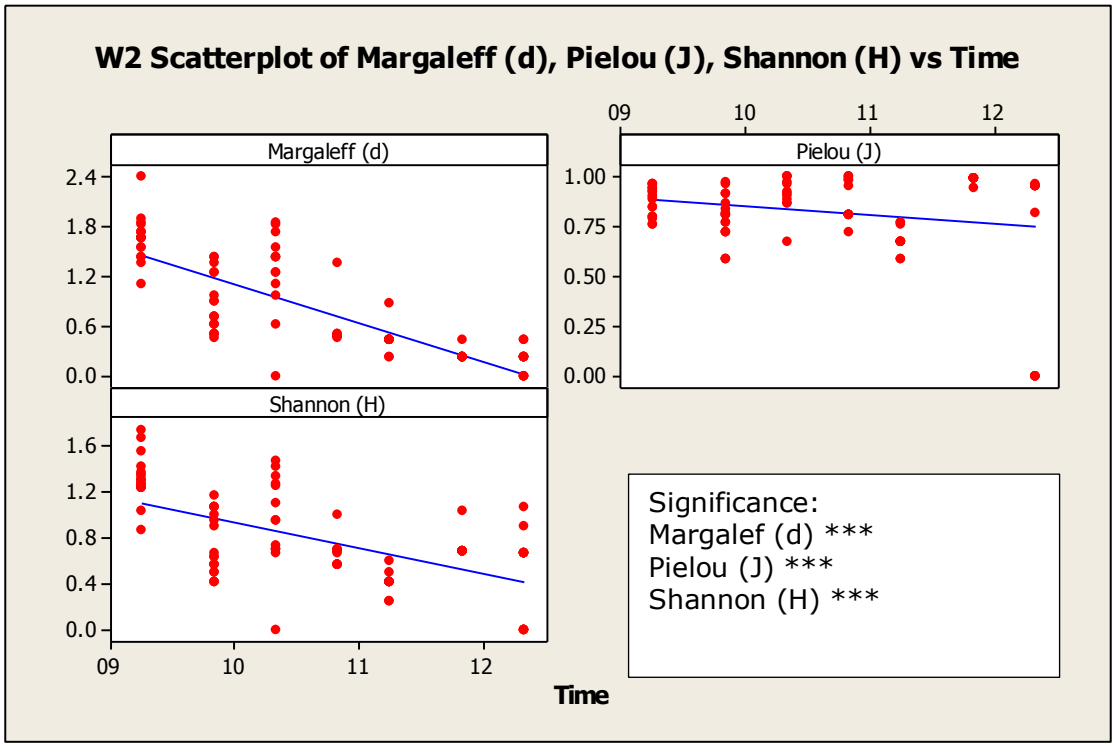


Figure 25 Wetland 2 plots showing the trend of the three diversity indices for aquatic habitat over the six monitoring occasions

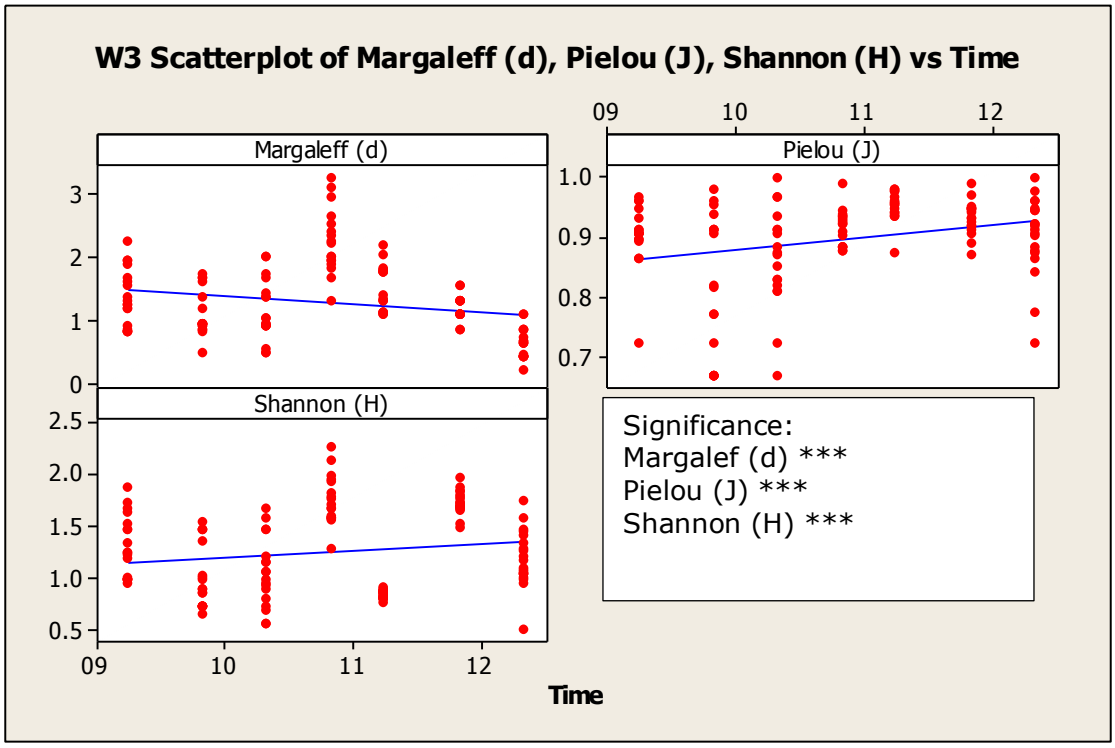


Figure 26 Wetland 3 plots showing the trend of the three diversity indices for aquatic habitat over the six monitoring occasions

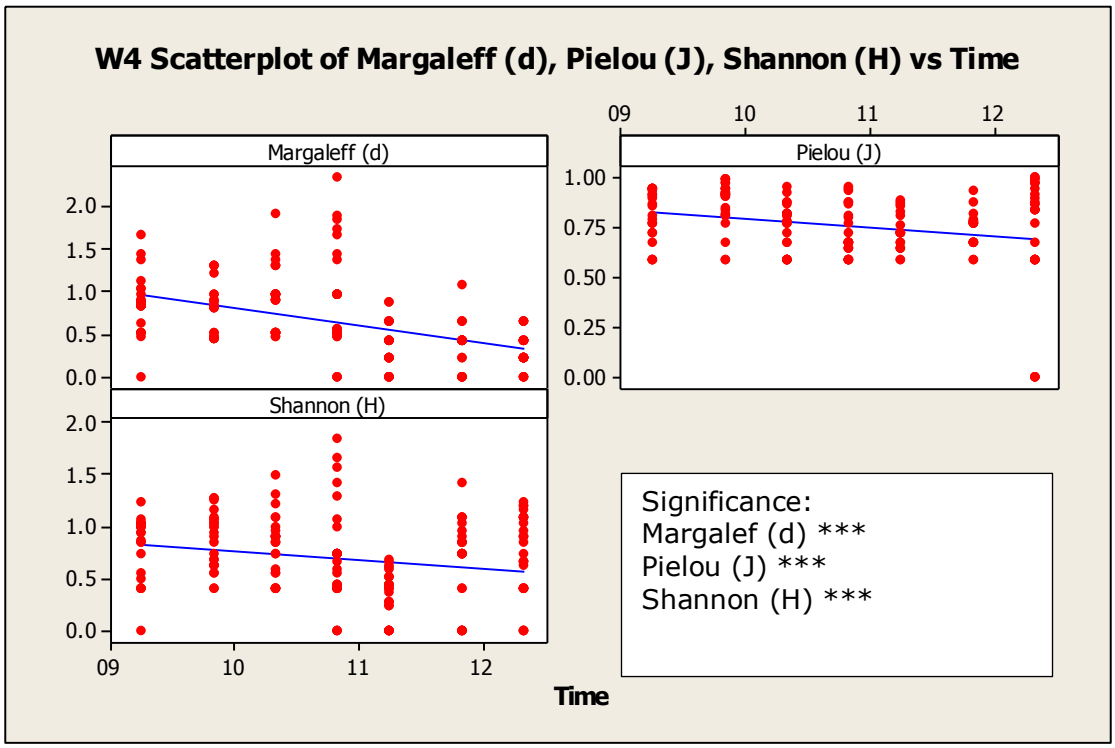


Figure 27 Wetland 4 plots showing the trend of the three diversity indices for aquatic habitat over the six monitoring occasions

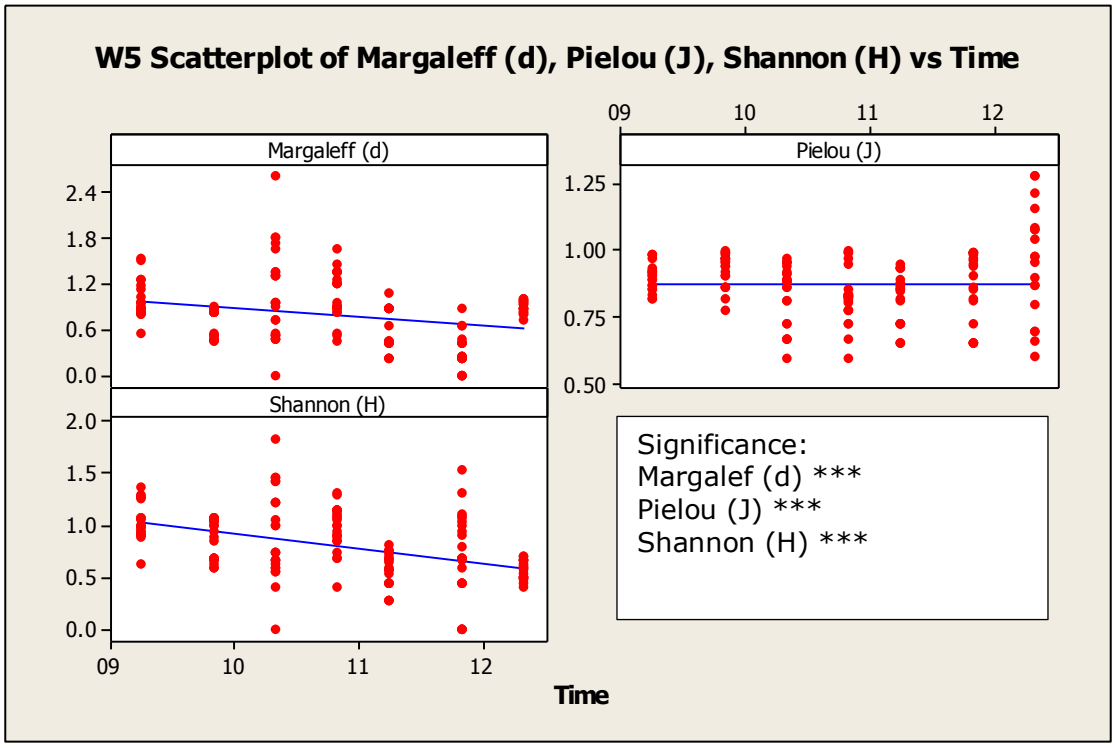


Figure 28 Wetland 5 plots showing the trend of the three diversity indices for aquatic habitat over the six monitoring occasions

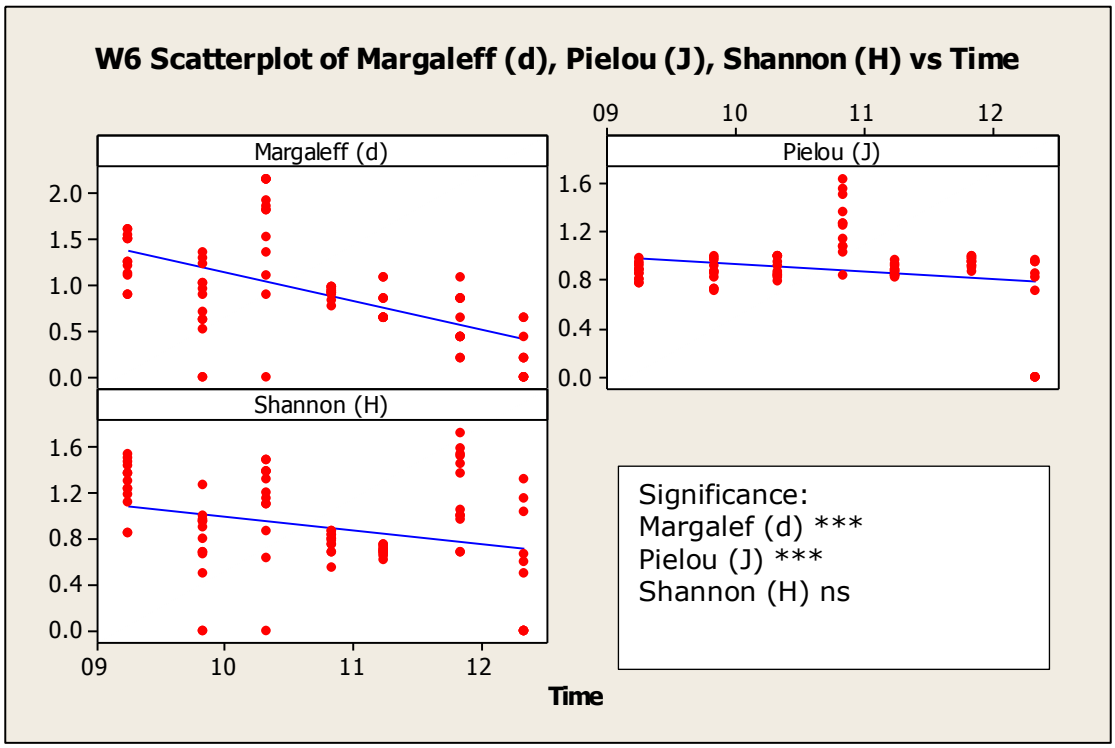


Figure 29 Wetland 6 plots showing the trend of the three diversity indices for aquatic habitat over the six monitoring occasions

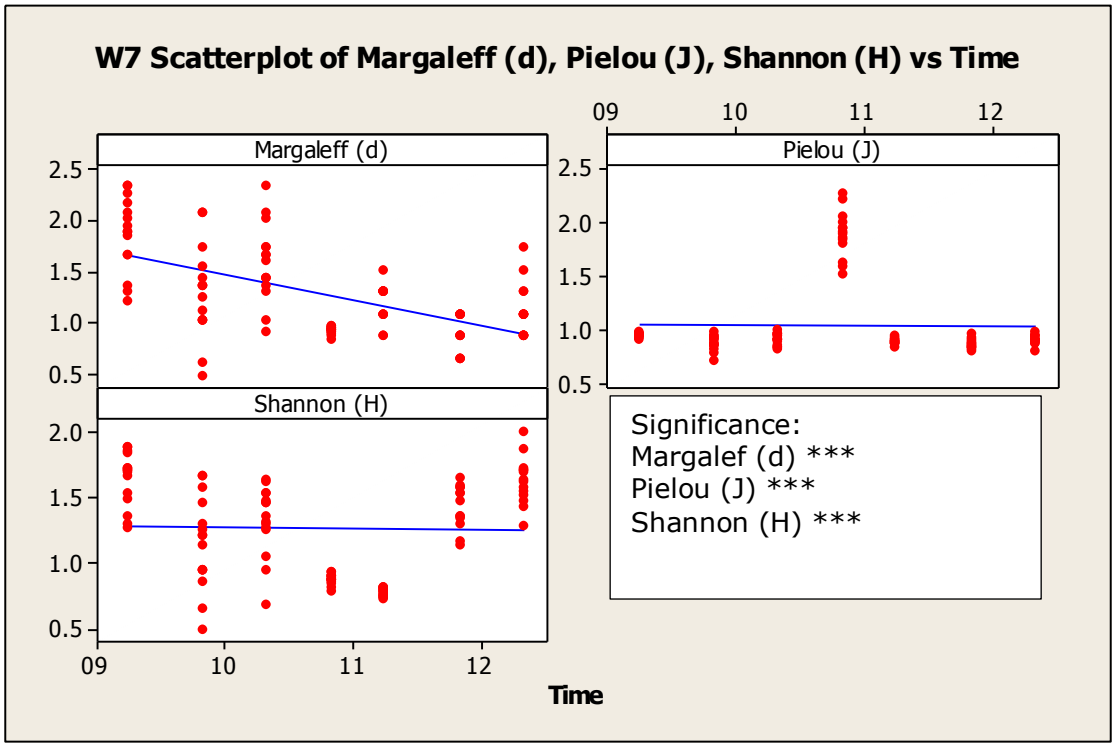


Figure 30 Wetland 7 plots showing the trend of the three diversity indices for aquatic habitat over the six monitoring occasions

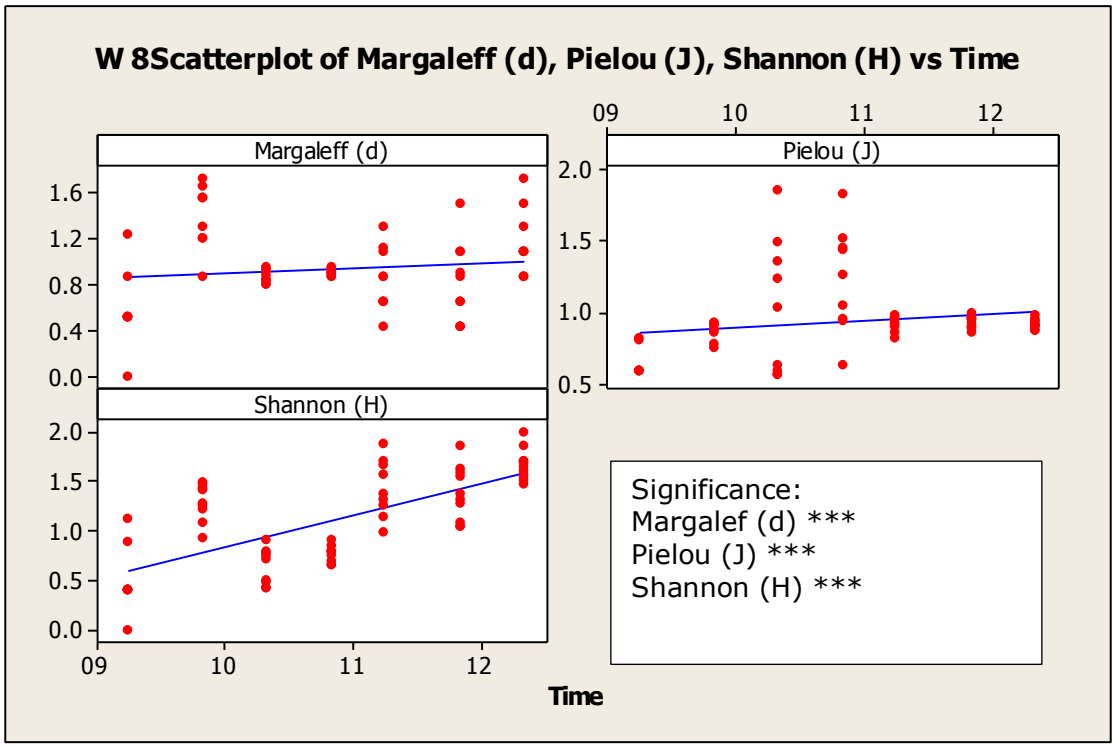


Figure 31 Wetland 8 plots showing the trend of the three diversity indices for aquatic habitat over the six monitoring occasions

The trends reported in November 2011 have continued. Other than for Wetlands 3 and 8, all significant trends have been downward. However, this downward trend does not necessarily imply that something is going 'wrong' with a wetland any more than an increasing trend would imply that a wetland is becoming 'good'. These indices can only be viewed as describing natural variation in aquatic habitat species composition and relative abundance.

Across all wetlands Pielou values were high, indicating that aquatic habitat was not dominated by one or more species. For Margalef and Shannon indices, where changes up or down were significant they were within a narrow range from a high starting point. The greatest fall was for Wetland 2 and this reflects the almost total loss of aquatic species since April 2009.

In the context of this monitoring program being primarily tasked with determining whether any detrimental changes occur in wetlands as a consequence of subsidence, it is important to note that changes in these indices were across all wetlands. In fact very little change occurred in either Wetland 6 or Wetland 8, the only wetlands that have been subject to subsidence.

5.6 Dominant species

The Simper module in Primer 6 was used to determine the dominant species in the abundance data and comparison was made for the six survey periods for each habitat type combined for all wetlands. The cutoff used in the analysis was 90% of the total species contributions.

Figure 32 shows that there are two dominant species in the 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.

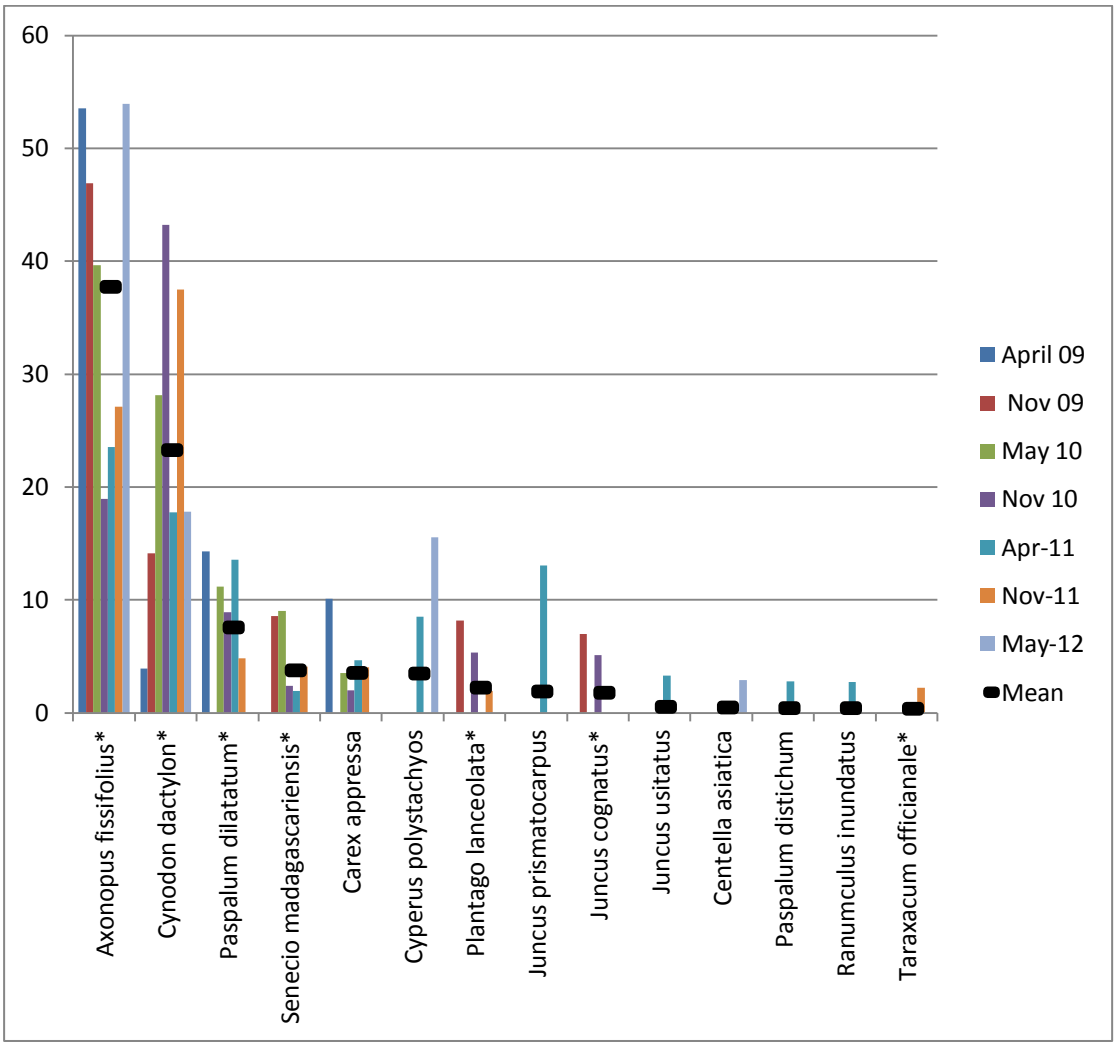


Figure 32 Simper analysis of dominant species in dry habitat for all wetlands
* Indicates weed species

Figure 33 shows that the dominant species in the margin habitat was *Carex appressa* followed by *Persicaria praetermissa*. Weeds persist into the margin habitat but in small quantities.

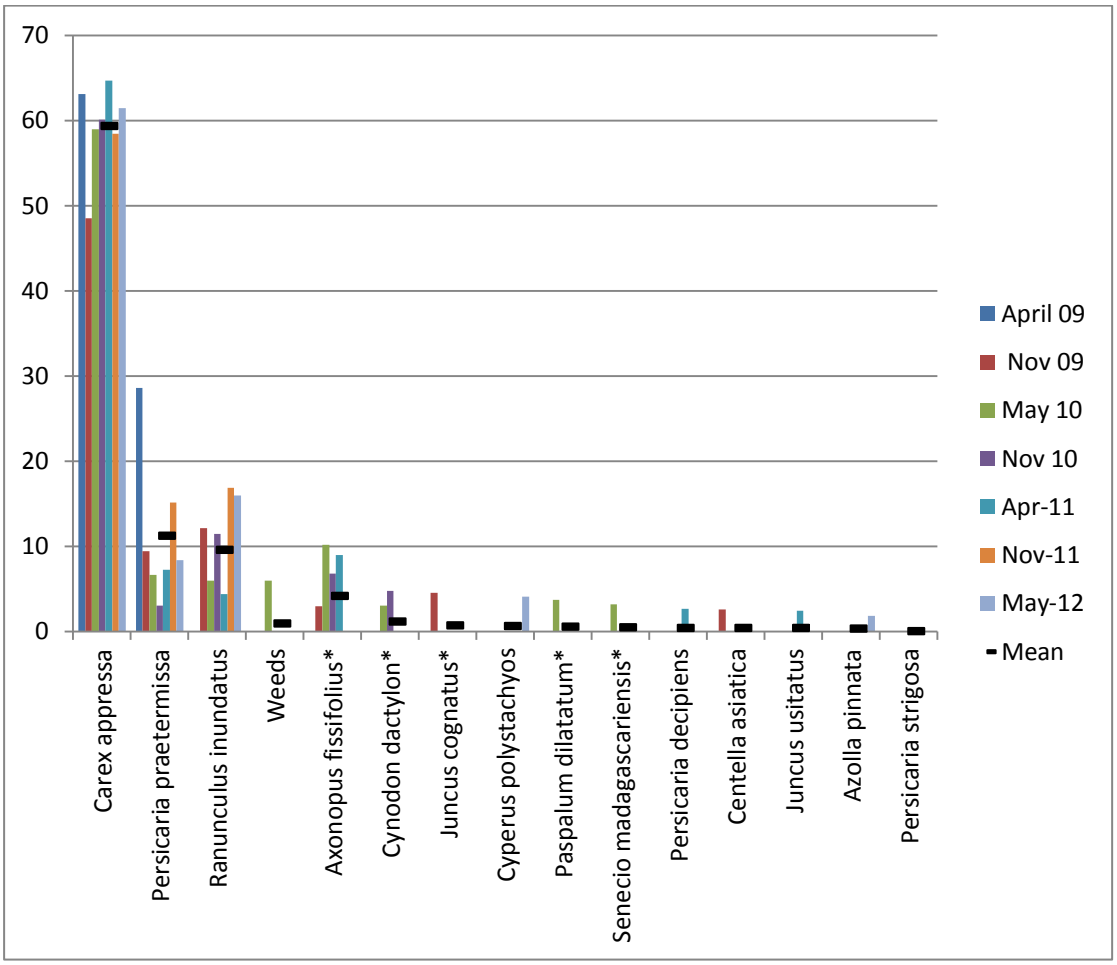


Figure 33 Simper analysis of dominant species in margin habitat for all wetlands
* Indicates weed species

Figure 34 shows that there are several species dominating Aquatic habitat with levels varying over monitoring occasions.

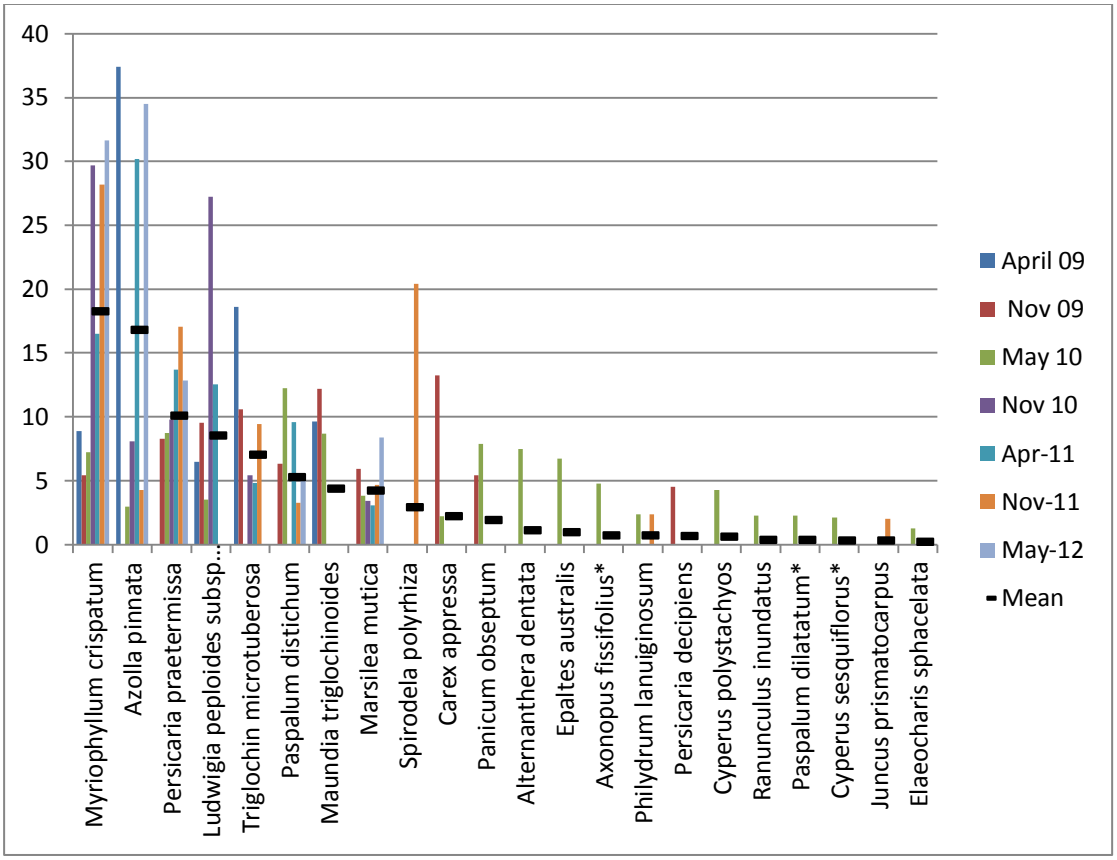


Figure 34 Simper analysis of dominant species in aquatic habitat for all wetlands
* Indicates weed species

These data show clearly that weeds are primarily restricted to the dry habitat with 75% of all species in that habitat being weeds. The margin habitat shows 6.45% weed species and aquatic habitat 2.52%.

The preceding analysis looked at the combined contribution from the top 90% of plants by their abundance in each habitat. There is a specific potential problem developing in Wetland 5 at the aquatic edge with the weed *Isolepis prolifera*. **Table 12** shows that this weed was apparently insignificant in April 2009 and has since spread densely along 6 m of the monitoring transect. Further investigation has revealed that there is a very large area dominated by this weed approximately 30 m south of the transect.

Table 12 *Isolepis prolifera* abundance over time

Month	8	9	10	11	12	13	Mean
April 09		1					0.17
Nov 09	2	4					1.00
May 10		3	3	3			1.50
Nov 10	3	3	1	1	1		1.50
Apr 11	4	4	3	2	1	1	2.50
Nov 11	4	4	4	4	4	2	3.70
May 12	1	4	5	5	6	2	3.83

5.7 Habitat analysis across all wetlands

To determine significant groupings across all wetlands the entire species abundance data for all wetlands were run through a cluster analysis in Primer 6 using the Simprof routine. Data used were the average abundances for each species in each habitat type. The Simprof routine classifies the cluster groups according to their significance (at 95%) which is shown by the black lines (significantly different groups) and the red lines (not significantly different).

Figures 35 and 36 show the dendrograms for April 2009 and May 2012.

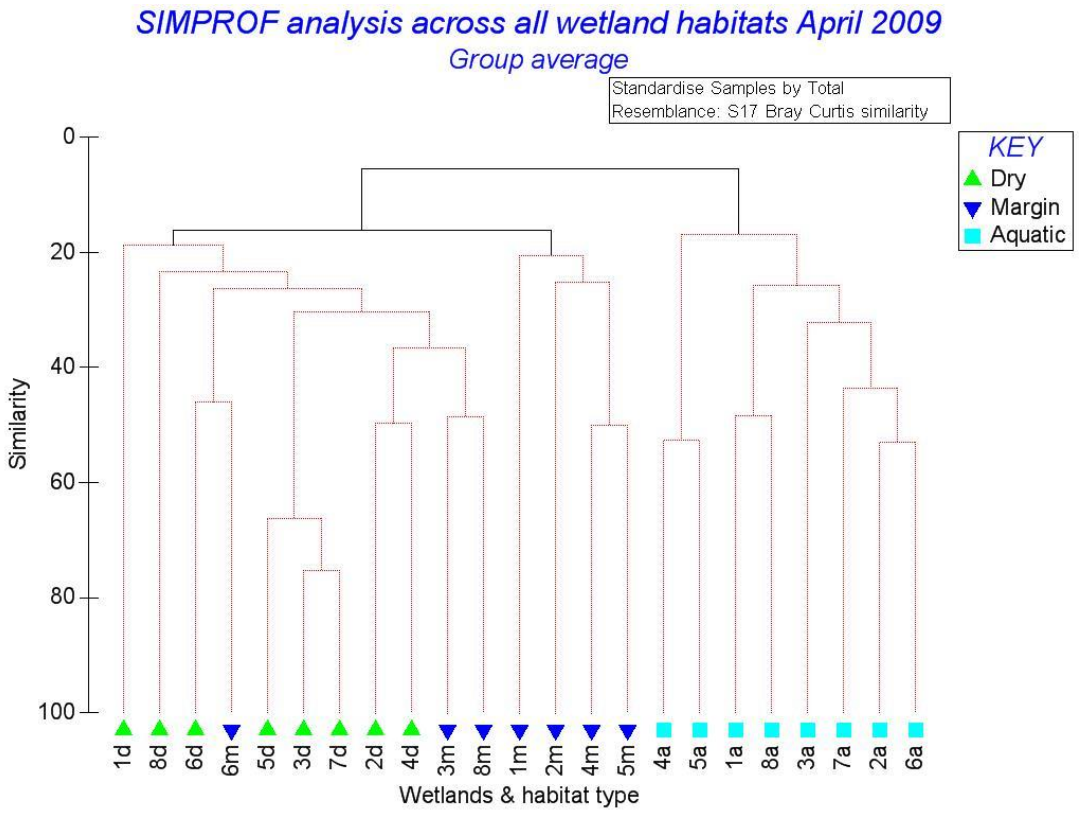


Figure 35 Simprof analysis of habitat across all wetlands (April 2009)
(Key to codes: 1D = Wetland 1, Dry habitat etc.)

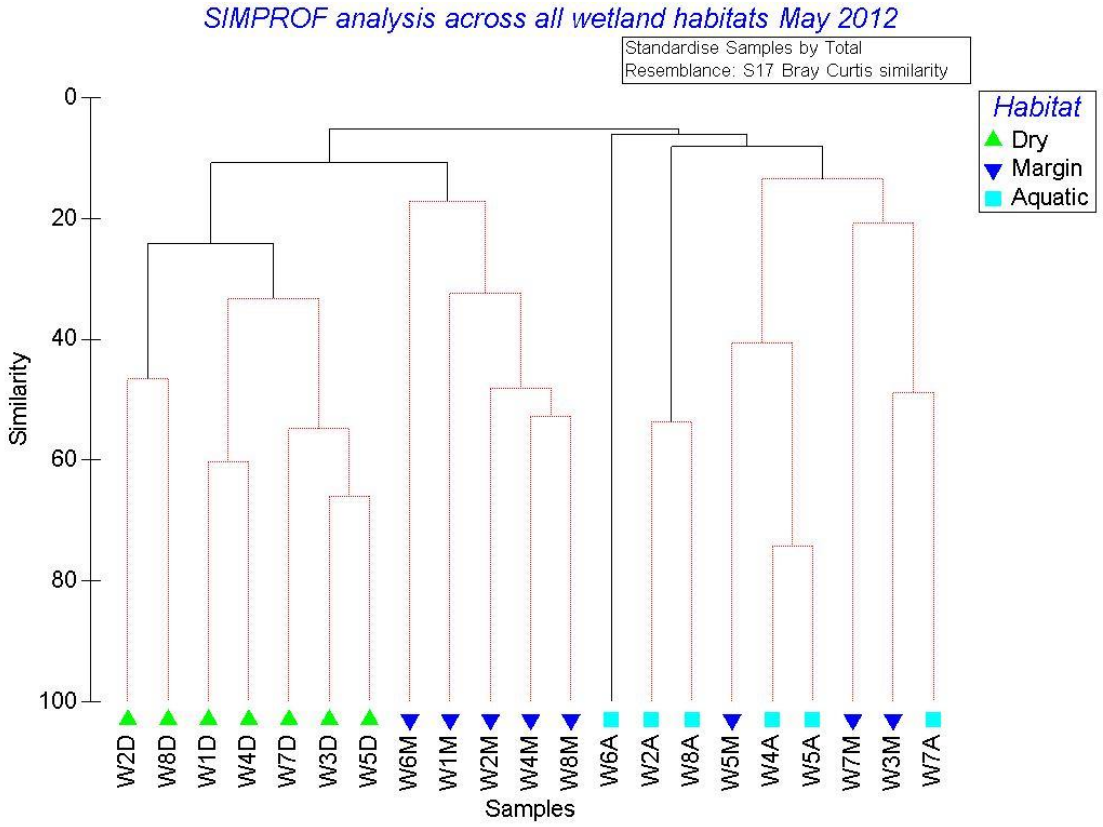


Figure 36 Simprof analysis of habitat across all wetlands (May 2012)
(Key to codes: 1D = Wetland 1, Dry habitat etc.)

In April 2009 when each wetland had plenty of water there was a clear separation between aquatic habitat, dry and margin habitats. As the water reduced that distinction has become much less clear and in May 2010 the three habitat types became less distinct. With the return of sufficient rain the separation of the habitats in is similar to that of April 2009.

As expected the dry habitat for all wetlands have grouped together. Margin habitat for wetlands 3, 5 and 7 have grouped with aquatic habitat. This is because free water with aquatic species was present below tussocks of *Carex appressa.*

5.8 Aquatic habitat variation over time

Because considerable variation in species content and abundance had been observed the November 2011 report provided analysis of the variation in aquatic habitat over the six monitoring occasions, 2009 – 2011.

An ANOSIM analysis (see Section 4.2 for details) was conducted to determine the significant differences between aquatic habitat content for each wetland and each monitoring occasion. Global analysis showed that there was no significant difference across all monitoring occasions in Aquatic habitat species composition for Wetlands 4 and 5. The other wetlands showed significant differences over time at a significance level of p <0.001 (99.9%). However, there were no consistent seasonal similarities in habitat, monitoring being carried out in winter and summer of each year.

Once again, this can only be described as natural variation. This analysis will be repeated in around 2014 after sufficient further data has been collected.

5.9 Water analysis

Figures 37 to 52 show the variation over time in the analysed data for each wetland. The data shown are total Nitrogen (Total N), total organic Nitrogen (TKN), total Phosphorus (Total P), pH, total suspended solids (TSS) and salinity (EC). The reader should be aware of the different scales for each wetland graph and compare actual values rather than column heights.

There was nothing remarkable about the parameters for May 2012. Because of past high variability, detailed statistical analysis will be considered after more data have been collected.

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 the 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 appears that the large amount of subsurface organic matter is resulting in a substantial change in the aquatic vegetation.

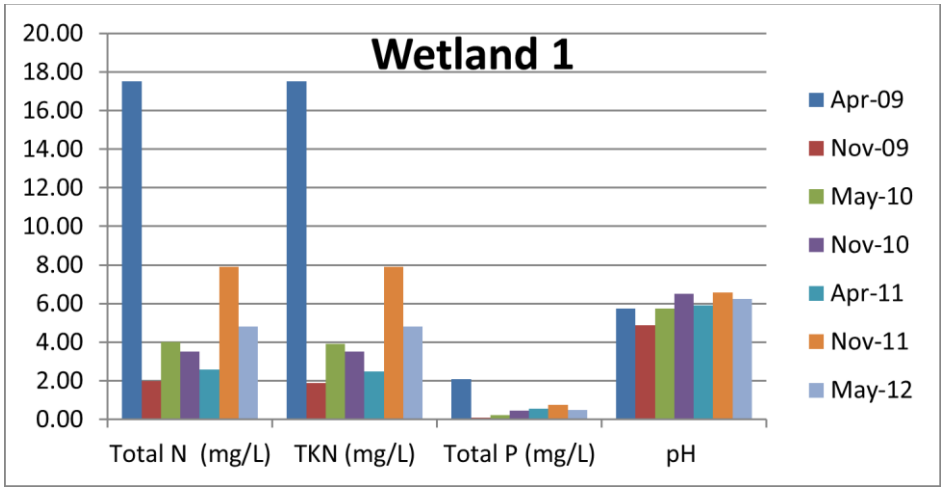


Figure37 Wetland 1 Nitrogen, Phosphorus and pH

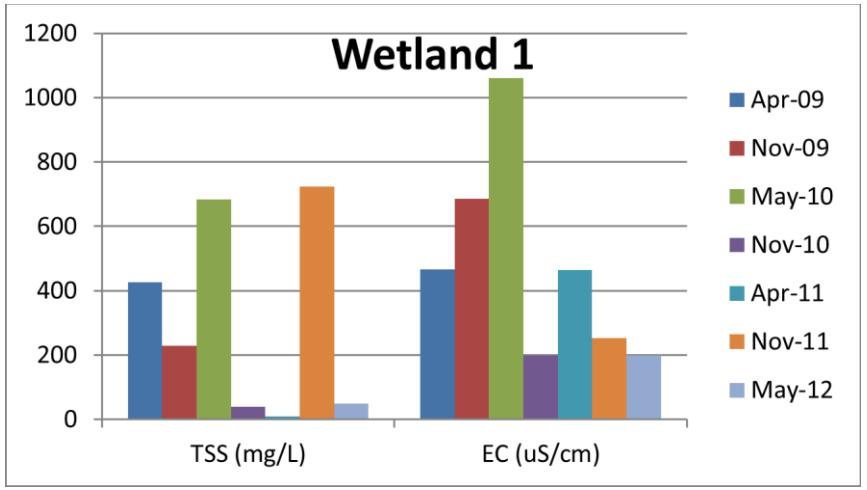


Figure 38 Wetland 1 suspended solids and salinity

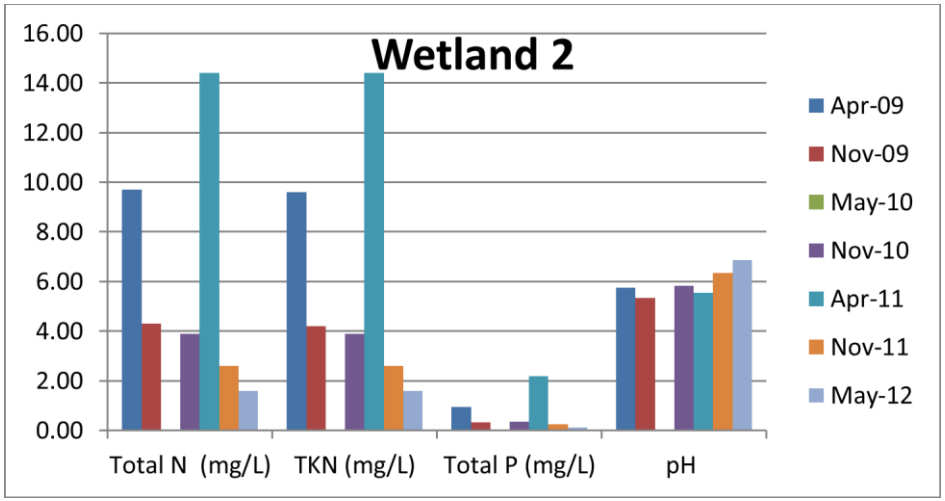


Figure 39 Wetland 2 Nitrogen, Phosphorus and pH

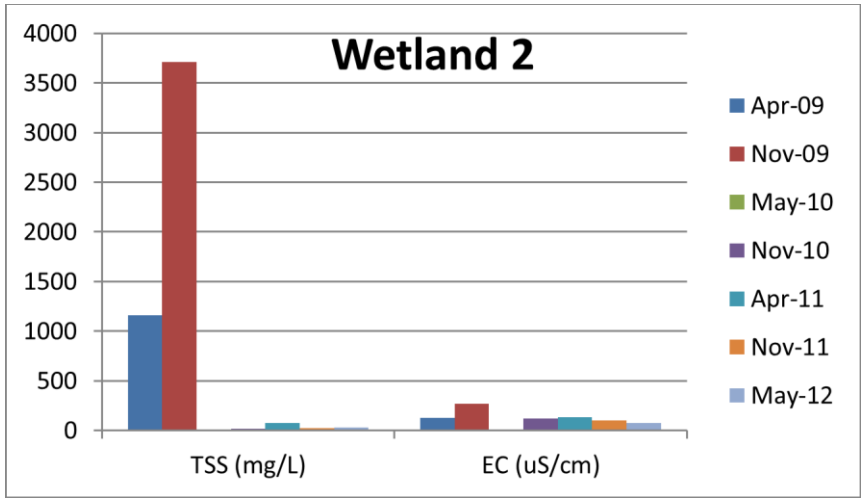


Figure 40 Wetland 2 suspended solids and salinity

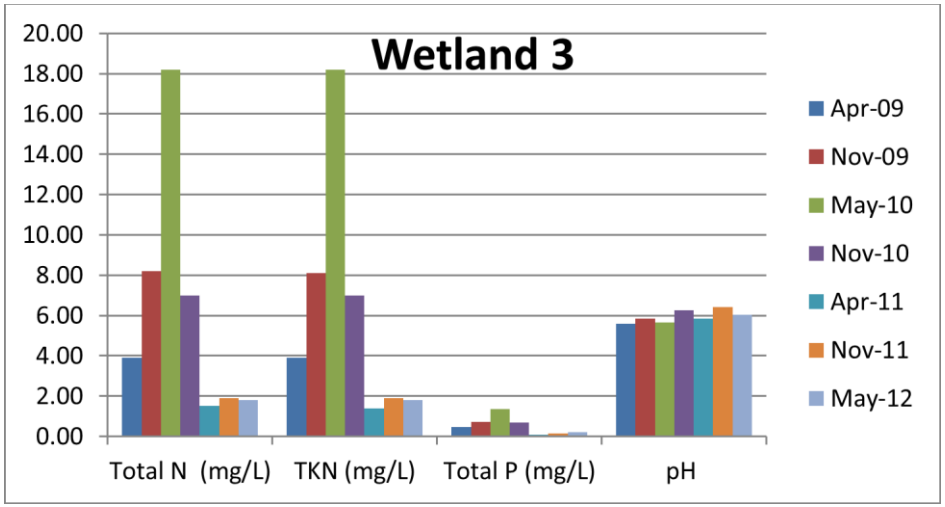


Figure 41 Wetland 3 Nitrogen, Phosphorus and pH

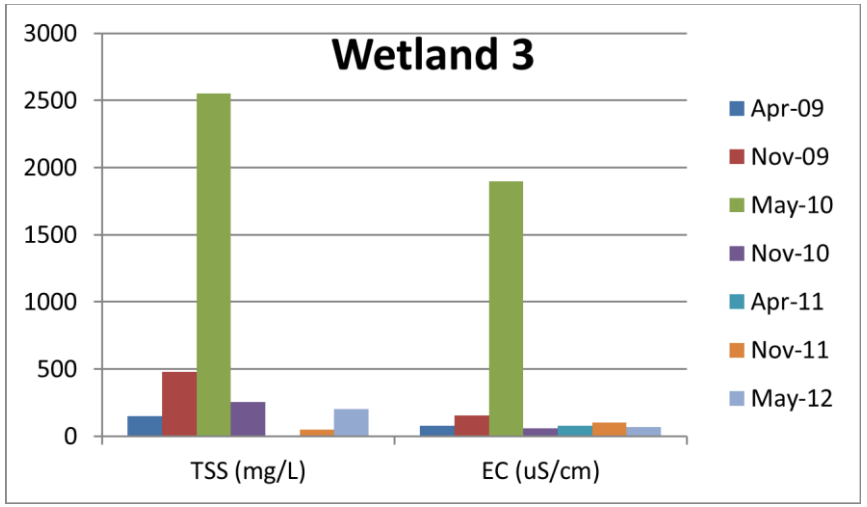


Figure 42 Wetland 3 suspended solids and salinity

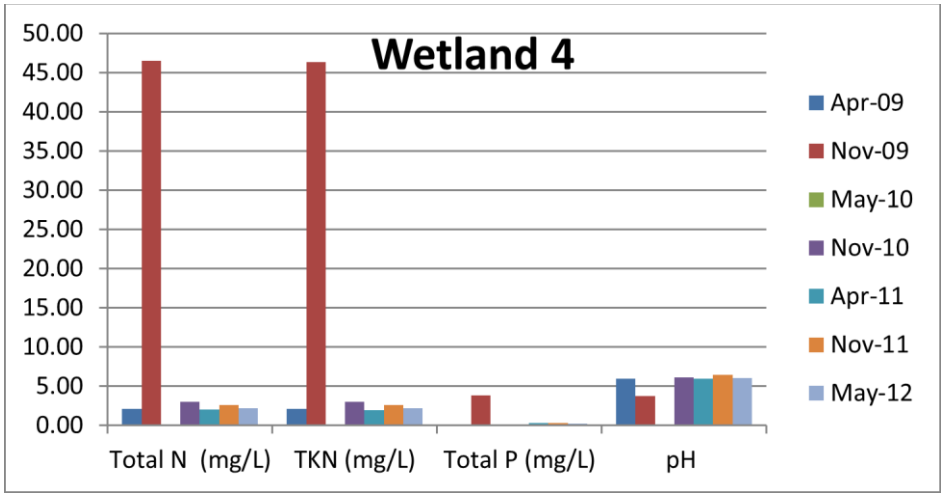


Figure 43 Wetland 4 Nitrogen, Phosphorus and pH

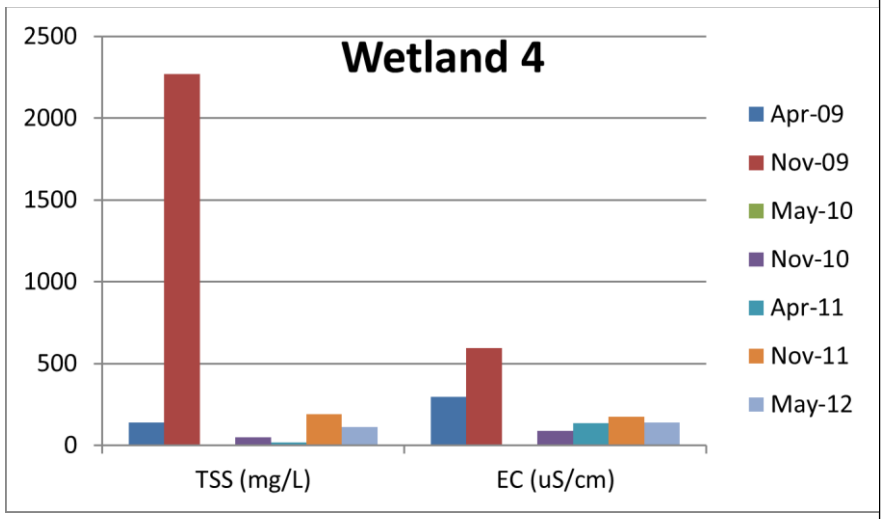


Figure 44 Wetland 4 suspended solids and salinity

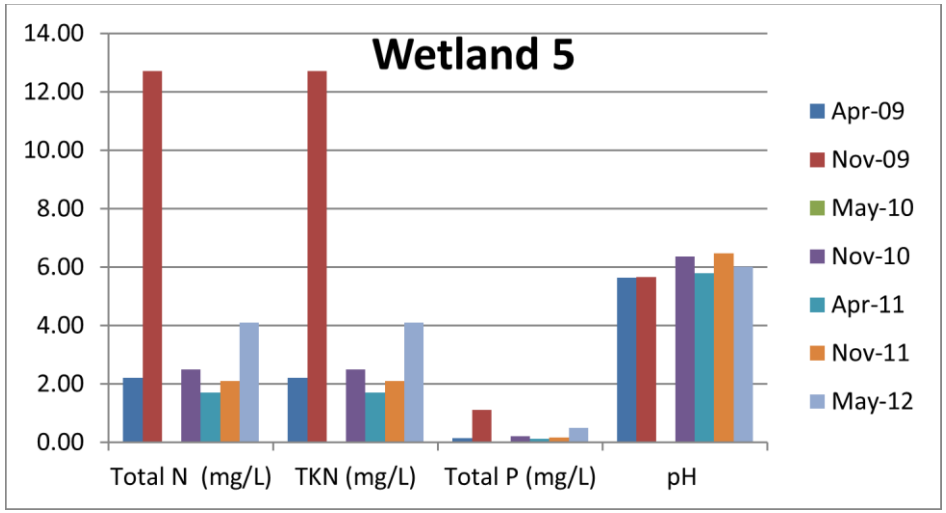


Figure 45 Wetland 5 Nitrogen, Phosphorus and pH

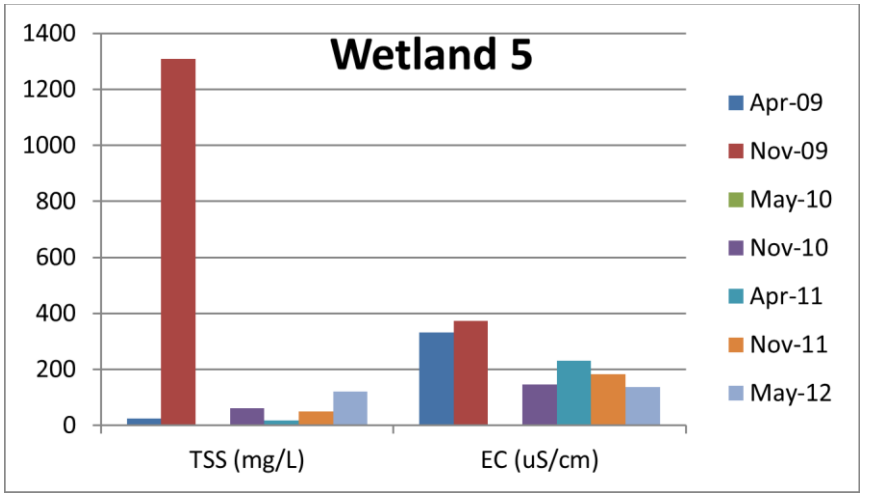


Figure 46 Wetland 5 suspended solids and salinity

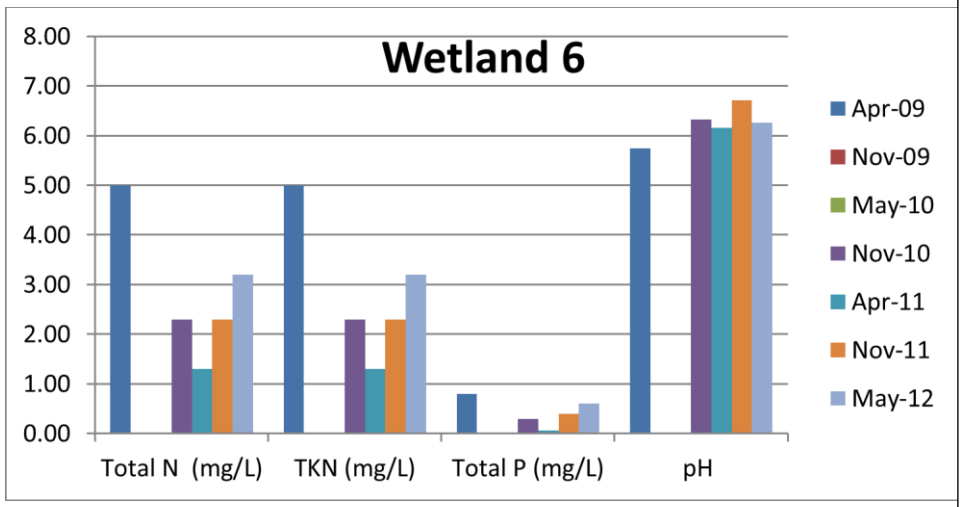


Figure 47 Wetland 6 Nitrogen, Phosphorus and pH

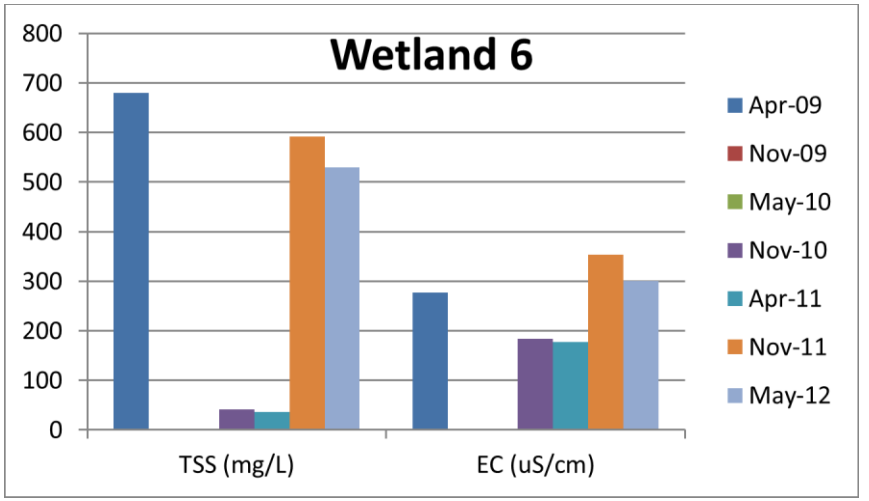


Figure 48 Wetland 6 suspended solids and salinity

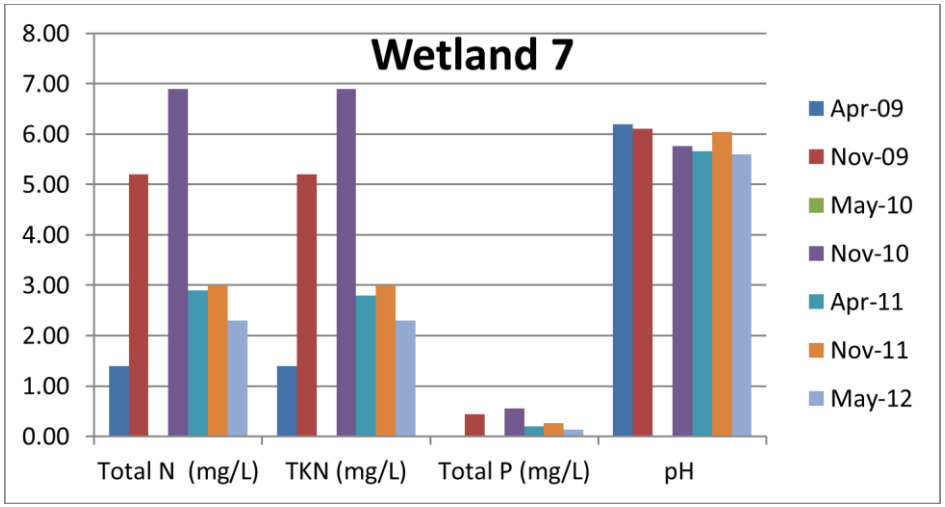


Figure 49 Wetland 7 Nitrogen, Phosphorus and pH

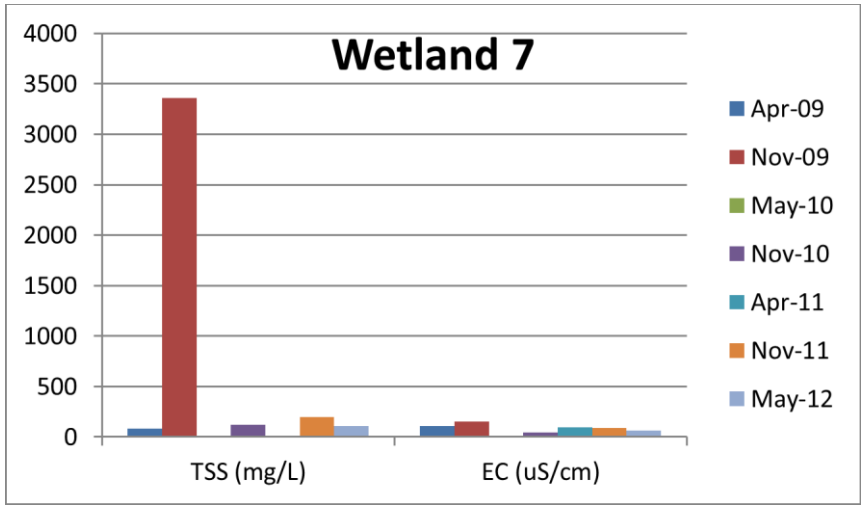


Figure 50 Wetland 7 suspended solids and salinity

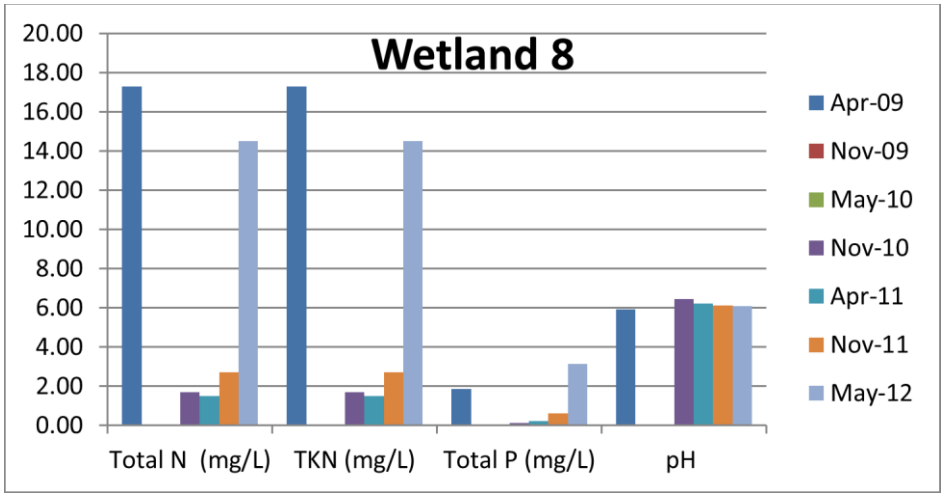


Figure 51 Wetland 8 Nitrogen, Phosphorus and pH

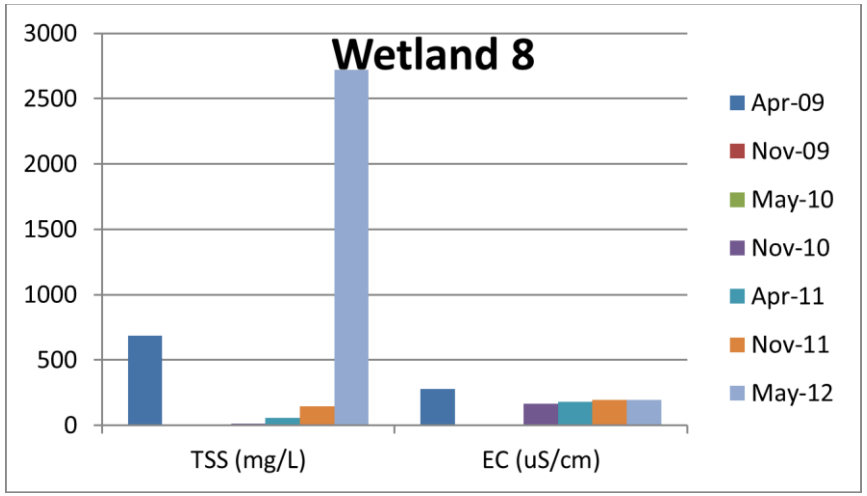


Figure 52 Wetland 8 suspended solids and salinity

Oxygen saturation

Oxygen saturation levels for the seven monitoring occasions are shown in **Figure 53** along with accumulated means for each wetland. 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. Wetland 8 was effectively anoxic at 13% saturation.

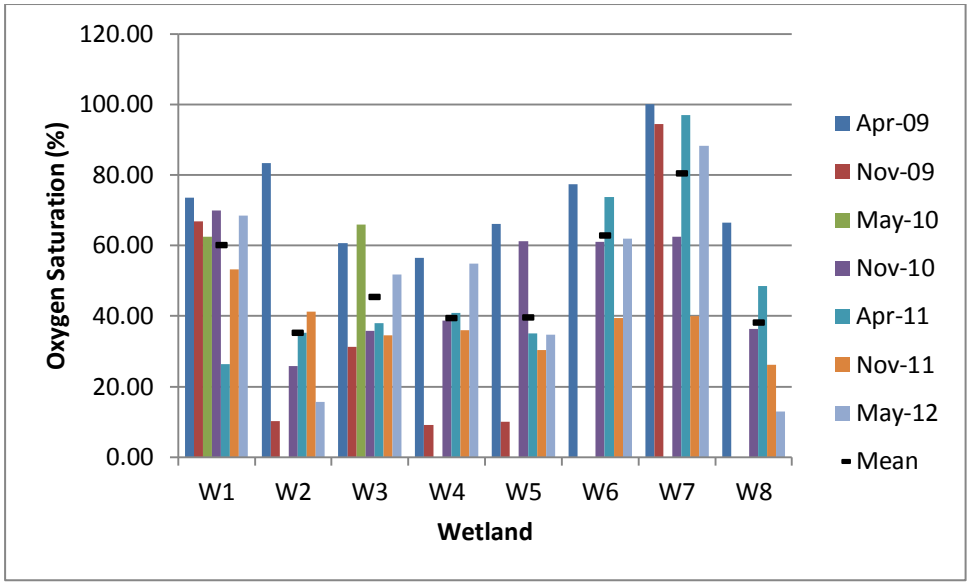


Figure 53 Oxygen saturation levels for each wetland and each monitoring occasion
The histogram shows the individual values for each monitoring occasion and each wetland. The points are the mean values of the seven monitoring occasions for each wetland.

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 place the Mandalong monitored wetlands at below acceptable levels for most monitoring occasions. However there is no available control over this and the recorded levels could well be typical of wetlands in a rural agricultural landscape.

6 Subsidence impact

6.1 Wetland 6

Figure 54 shows the location of the vegetation monitoring transect and subsidence monitoring lines at Wetland 6. Panel 12 has been subsided in May 2012.

Data from the subsidence monitoring transects recorded in early December 2011 show that there has only been 0.03 – 0.06 m of subsidence along line 11MG2, increasing to the north west. Subsidence recorded along line CS5 was 0.30 m to 0.03 m decreasing from the centre of panel 11.

Data from the subsidence monitoring transects was recorded in mid June 2012. The crossline transect CS5 shows that the wetland itself has subsided 0.19 m with negligible tilt; subsidence increases to the north west and south east of the wetland. Subsidence along the line of the wetland and the underlying pillars show subsidence increasing south west away from the wetland but by only 0.02 m. This would lend support to the observation from the transect data that the once dry habitat has been replaced by moister margin habitat. Looking at **Figure 4** 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. None of this would be expected to impact negatively on the wetland habitat.

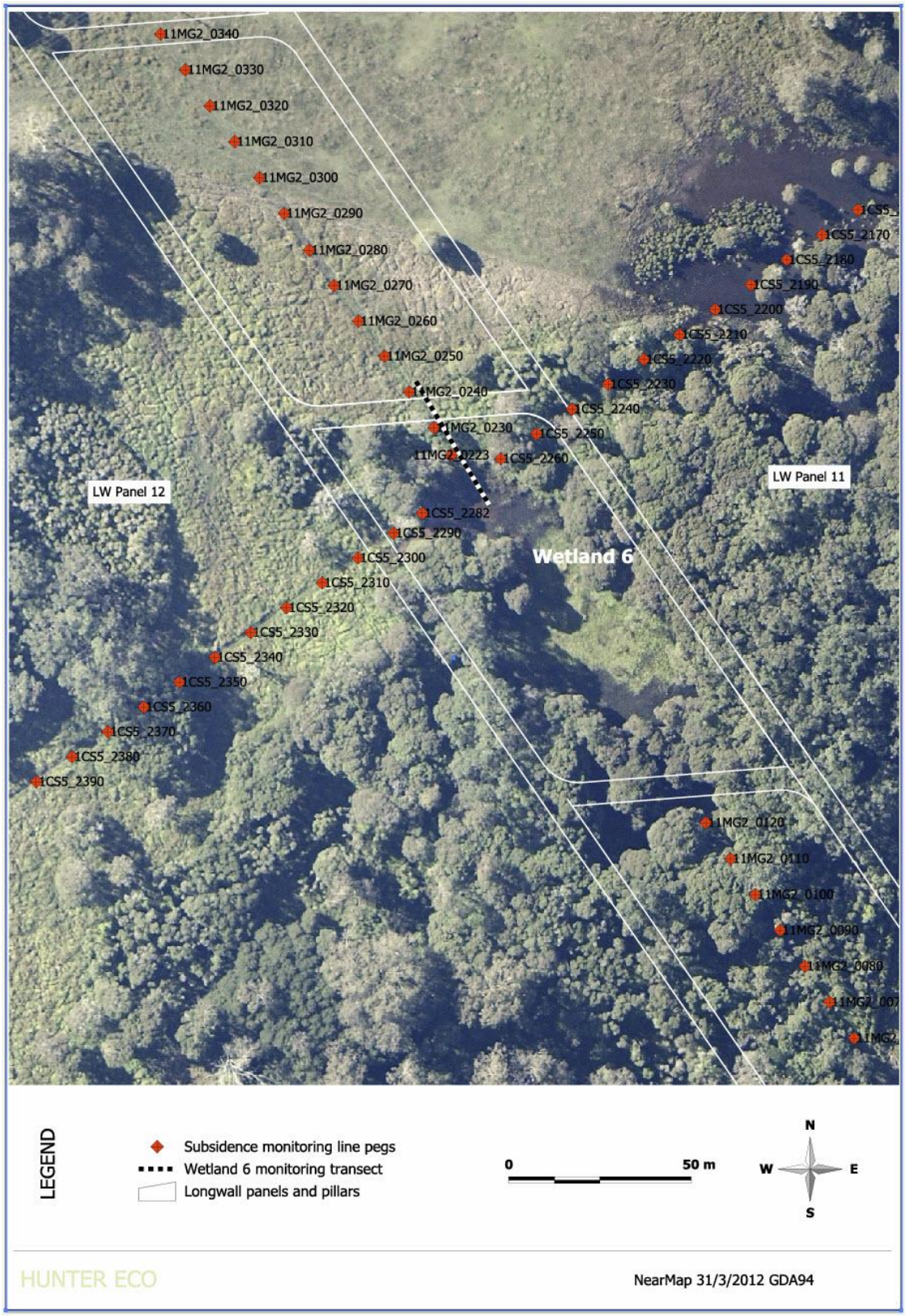


Figure 54 Wetland 6 subsidence monitoring lines and wetland monitoring transect

6.2 Wetland 8

There is a subsidence monitoring survey line running through a section of the overall wetland complex of which Wetland 8 is a part (**Figure 55**).

Survey data collected on 7 June 2012 show subsidence at peg zero has increased from 0.173 m on 10 June 2011 to 0.207 m. At peg 13 it has increased from 0.488 m to 0.522 m. Tilt (2 – 6 mm/m) towards the west remains approximately the same. The main impact on water levels would come from increase in subsidence from the edge of the panel to the centre. As a consequence, water would be expected to move towards the deepest part. However, as noted in section 5.3 above there is a low barrier at the start of the monitoring transect preventing water from moving in that direction and, that water appears to have increased to the west and south west.

Taking into account the edge of the subsided panel and the fact that the land is dipping and tilting toward the centre, it is conceivable that the aquatic edge along the monitoring transect could contract rather than expand. There is no evidence of this happening in either the water edge or the habitat transition boundaries.

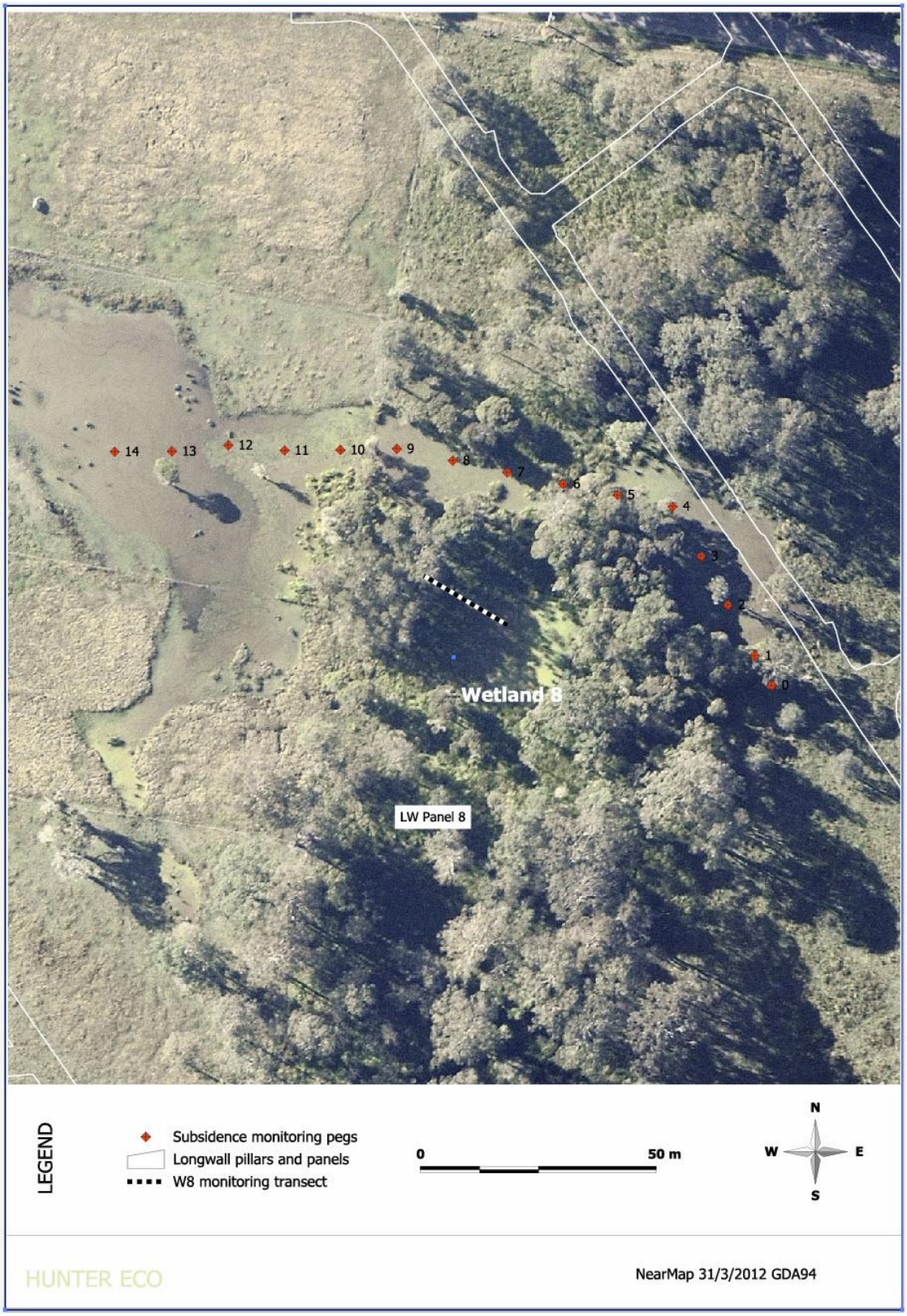


Figure 55 Wetland 8 subsidence monitoring line and wetland monitoring transect

7 Management actions

The Mandalong mine Wetland Management Plan (Driscoll 2009a) provides a table describing monitoring results that would trigger further investigation and possible remedial action. The following **Table 13** is an assessment of the current monitoring results and the triggers for action. All changes recorded between the April 2009 and May 2012 can be explained as being from causes other than mining subsidence. Even though Wetland 8 has experienced subsidence for over 12 months there is, as yet, no clear evidence of change that could be attributed to subsidence.

Table 13 Responses to the WMP triggers

Trigger	Result at May 2012	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.	See Section 5.5 for discussion concluding that this was likely to be within the bounds of natural variation. No subsidence impact was detected.
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

8 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 8 wetlands started in April 2009 so as at May 2012 the total monitoring period has been 3 years, seven monitoring occasions. All wetlands started out with water then began to dry until May 2010 when only Wetlands 1 and 3 had water. Section 5.9 shows an increasing rainfall trend which is reflected in the water levels in all wetlands.

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. The challenge will then be to find whether there is a subsidence signal in amongst this variation.

Wetland 6 is located over a pillar between panels 11 and 12 with panel 12 recently 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 be a consequence of increased rainfall since the start of monitoring. Wetland 8 has been subject to subsidence for over 18 months and so far there is no change in the wetland vegetation and water levels that can clearly be assigned to being an impact of subsidence.

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 5.6. 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). Section 5.1 shows that the proportion of weeds to native species over time has reduced significantly for Wetlands 6 and 7 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 has recovered at the south eastern end of Wetland 6, away from the monitoring transect. The extent of this species was much the same for May 2012.

Game camera monitoring of Wetland 2 in late November 2011 confirmed deer moving through the wetland on two occasions over two weeks. Camera monitoring of Wetland 6 from late December 2011 to early January 2012 showed considerable deer activity. Camera monitoring of Wetland 7 in February 2012 revealed no deer activity.

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. At the time this report was being prepared, fencing of the large wetland that contains monitored Wetlands 4 and 5 was underway. The fencing is standard stock-proof fencing, not deer-proof, and game camera monitoring will be undertaken once fencing is complete.

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Appendix 1 Cumulative floristics at May 2012

	WETLANDS							
Family and Species	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Amaranthaceae								
Alternanthera denticulata		✓			✓	✓		✓
Apiaceae								
Centella asiatica	✓	✓		☑	✓	✓	✓	✓
*Cyclospermum leptophyllum**								✓
Daucus glochiatus								✓
*Hydrocotyle bonariensis**						✓		
Hydrocotyle laxiflora				✓	✓			
Hydrocotyle tripartita		✓		✓	✓			
Hydrocotyle verticillata						✓		
Apocynaceae								
Parsonsia straminea							✓	✓
Asteraceae								
*Aster subulatus**	✓				✓	☑	✓	✓
*Cirsium vulgare**								✓
Epaltes australis	✓	✓			✓	✓		✓
Euchiton sphaericus						✓		✓
*Senecio madagascariensis**	✓		✓	✓	✓	✓	✓	☑
*Taraxacum officinale**	✓	✓	✓		☑		✓	
Azollaceae								
Azolla pinnata	✓	✓	✓	✓	✓	✓	☑	✓
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	✓		✓		✓		✓	
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.								✓
Phylidraceae								
Philydrum lanuginosum	✓		✓	✓	✓		☑	
Plantaginaceae								
*Plantago lanceolata**		✓		✓	✓		☑	✓
Poaceae								
*Andropogon virginicus**			✓		✓			
*Axonopus fissifolius**	✓	✓	☑	☑	☑	✓	✓	☑
Briza minor					✓		✓	✓
*Cynodon dactylon**	☑	☑	✓	☑	✓		✓	✓
Echinochloa colona						✓		
Eragrostis alveiformis				✓				
Hemarthria uncinata						✓		
Lachnagrostis filiformis						✓		
*Lolium perenne**								✓
Microlaena stipoides					✓			
Panicum bisulcatum	✓				✓	✓		✓
Panicum obseptum		☑	☑	✓	✓	✓	✓	
*Paspalum dilatatum**	☑	✓	✓	✓	✓	✓	☑	✓
Paspalum distichum	☑		✓	☑	✓	✓	☑	✓
*Pennisetum clandestinum**							✓	✓
Sacciolepis indica			✓		✓			
*Setaria parviflora**	✓							✓
*Setaria sphacelata**							✓	
*Sporobolus africanus**			✓		✓		✓	
Themeda australis					✓			
*Vulpia bromoides**	✓							

Polygonaceae								
Persicaria decipiens	✓		✓	✓		☑	✓	✓
Persicaria praetermissa		✓	✓	☑	☑		✓	✓
Persicaria strigosa	✓		✓			✓		
*Rumex brownii**								✓
*Rumex sp**						✓	✓	
Potamogetonaceae								
Potamogeton octandrus	✓		✓	✓		✓	✓	
Ranunculaceae								
Ranunculus inundatus	✓	✓	✓	☑	✓	☑	☑	☑
Ranunculus lappaceus					✓	✓		
Ricciaceae								
Ricciocarpus natans		✓					✓	✓
Rosaceae								
*Rubus discolor**		✓			✓			
Scrophulariaceae								
Veronica sp								✓
Solanaceae								
*Solanum nigrans**					✓			
Verbenaceae								
*Verbena bonariensis**								✓
Total Species	**41**	**28**	**37**	**32**	**49**	**41**	**46**	**56**

KEY ✓ = Present in transect; ✓ = New in November 2011; ☑ = present at all monitoring events

Appendix 2 Wetland 6 feral deer

Camera monitoring from 23 December 2011 to 19 January 2012



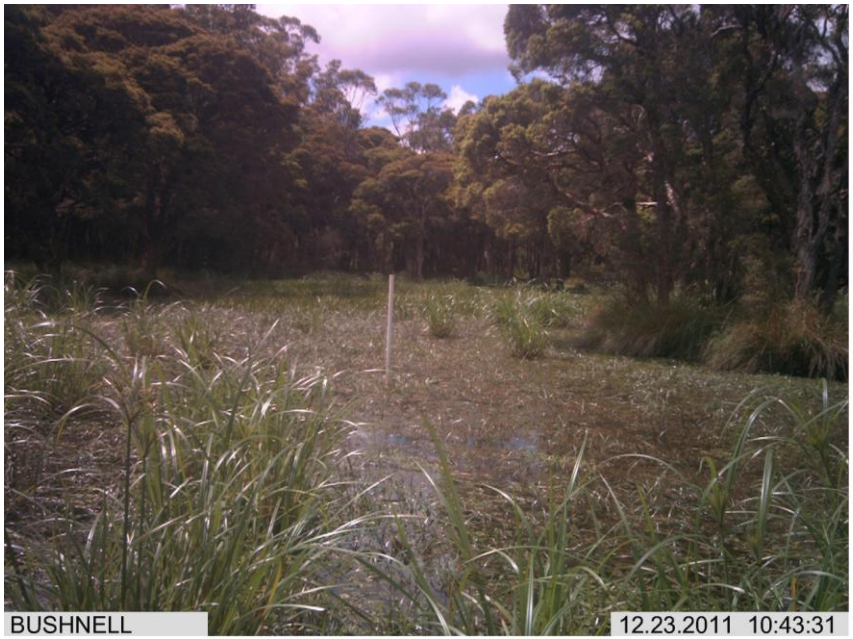
Red Deer

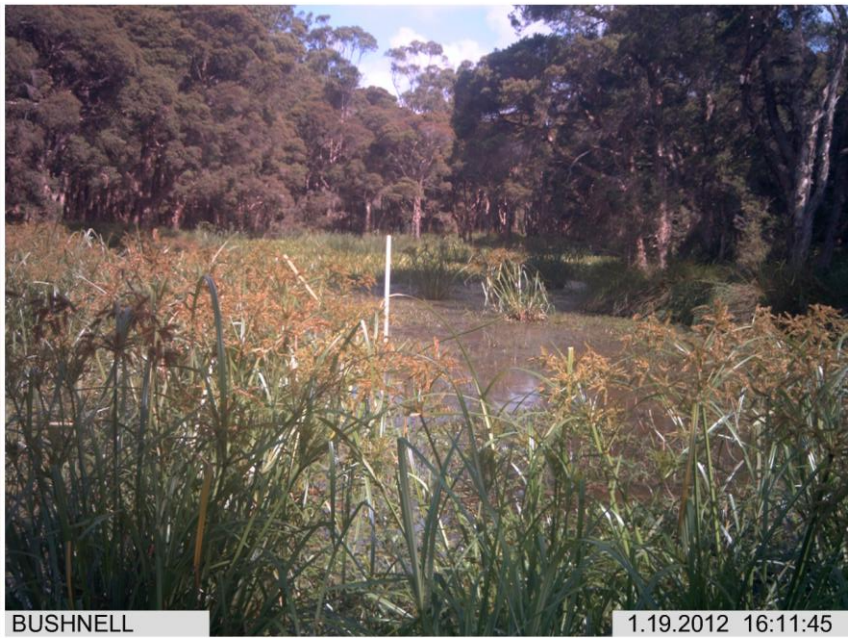


Red Deer



Rusa Deer





This image shows the changed condition of the wetland from the start of the camera monitoring period. The aquatic vegetation had recently recovered, maybe from previous over grazing; it was certainly devoid of vegetation at the time of the November 2011 monitoring. Loss of aquatic vegetation from grazing deer can be clearly seen in the area to the right of the monitoing transect marker.

Centennial Coal

Centennial Coal Company Limited
P O Box 1000
Toronto NSW 2283
www.centennialcoal.com.au

Centennial Coal



Mandalong Wetlands

Monitoring Report

Centennial Mandalong

November 2012

HUNTER ECO

Centennial Coal
Environment Matters

Executive Summary

Conditions of Consent for the Centennial Mandalong underground coalmine 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 are control sites unaffected by subsidence and five are within the subsidence area. This report presents the results from monitoring in November 2012 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.

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.

Similarity analysis has shown that the monitoring transects include three habitat types: dry, margin and aquatic. The location of these habitats has remained the same for each wetland since April 2009. A feature of the floristic content of the aquatic habitat has been a high level of variation between monitoring occasions.

Wetland 8 has been subject to subsidence for over 12 months as of November 2012 and there is no detectable impact. Wetland 6 is located over the pillars between longwalls 11 and 12. As of May 2012 both of these longwalls have been subsided. So far, it appears that increased rainfall has had the greatest impact on Wetland 6.

Evidence is accumulating that feral deer are having a negative impact on aquatic habitat for some wetlands.

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Centennial Coal Mandalong Underground Coalmine Wetlands Monitoring Report November 2012

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. The mining process is longwall mining and at completion of coal extraction the longwall void is collapsed. This collapse results in subsidence of the overburden with effects ultimately transmitted to the surface to varying degrees. 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. The degree of impact at the surface is dependent on a number of factors, mainly the depth of the longwall below the surface and the physical structure and composition of the overburden.

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 (Driscoll 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 (Driscoll 2009b) which described the status of the wetlands prior to any subsidence having occurred. The current report provides data and analysis from the seventh 6-monthly monitoring of the 8 wetlands since baseline monitoring, eight monitoring occasions. Data for the baseline report were recorded prior to any subsidence having occurred at any of the 5 wetlands within the subsidence impact area. As of November 2012 subsidence had been completed for longwall panel 13 (**Figure 1**). Wetland 7, being located directly over a pillar between panels 13 and 14, now has the potential to be impacted by subsidence.

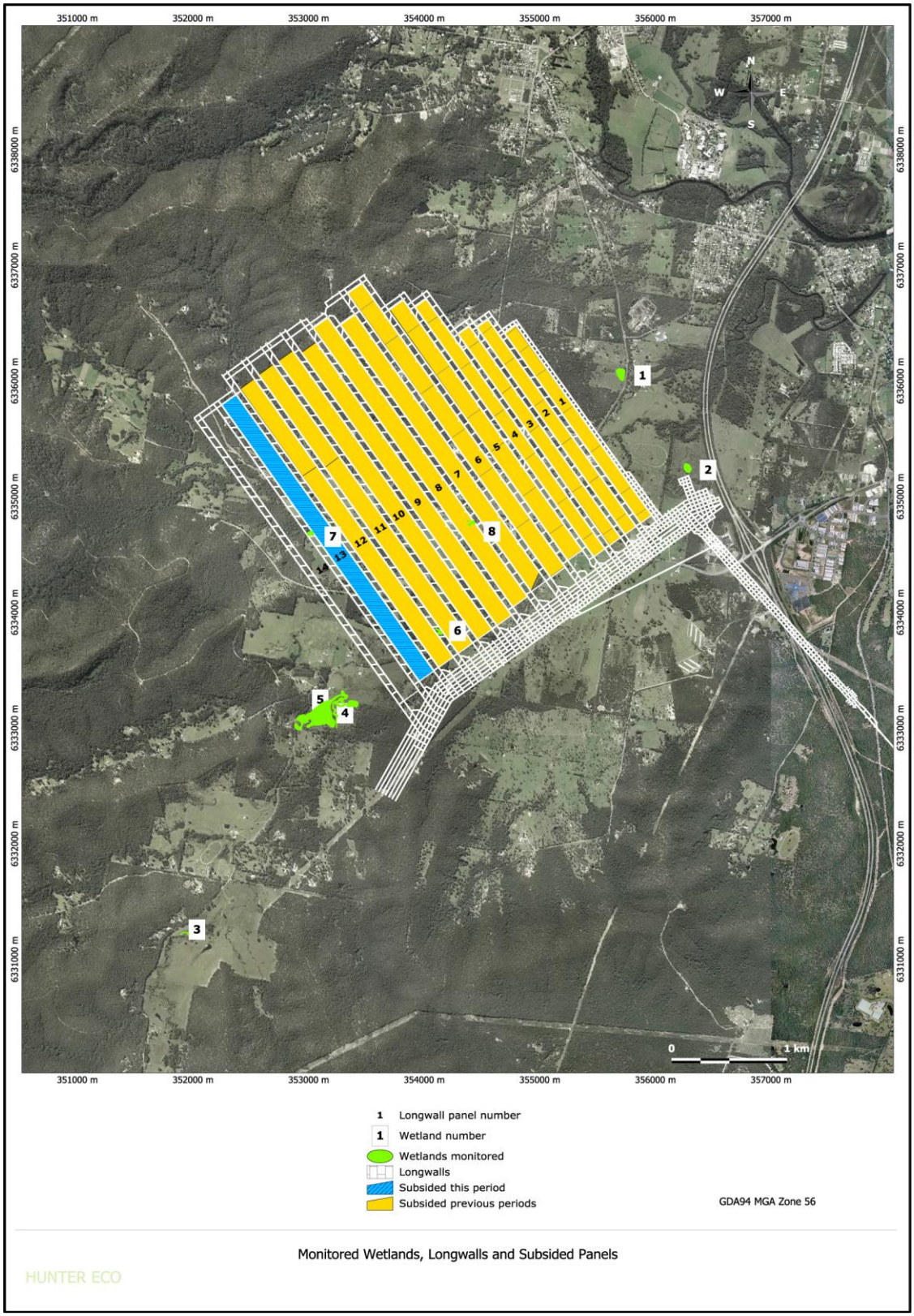


Figure 1 Monitored wetlands, longwalls and subsided panels

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.

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.

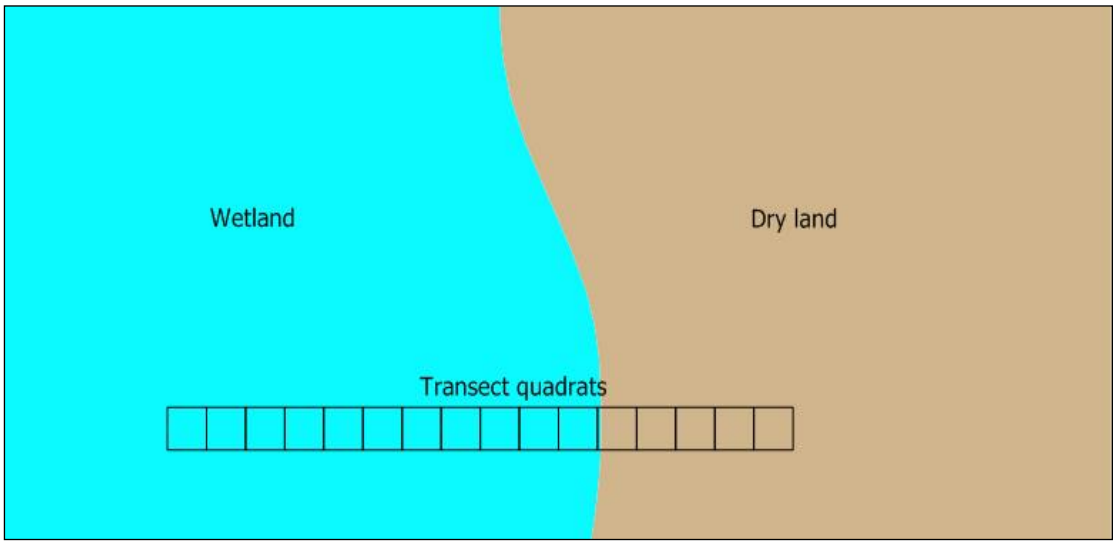


Figure 2 Schematic of a sampling transect.

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

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.

Split Moving Window (SMW)

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.

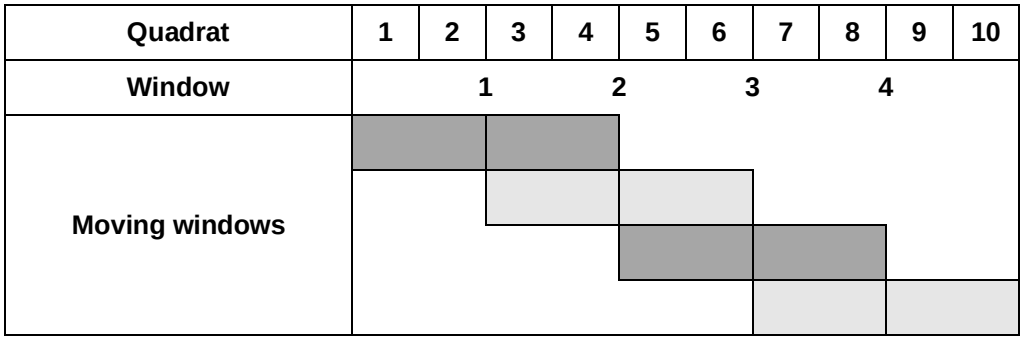


Figure 3 Schematic for SMW analysis using a window of four quadrats.

Multi-dimensional Scaling (MDS)

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, 4^{th} 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.

Biodiversity

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 8 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 21st and 22nd of November 2012. 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.

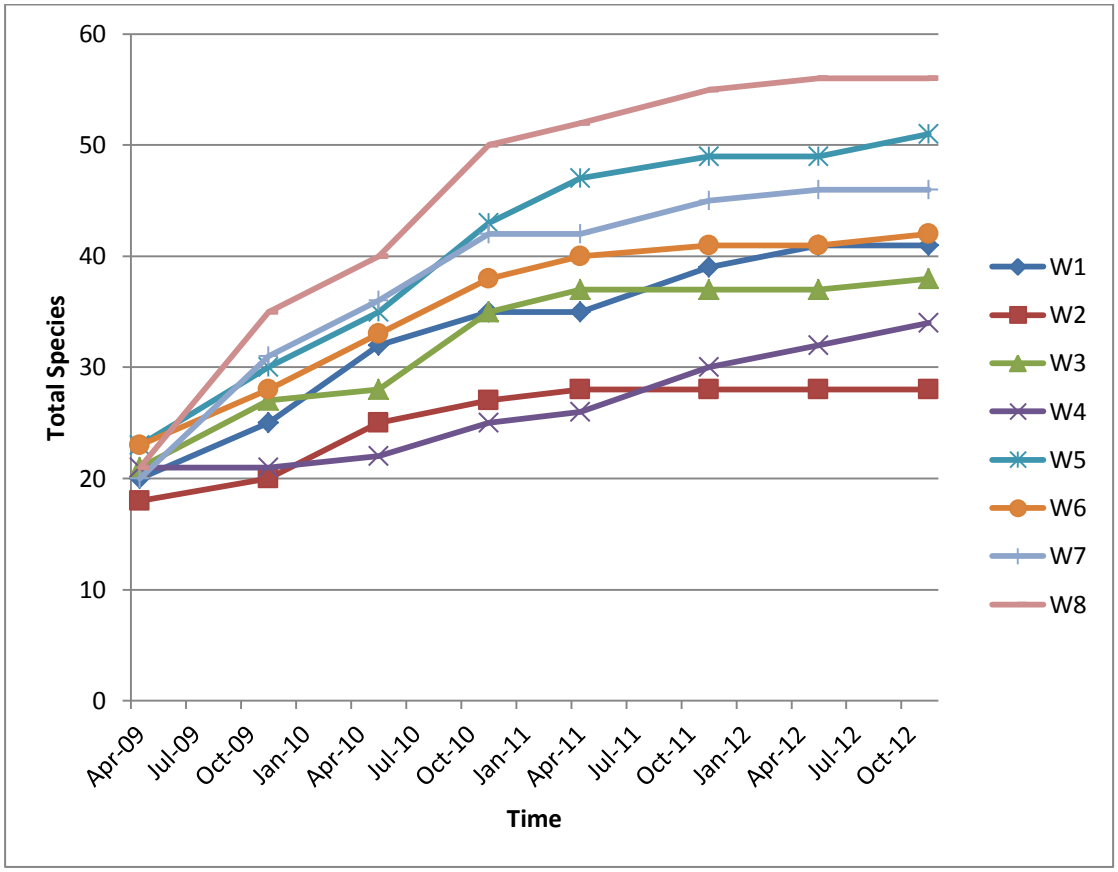


Figure 4 Cumulative species for each wetland transect over time

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.

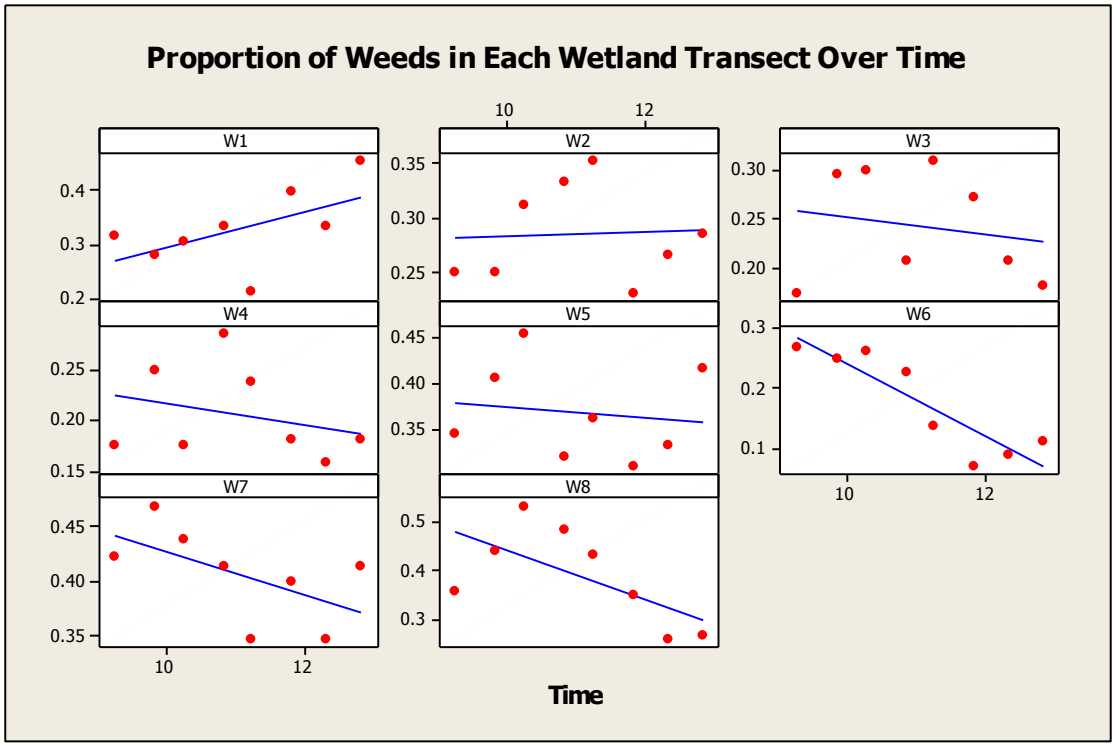


Figure 5 The proportion of weed species to total species in each wetland and each monitoring occasion

To determine whether the trendlines shown in **Figure 5** were significant, a least squares regression was conducted (**Table 3**). The regression shows that the trend was only significant for Wetland 6 ($p < 0.05$) meaning that for this wetland the proportion of weeds to native species has been decreasing over time. 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.

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

Wetland	r^2	F-value	Significance (*p*-value)
W1	0.33	(1,7) 2.94	0.137
W2	0.30	(1,7) 0.02	0.893
W3	0.04	(1,7) 0.23	0.646
W4	0.08	(1,7) 0.51	0.503
W5	0..02	(1,7) 0.15	0.714
W6	0.81	(1,7) 25.75	**0.002**
W7	0.34	(1,7) 3.06	0.131
W8	0.41	(1,7) 4.16	0.087

This analysis has dealt with diversity of weed species. For example, in five weed species, whether there was only one plant of each species or many more, there would still only be five weed species present. Section 5.6 below looks at the abundance of weed species along with native species in relation to habitat type.

5.2 Water levels and rainfall

All wetlands had abundant water in May 2012 but in the current survey wetlands 6 and 8 were dry, with low water levels in the remainder. Water level in wetlands will primarily be a function of recent rainfall runoff from the immediate catchment. **Figure 6** shows monthly rainfall recorded at the Centennial Mandalong automatic weather station (AWS) since January 2009. Reduced rainfall leading up to November 2012 is obvious.

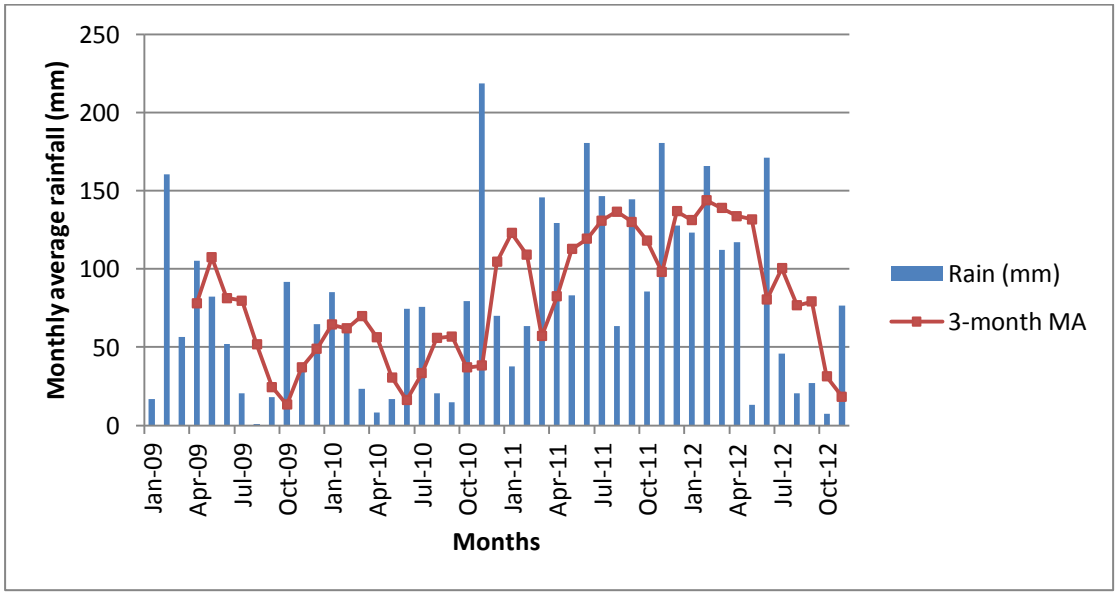
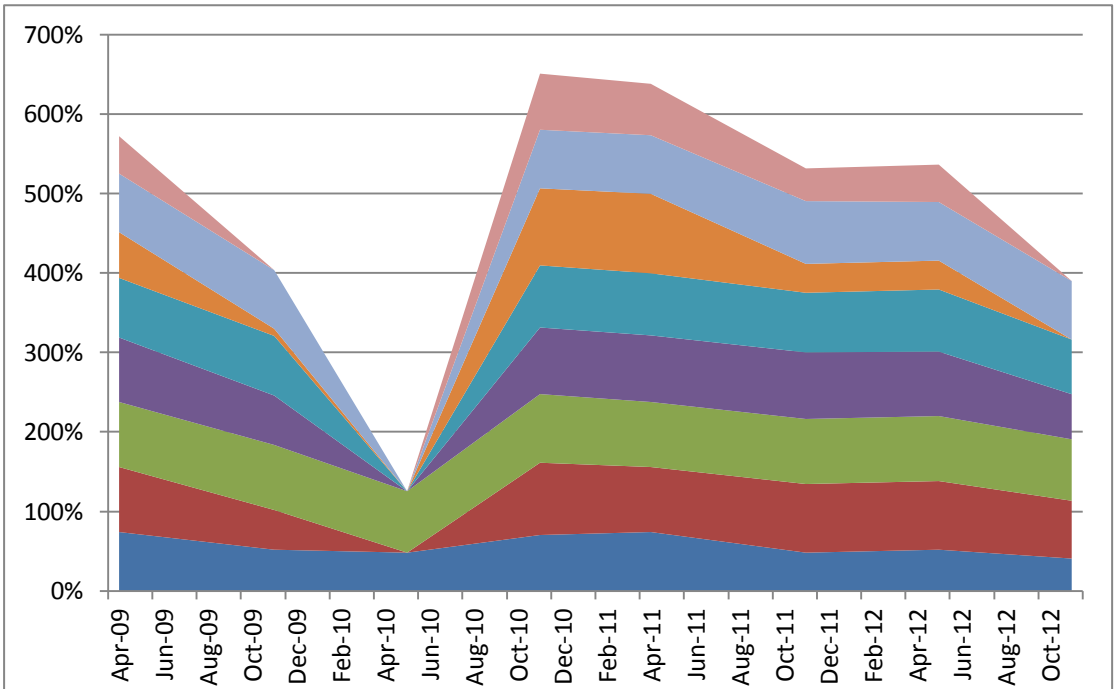


Figure 6 Monthly average rainfall at Mandalong for 2009 to 2011
3-month MA is a 3-month moving average

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
W8	47%	0%	0%	71%	65%	41%	47%	0%
W7	74%	74%	0%	74%	74%	79%	74%	74%
W6	58%	9%	0%	97%	100%	36%	36%	0%
W5	75%	75%	0%	78%	78%	75%	78%	69%
W4	81%	62%	0%	84%	84%	84%	81%	57%
W3	82%	82%	77%	86%	82%	82%	82%	77%
W2	82%	50%	0%	91%	82%	86%	86%	73%
W1	74%	52%	48%	70%	74%	48%	52%	41%

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

While this wetland (**Figure 8**) was full of water, there was no aquatic vegetation present, as was the case in May 2012. The first Aquatic habitat quadrat contained a small amount of Margin habitat vegetation, so shows in the MDS plot.

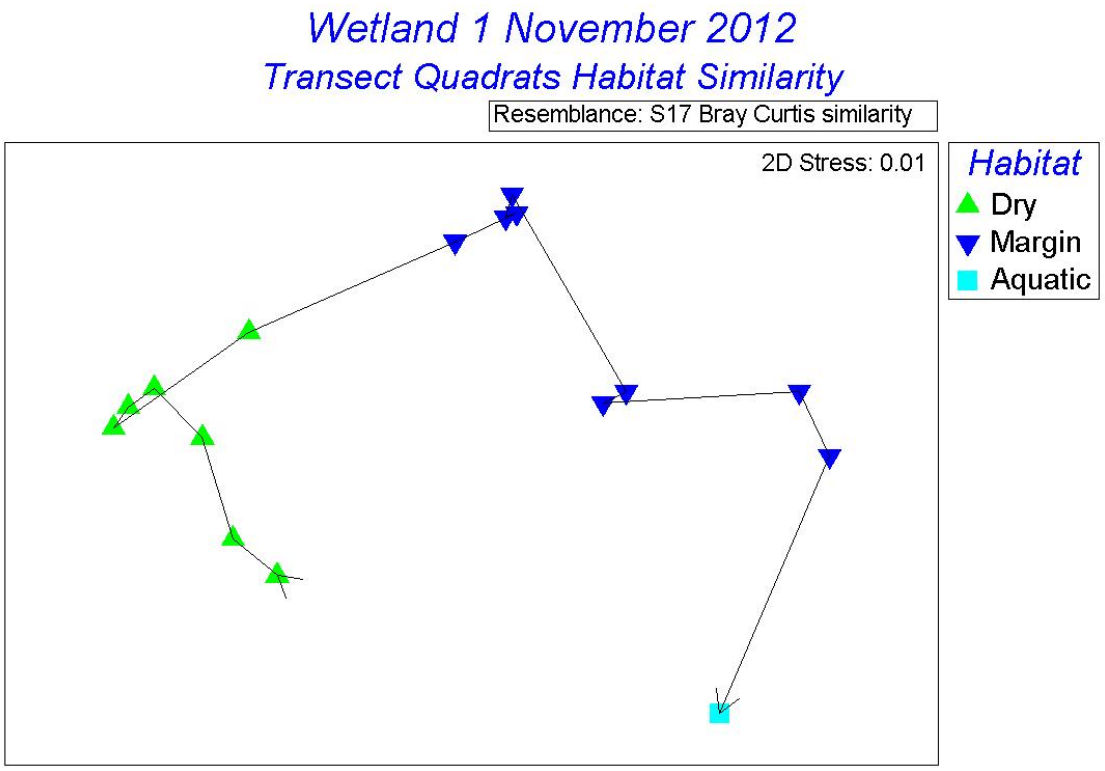


Figure 8 MDS showing Wetland 1 transect quadrats grouped according to habitat type

5.3.2 Wetland 2

This wetland (**Figure 9)** was full of water. Other than for one quadrat containing *Eleocharis sphacelata* reeds, the water surface was covered with the small floating plants *Azolla pinnata* and *Spirodela polyrhiza*.

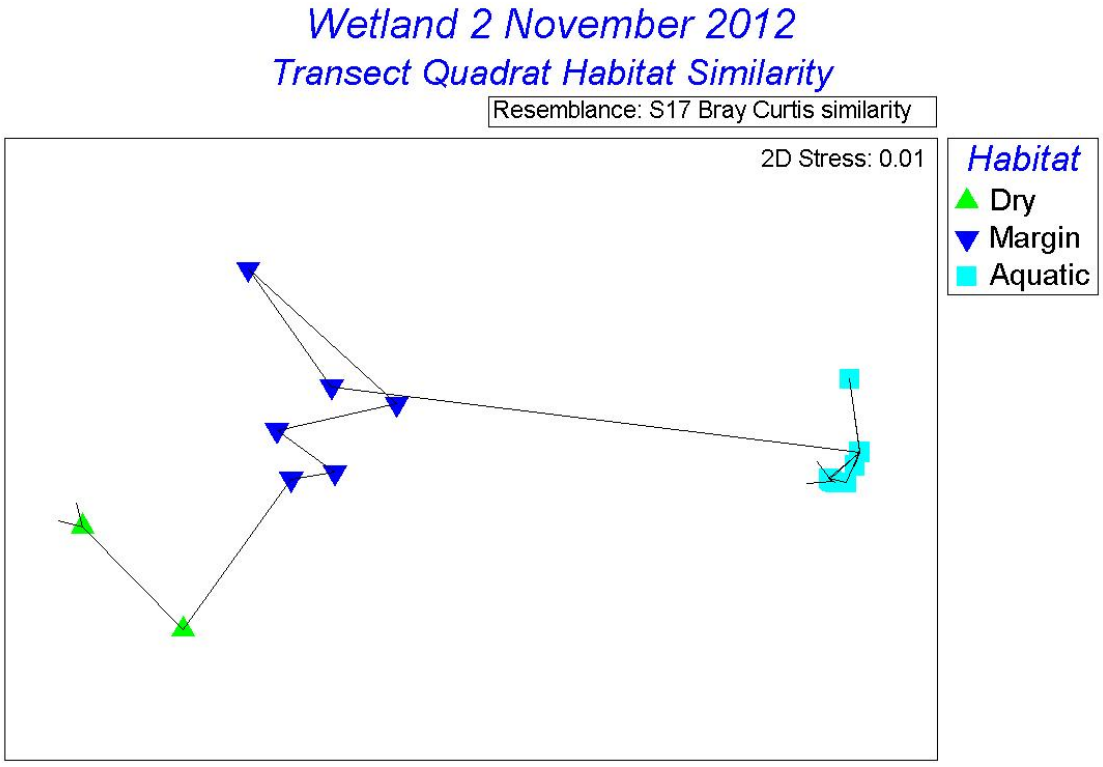


Figure 9 MDS showing Wetland 2 transect quadrats grouped according to habitat type

5.3.3 Wetland 3

What might now be loosely called the aquatic vegetation in Wetland 3 (**Figure 10**) is developing a mix of Margin and Aquatic species even though there is deep water. This is reflected in the MDS with some quadrats appearing similar to Margin habitat. This is a result of a dense layer of organic matter throughout the aquatic area supporting the growth of drier habitat species.

Cattle have been grazing in and around this wetland with manure deposits in the aquatic area. Grazing and nutrient enrichment will have an impact on this wetland.

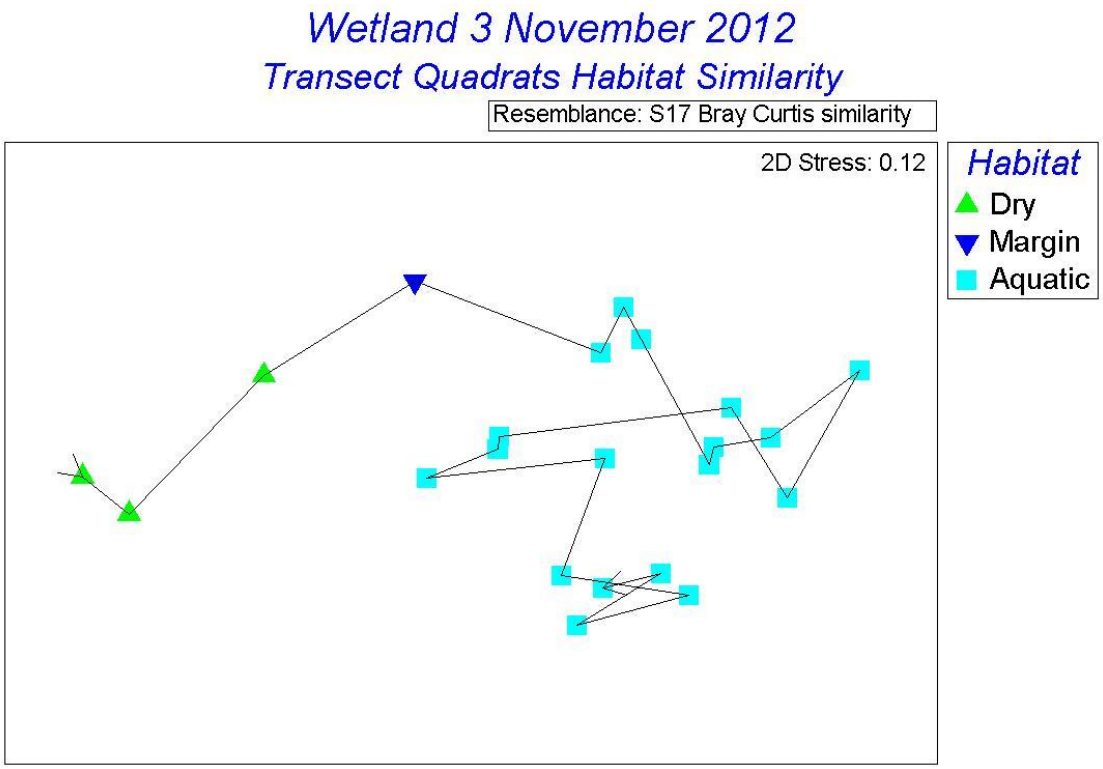


Figure 10 MDS showing Wetland 3 transect quadrats grouped according to habitat type

5.3.4 Wetland 4

Other than water levels being low in this wetland, the three habitat types were clearly distinguishable (**Figure 11**). This wetland has recently been fenced from stock and feral deer grazing and this should be reflected in improved diversity in the future.

5.3.1 Wetland 5

Water levels were also low in this wetland as expected being located in the same large wetland as Wetland 4 and the MDS (**Figure 12**) shows distinct habitat separation. The weed *Isolepis prolifera* appears to have contracted since May 2012 (**Table 4**) although it is more dense at the aquatic edge.

Table 4 *Isolepis prolifera* abundance over time

Month	7	8	9	10	11	12	13	Mean
April 09			1					0.17
Nov 09		2	4					1.00
May 10			3	3	3			1.50
Nov 10		3	3	1	1	1		1.50
Apr 11		4	4	3	2	1	1	2.50
Nov 11		4	4	4	4	4	2	3.70
May 12		1	4	5	5	6	2	3.83
Nov 12	1	5	5	3	2	1		2.83

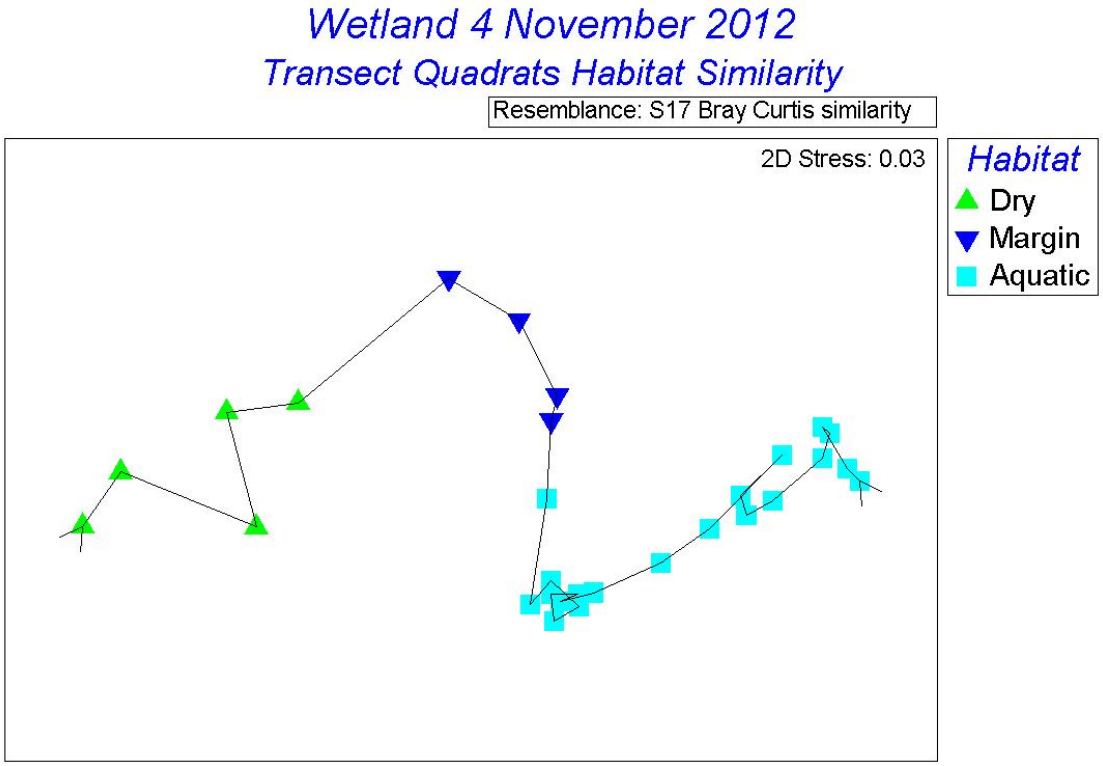


Figure 11 MDS showing Wetland 4 transect quadrats grouped according to habitat type

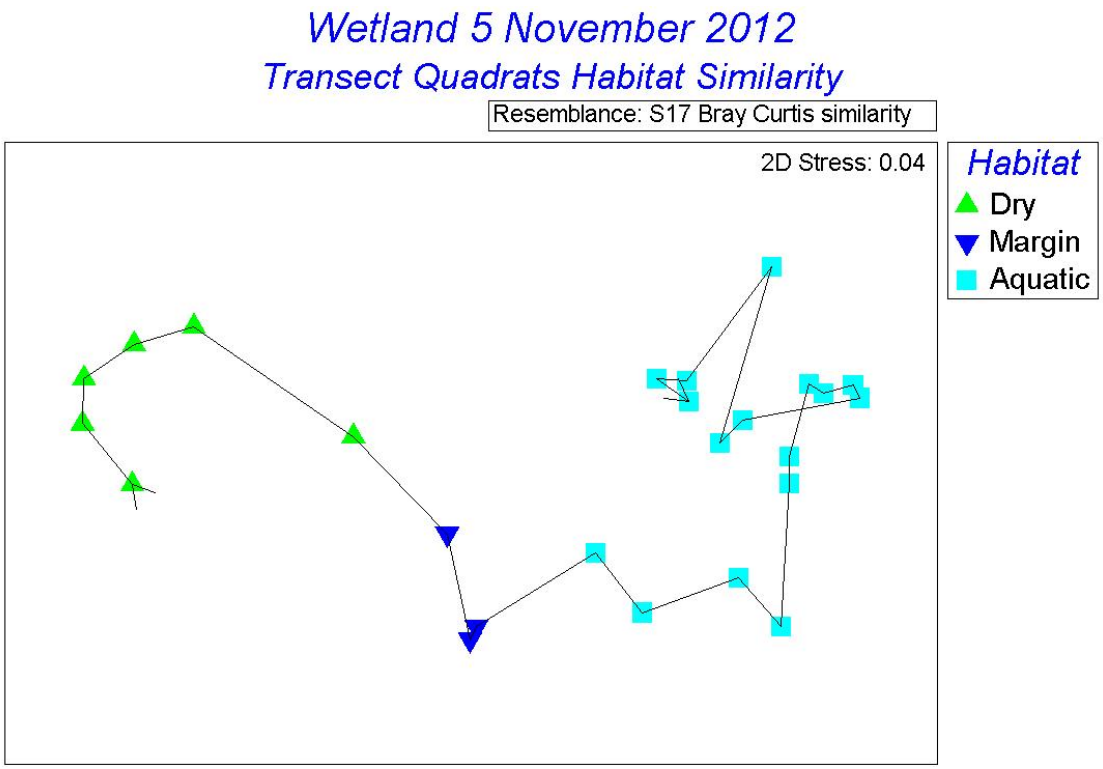


Figure 12 MDS showing Wetland 5 transect quadrats grouped according to habitat type

5.3.2 Wetland 6

The part of this wetland containing the monitoring transect was dry so the Aquatic habitat shown in **Figure 13** was sparse although it did contain several aquatic species growing in the mud. Other parts of the wetland still had shallow water.

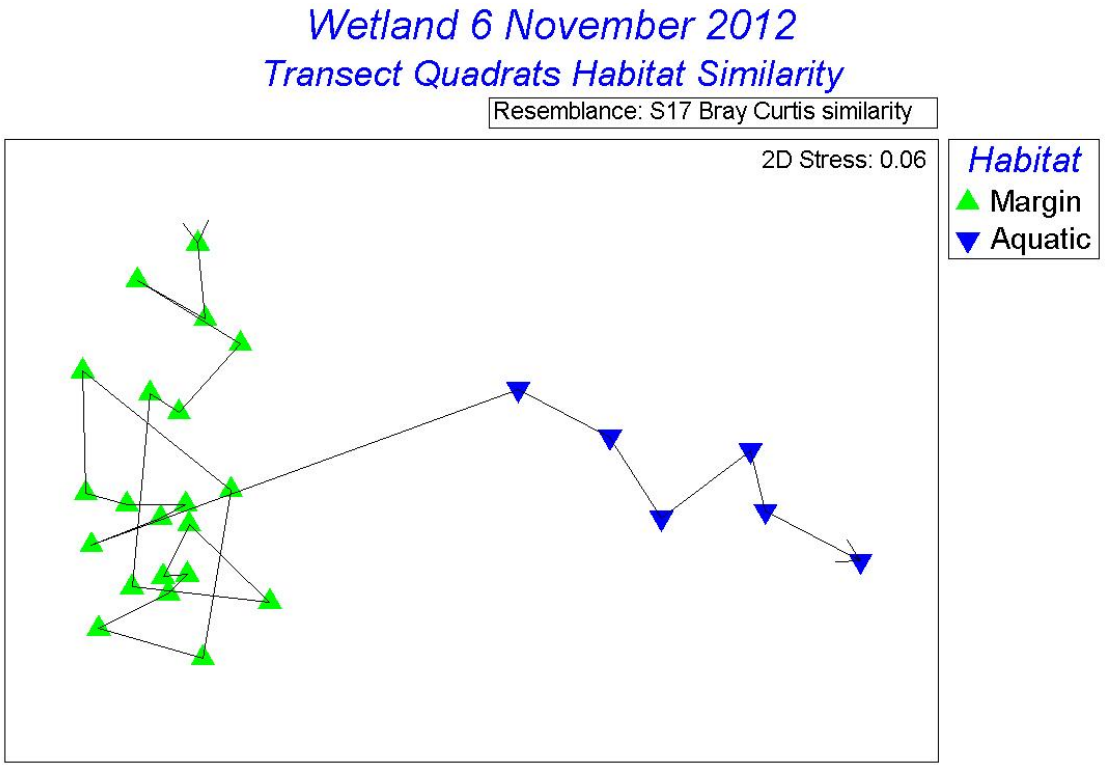


Figure 13 MDS showing Wetland 6 transect quadrats grouped according to habitat type

Since the start of monitoring in April 2009, there has been a marked change in Dry and Margin habitat for this wetland. The characteristic Dry habitat species in the first five transect quadrats (**Figure 14**) have been replaced by Margin habitat species. Furthermore, Margin habitat has extended significantly into Aquatic habitat (see further discussion in Section 6).

Four Fallow Deer were seen grazing in this wetland.

In April 2009 there was a patch of the threatened aquatic plant *Maundia triglochinoides* at the end of the monitoring transect. This patch did not recover from the dry period in 2010. However, at November 2012 there is a substantial patch in this wetland away from the monitoring transect (**Figure 15**).

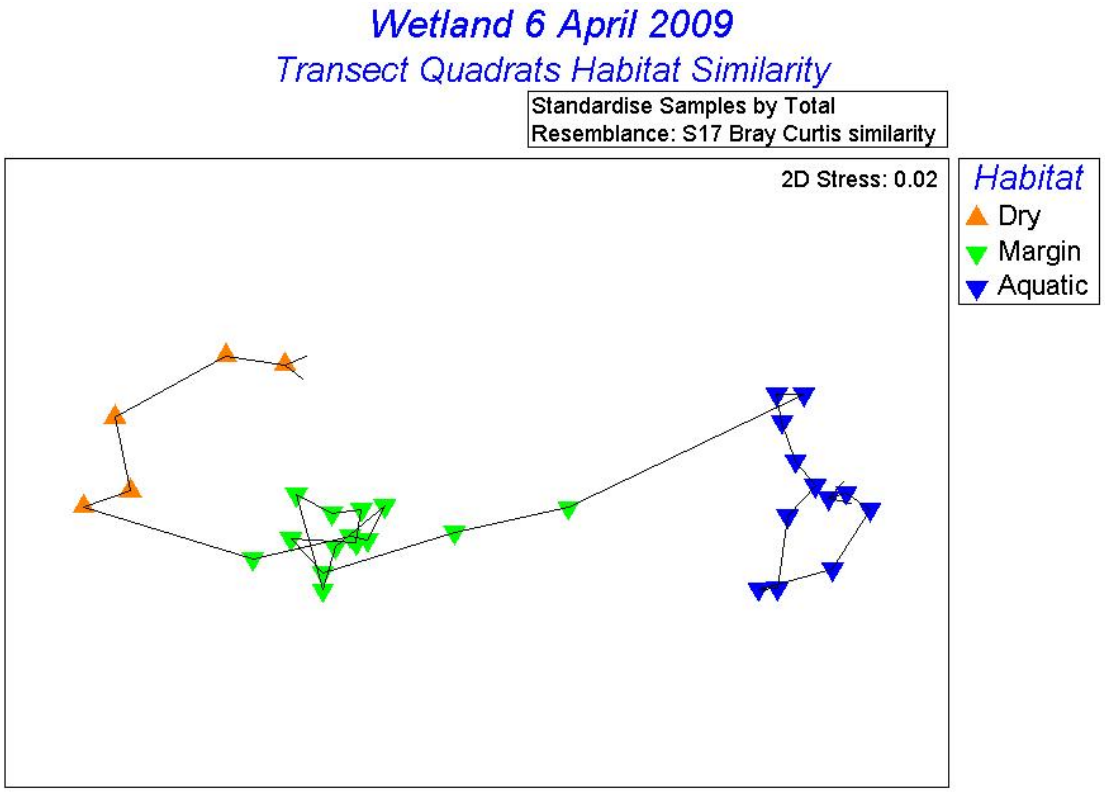


Figure 14 MDS showing Wetland 6 transect quadrats grouped according to habitat type for April 2009



Figure 15 Wetland 6 Maundia triglochinoides patch November 2012

5.3.3 Wetland 7

This wetland (**Figure 16**) 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. Other parts of this wetland have a more gradual transition that includes the more typical Margin habitat.

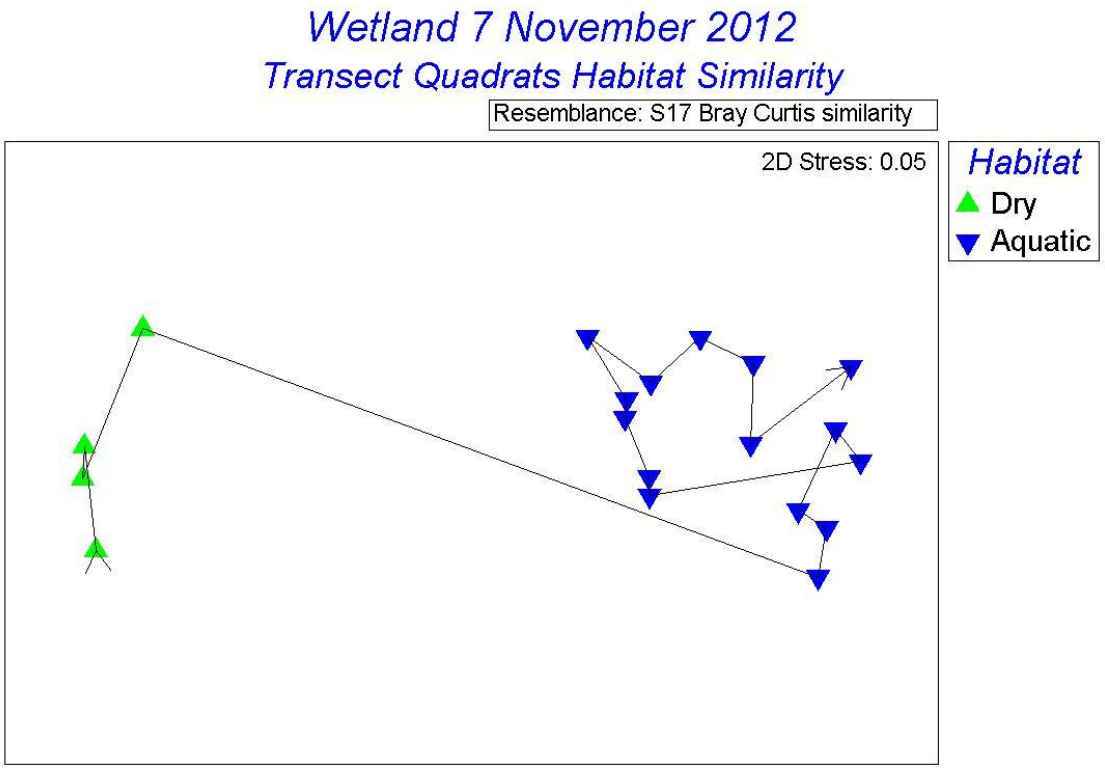


Figure 16 MDS showing Wetland 7 transect quadrats grouped according to habitat type

5.3.1 Wetland 8

This wetland (**Figure 17**) was dry although it did contain several aquatic species growing in the mud. There was evidence of cattle grazing in and around this wetland.

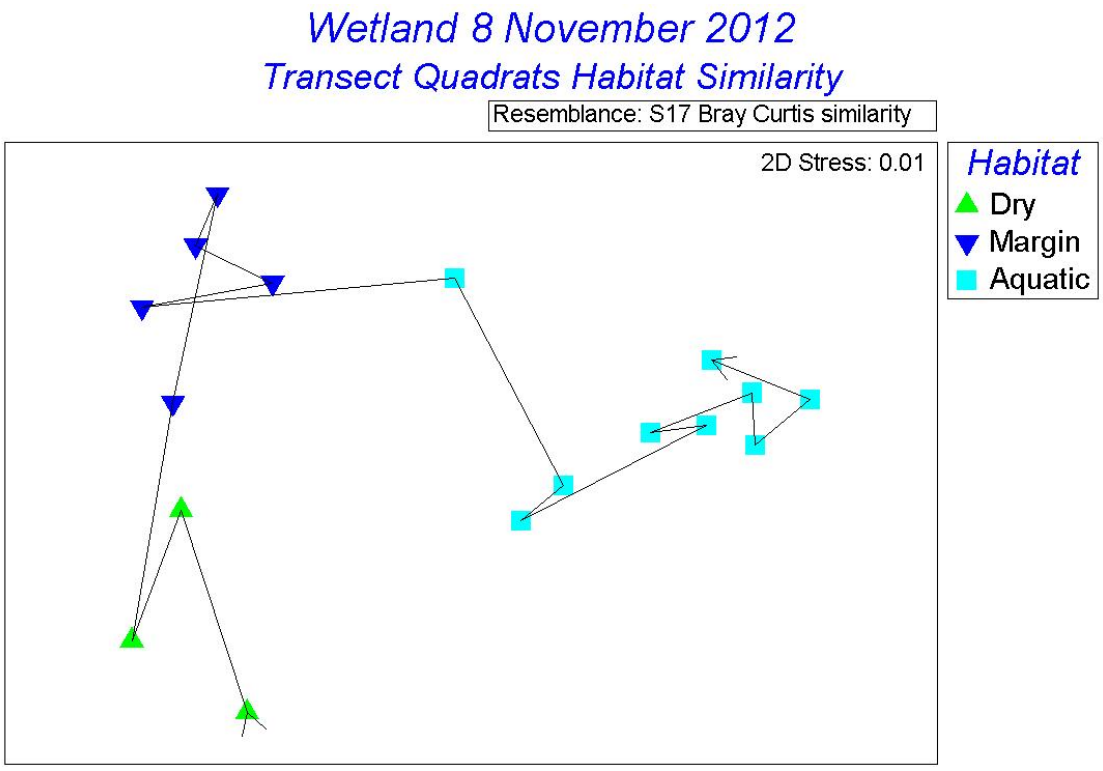


Figure 17 MDS showing Wetland 8 transect quadrats grouped according to habitat type

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 18**) shows clear separation of each of the three habitat types.

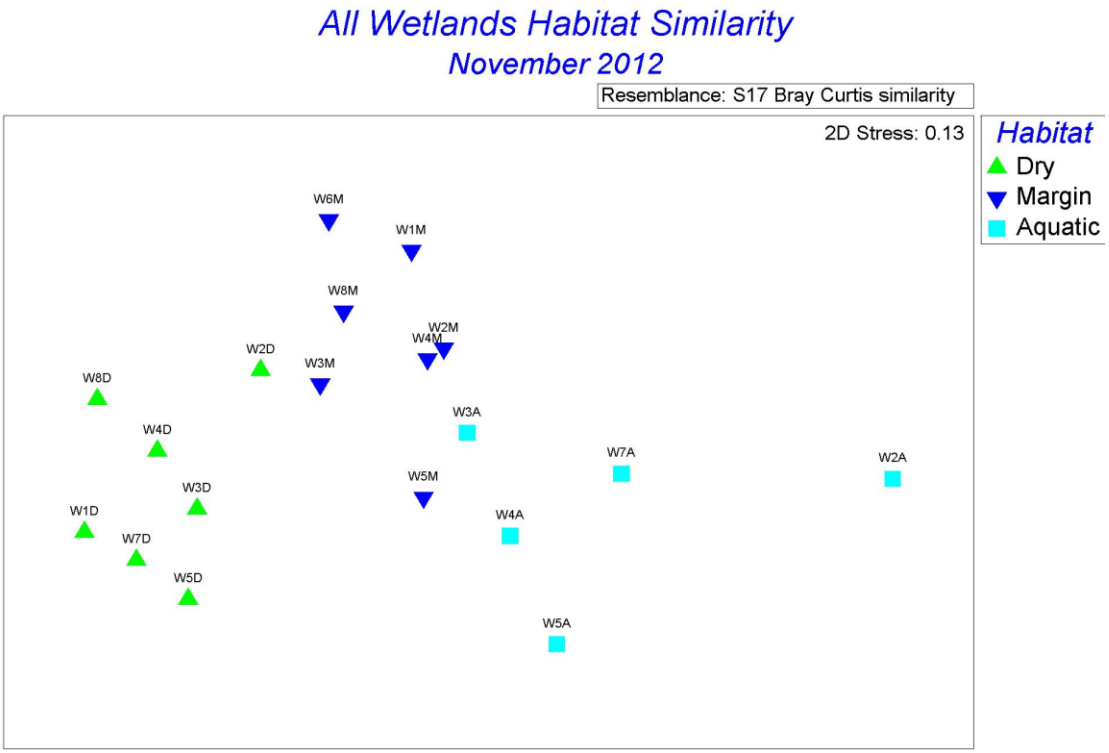


Figure 18 MDS showing habitat similarity across all wetlands

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 19 shows the metres of aquatic habitat in each transect over time. While there is an amount of variation and some trends appear to be present, least squares regression showed that for Wetland 6 only the trend was significant ($F(1,7) = 23.02$, $p<0.05$). This indicates that Margin habitat has grown out into Aquatic habitat by 4 metres since April 2009.

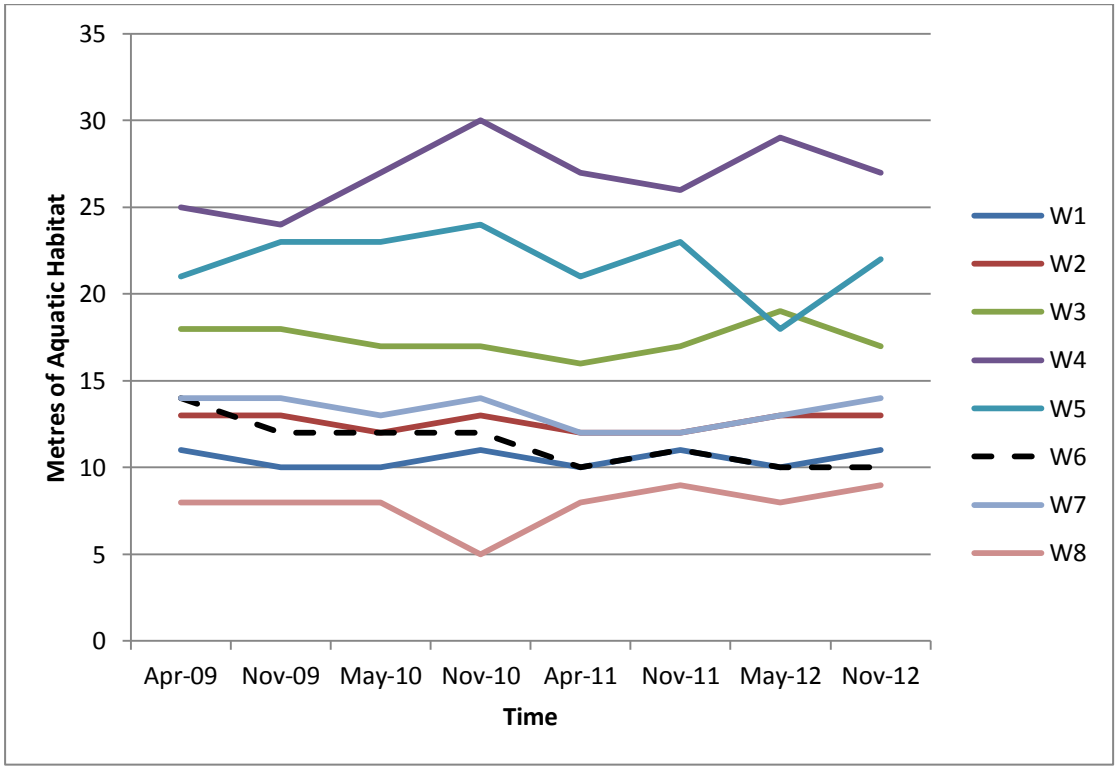


Figure 19 Metres of Aquatic habitat in each wetland transect over time

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 six 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 20** to **24** 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 (also, Wetland 1 had no aquatic vegetation in May or November 2012).

Results are as follows:

- Wetland 2 showed a significant decrease in the three indices at a high level of certainty (99%) over time.
- 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 over time.
- Wetland 5 only Shannon diversity showed a significant fall over time with the other two indices remaining essentially unchanged.
- Wetland 7 only Shannon diversity showed a significant rise over time with the other two indices remaining essentially unchanged.

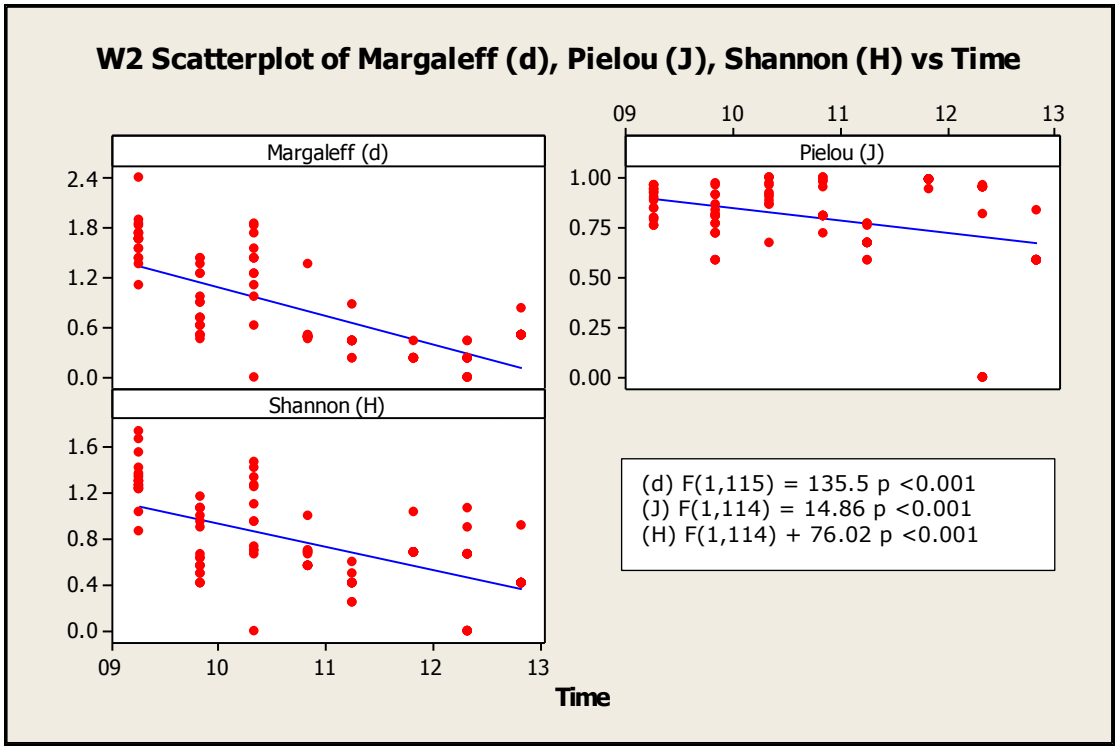


Figure 20 Wetland 2 plots showing the trend of the three diversity indices for aquatic habitat over the eight monitoring occasions

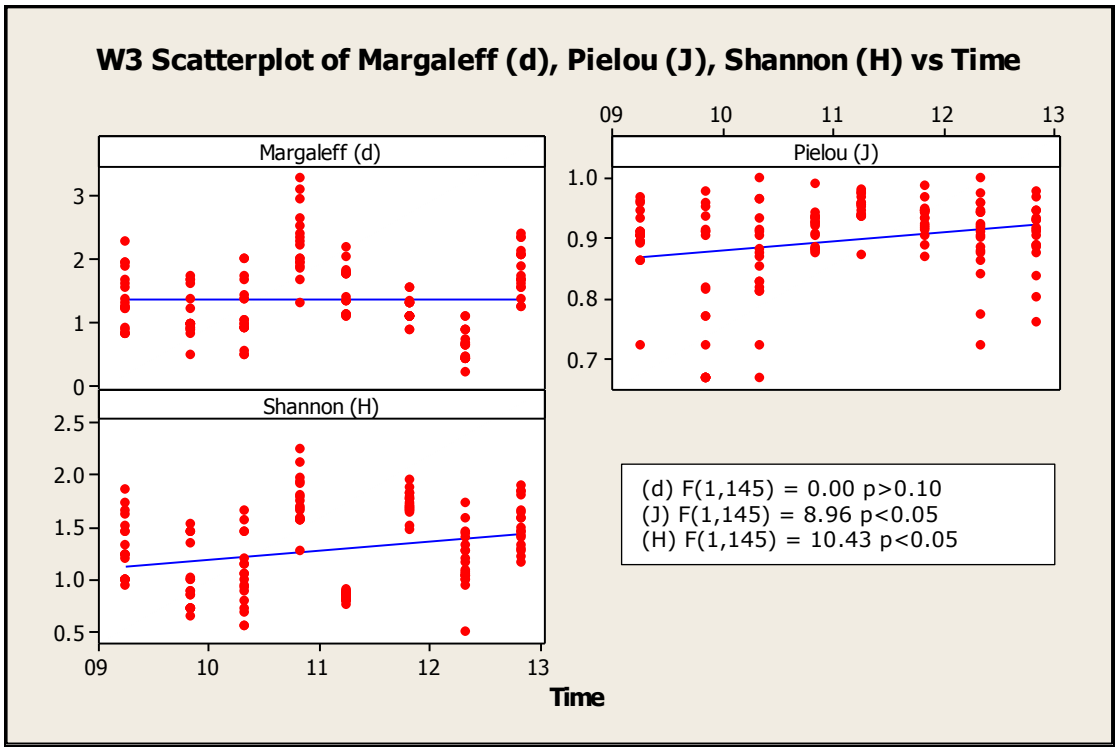


Figure 21 Wetland 3 plots showing the trend of the three diversity indices for aquatic habitat over the eight monitoring occasions

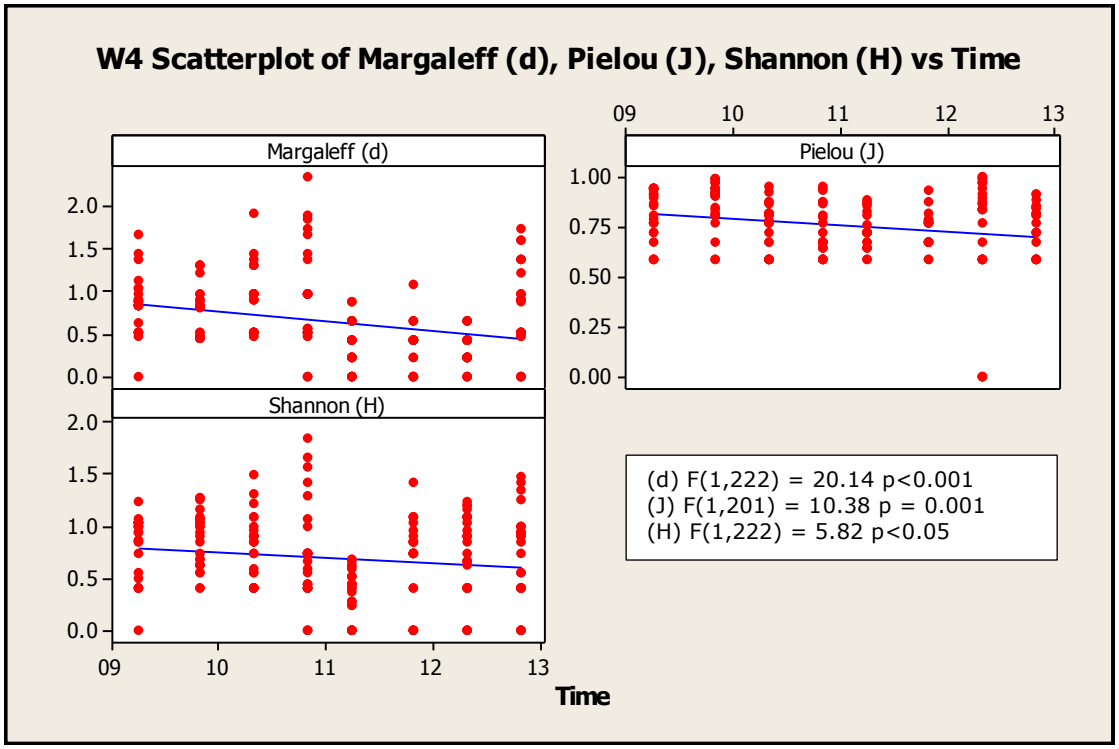


Figure 22 Wetland 4 plots showing the trend of the three diversity indices for aquatic habitat over the eight monitoring occasions

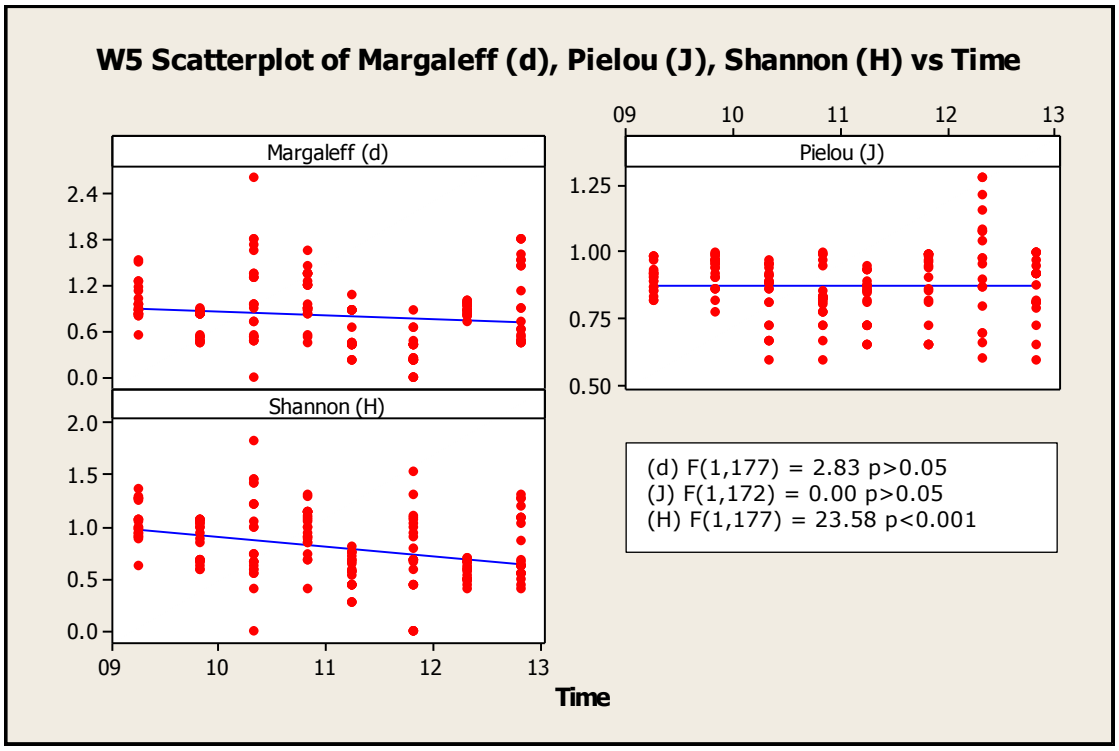


Figure 23 Wetland 5 plots showing the trend of the three diversity indices for aquatic habitat over the eight monitoring occasions

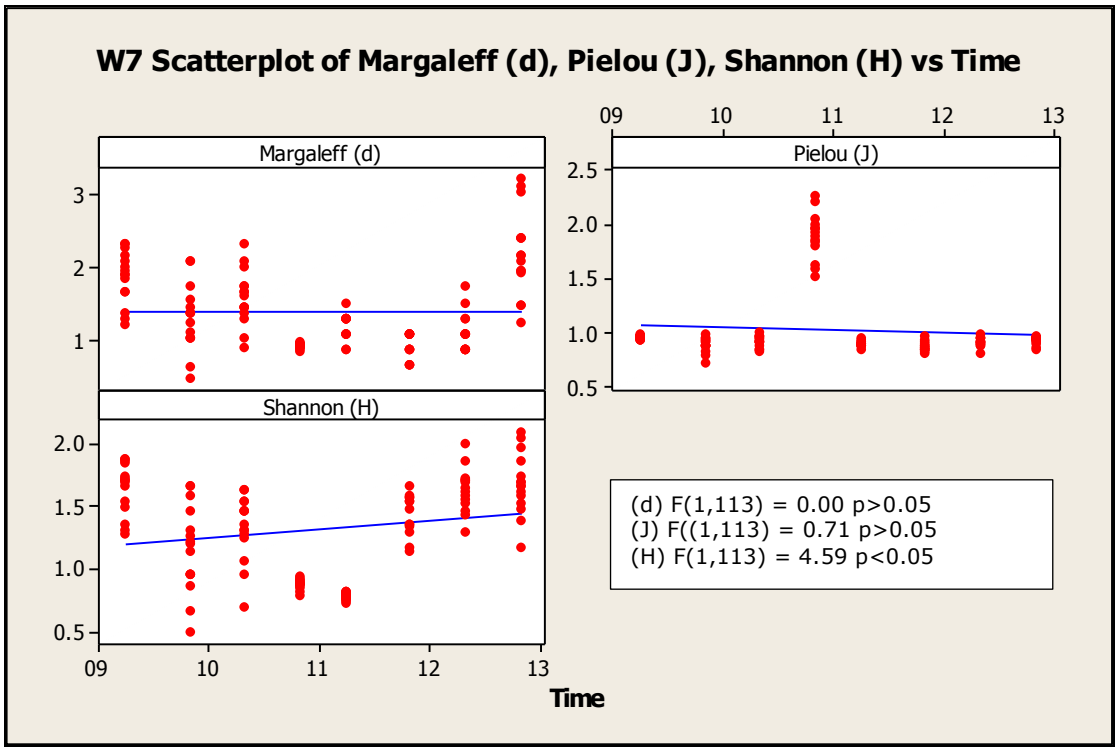


Figure 24 Wetland 7 plots showing the trend of the three diversity indices for aquatic habitat over the six monitoring occasions

However, this downward trend does not necessarily imply that something is going 'wrong' with a wetland any more than an increasing trend would imply that a wetland is becoming 'good'. These indices can only be viewed as describing natural variation in aquatic habitat species composition and relative abundance.

Across all wetlands Pielou values were high, indicating that aquatic habitat was not dominated by one or more species. For Margalef and Shannon indices, where changes up or down were significant they were within a narrow range from a high starting point. The greatest fall was for Wetland 2 and this reflects the almost total loss of aquatic species since April 2009.

In the context of this monitoring program being primarily tasked with determining whether any detrimental changes occur in wetlands as a consequence of subsidence, it is important to note that changes in these indices were across all wetlands. In fact very little change occurred in either Wetland 6 or Wetland 8, the only wetlands that have been subject to subsidence.

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 cutoff used in the analysis was 90% of the total species contributions.

Figure 25 shows that there are two clearly dominant species in Dry habitat. These are the weedy grasses *Axonopus fissifolius* (Carpet Grass) and *Cynodon dactylon* (Couch). Also, the top four contributing species are weeds. It is expected that dry grassland that has been cleared and then grazed for many years would be dominated by weed species.

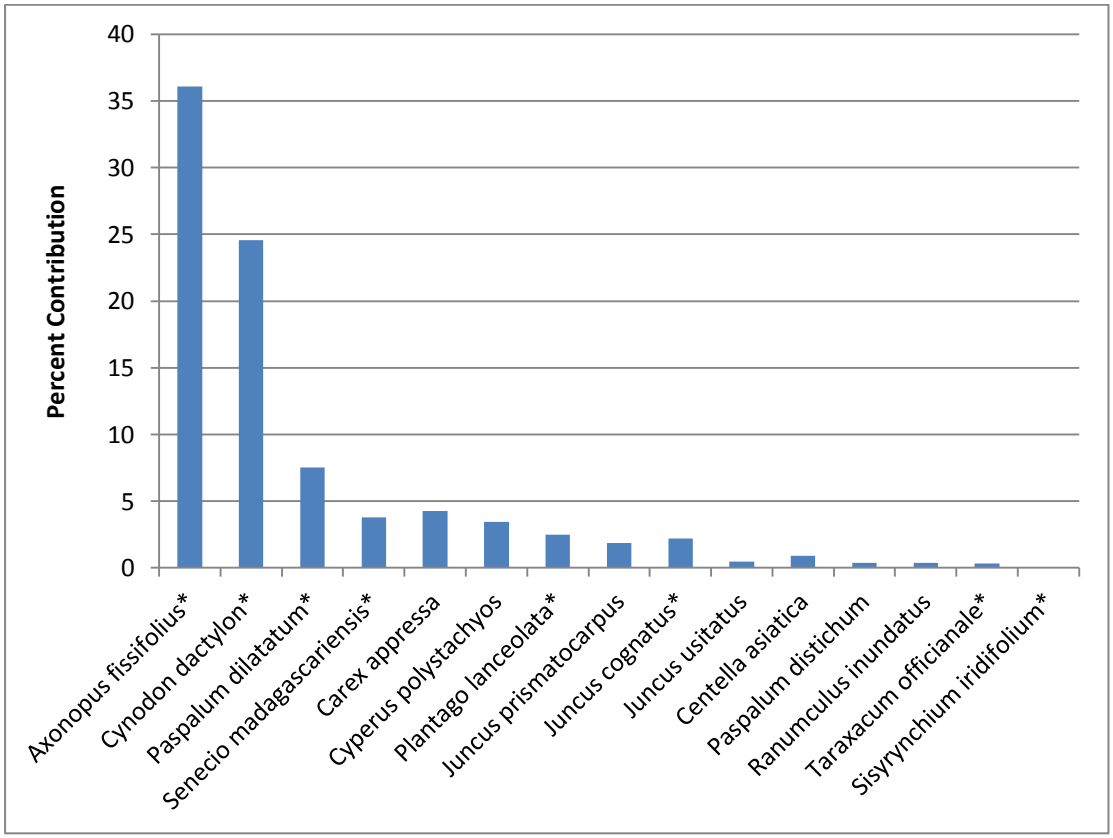


Figure 25 Simper analysis of dominant species in Dry habitat for all wetlands

* Indicates weed species

Figure 26 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.

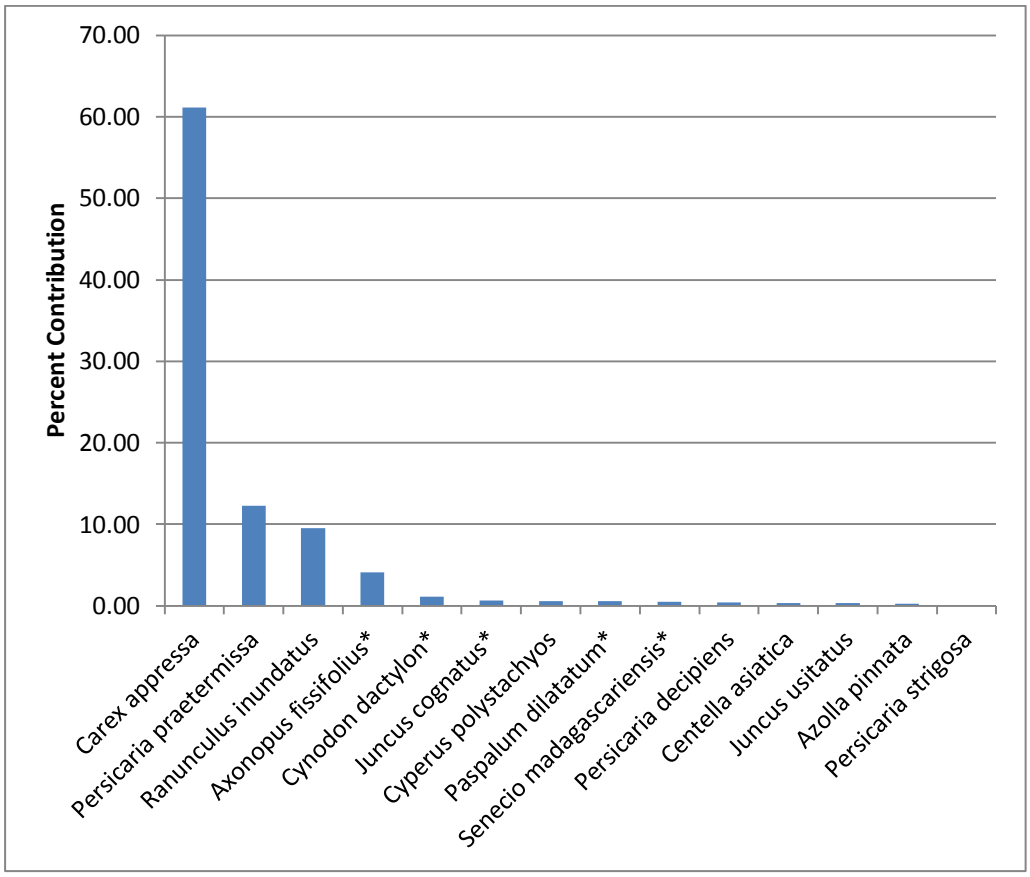


Figure 26 Simper analysis of dominant species in margin habitat for all wetlands

* Indicates weed species

Figure 27 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.

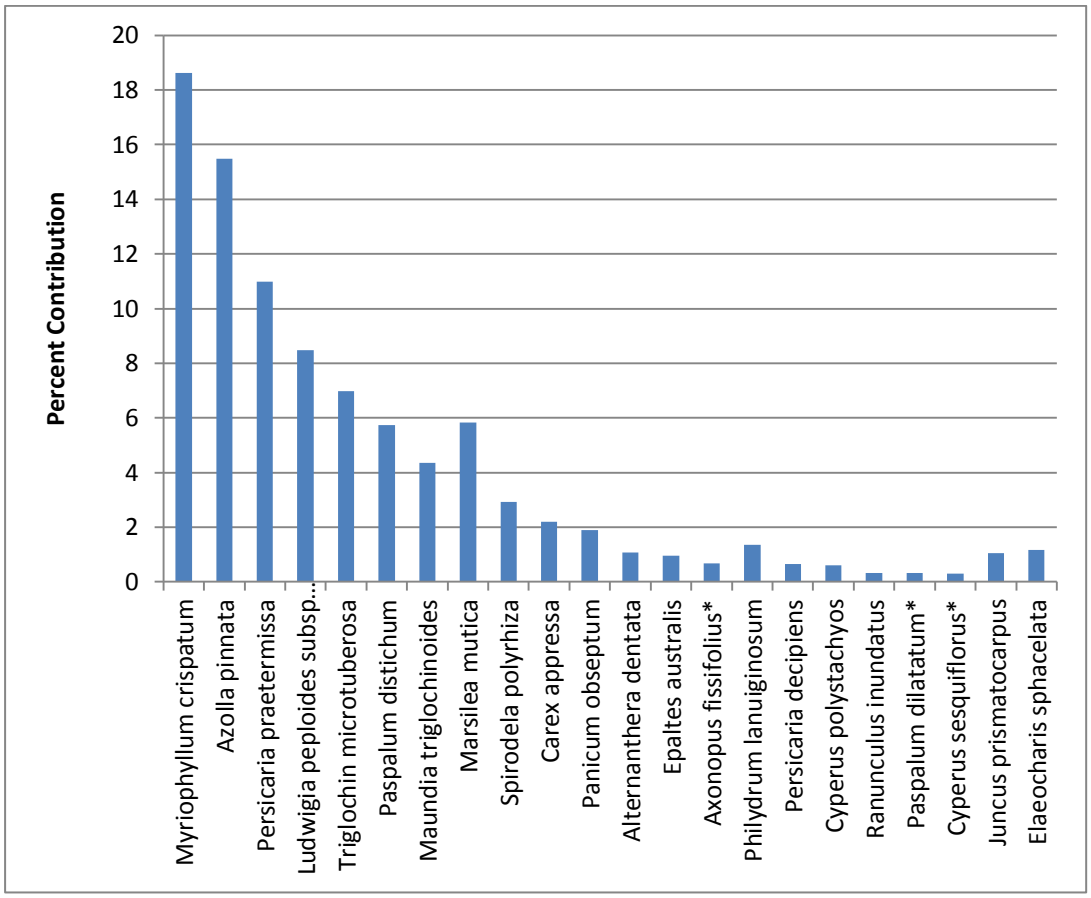


Figure 27 Simper analysis of dominant species in aquatic habitat for all wetlands

* Indicates weed species

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%.

6.4 Aquatic habitat variation over time and season

This investigation examined whether there were any patterns to overall wetland condition that related to year or season of sampling. Seasons were Autumn, April/May monitoring, and Spring, November monitoring. **Figure 28** shows MDS similarity plots for all wetlands by year. In most wetlands there is a hint of grouping by year but for the most part there is little separation between groups. Wetlands 2 , 3 and 6 show the separation by year. At this stage it is unclear as to what factors would be involved. However, it is clear that the effect is not strong enough to impact all wetlands.

Figure 29 shows MDS similarity plots for all wetlands by season and, other than for Wetland 1, there is no difference between seasons.

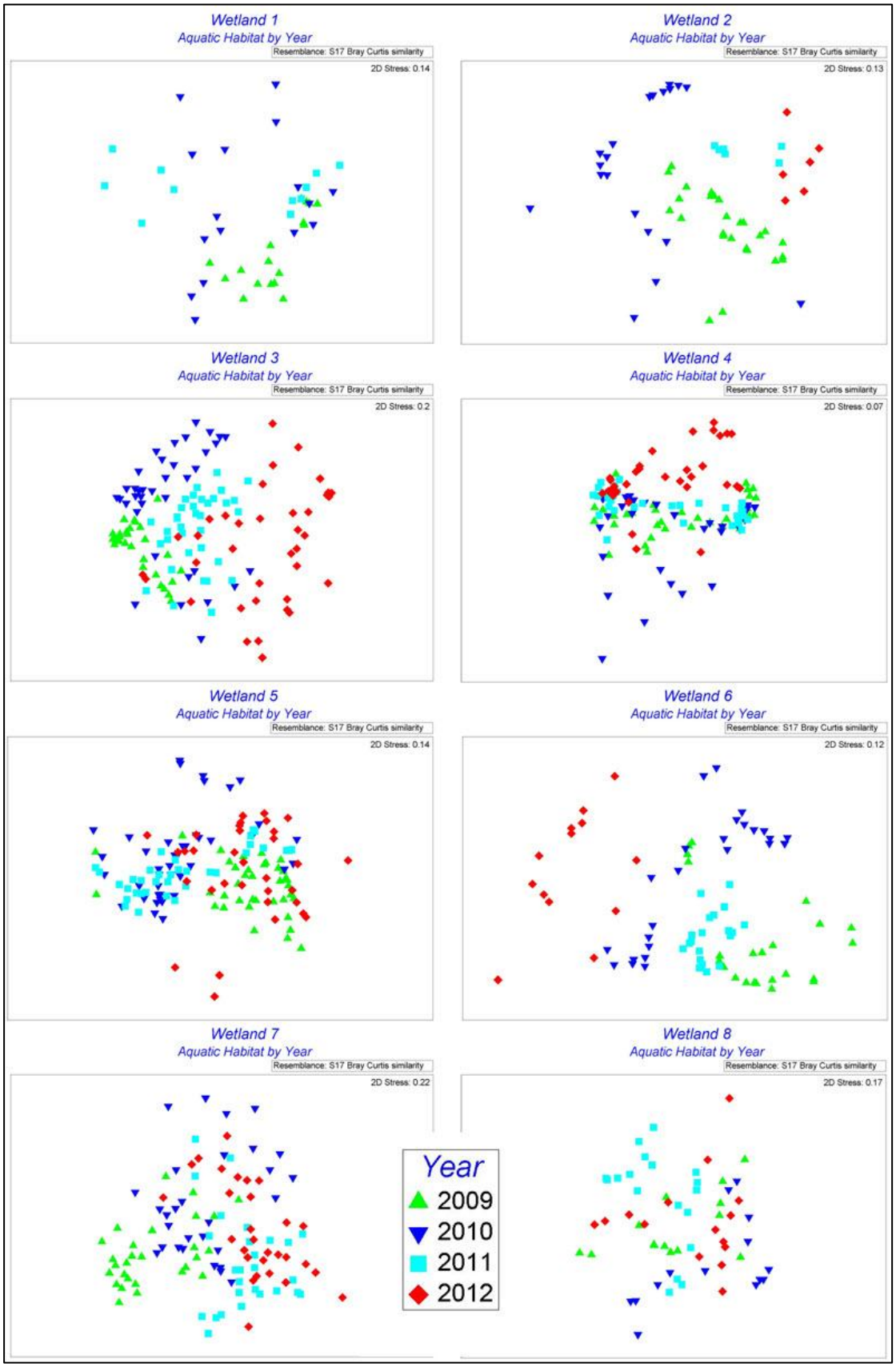


Figure 28 Aquatic habitat similarity by year

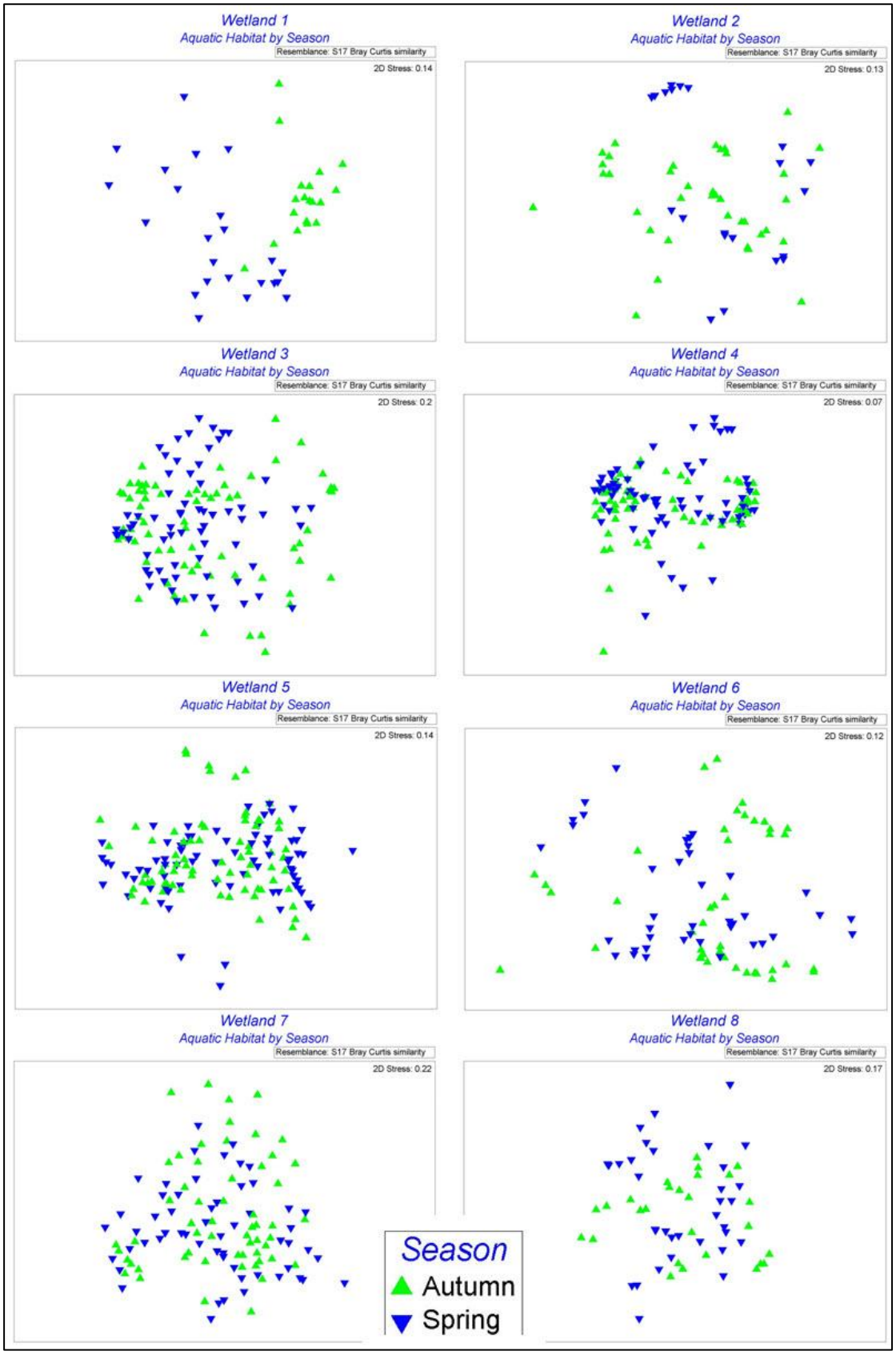


Figure 29 Aquatic habitat similarity by season

6.5 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 is resulting in a substantial change in the aquatic vegetation. This effect continues in November 2012.

Similarity analysis using all water analytes was conducted to determine whether any patterns existed between wetlands, year or season. MDS plots in **Figure 30** show no groupings. From this analysis it can be concluded that there is no effect of wetland, year or season on the measured water variables. This information can be related back to the analysis presented in Section 6.4 with the conclusion that water composition has no effect on the variation seen between years.

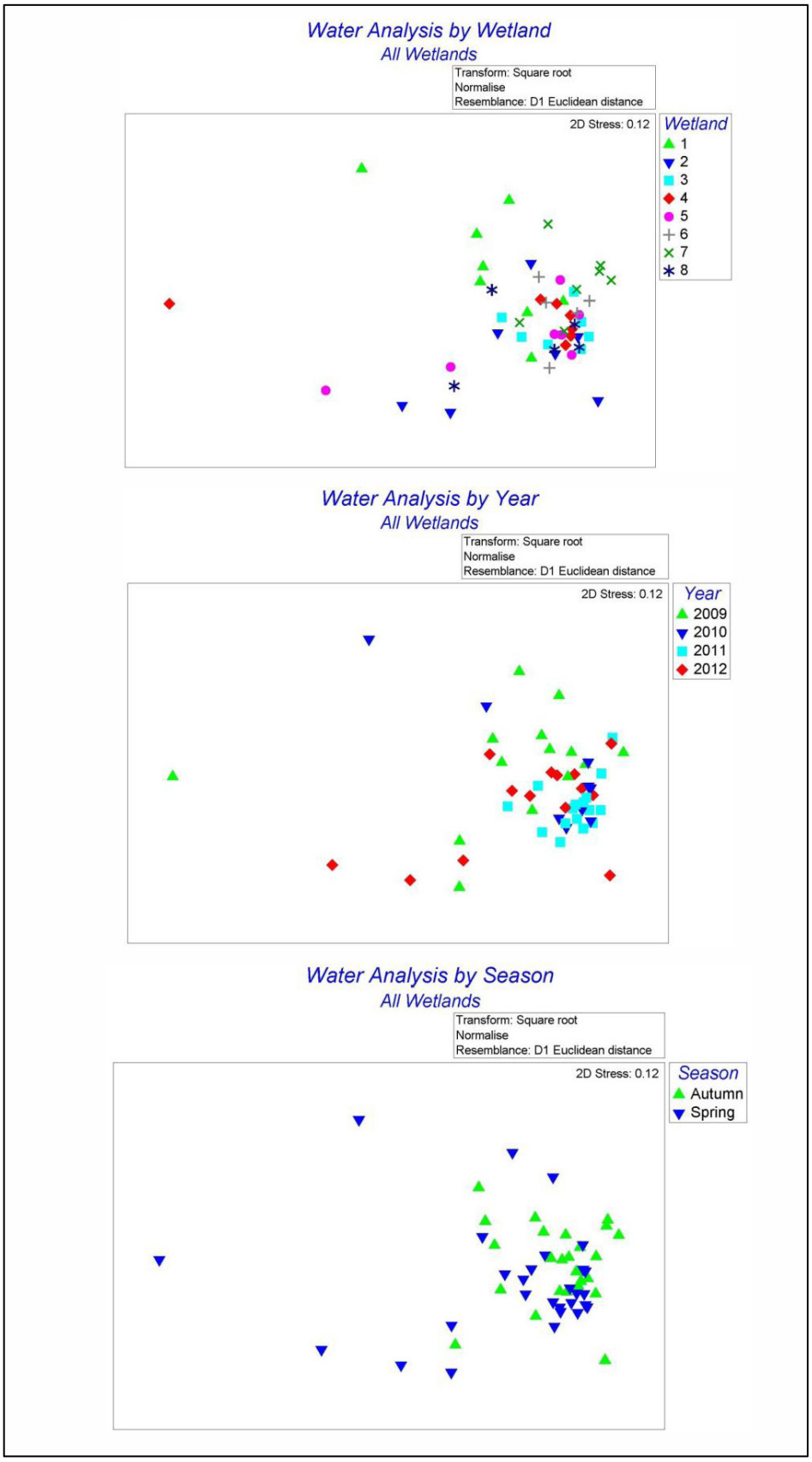


Figure 30 MDS similarity plots of water analysis by wetland, year and season

Oxygen saturation

Oxygen saturation levels for the eight monitoring occasions are plotted in **Figure 31**. 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.

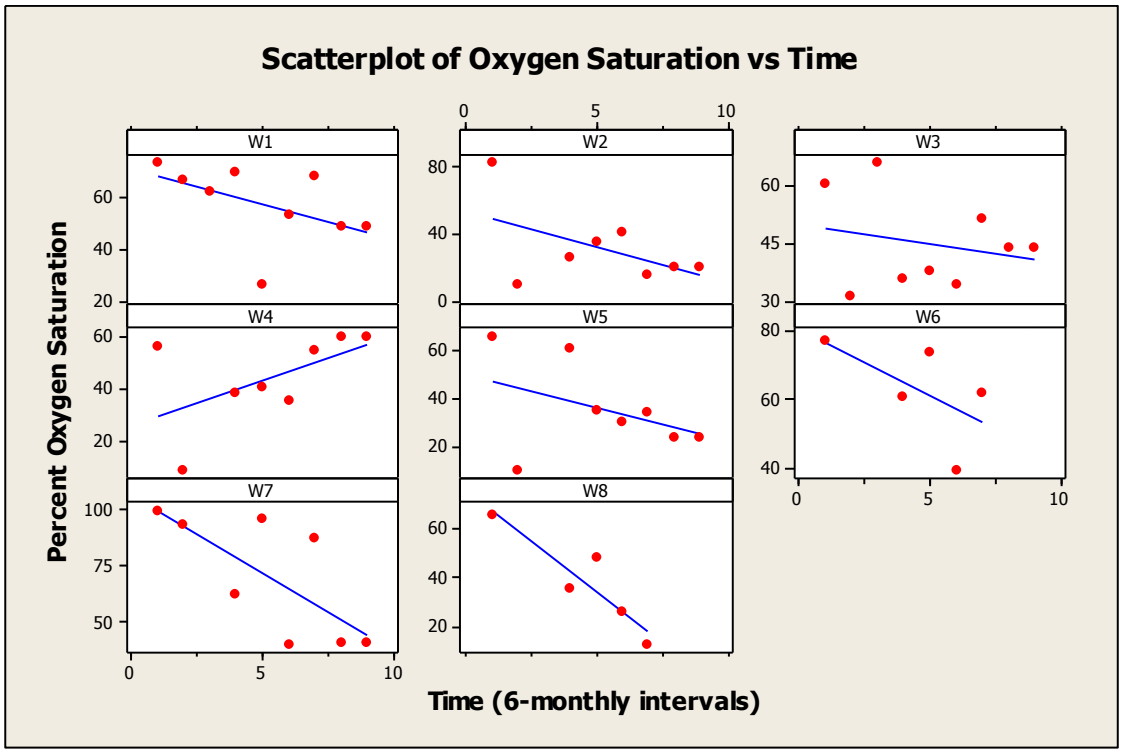


Figure 31 Oxygen saturation levels over time for each wetland

The only wetland for which the trend (downward over time) was significant was Wetland 7 ($F(1,7) = 6.27$ $p = 0.046$).

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 place the Mandalong monitored wetlands at below acceptable levels for most monitoring occasions. However there is no available control over this and the recorded levels could well be typical of wetlands in a rural agricultural landscape.

7 Subsidence impact

7.1 Wetland 6

Figure 32 shows the location of the vegetation monitoring transect and subsidence monitoring lines at Wetland 6. Panel 12 has been subsided in May 2012.

Data from the subsidence monitoring transects recorded in early December 2011 showed that there had only been 0.03 – 0.06 m of subsidence along line 11MG2, increasing to the north west. However at 4 May 2012 subsidence had increased to 0.206 – 0.229. Subsidence data recorded 20 June 2012 along line CS5 was 0.30 m to 0.03 m decreasing from the centre of panel 11. No further data have been collected.

The crossline transect CS5 shows that the wetland itself has subsided 0.19 m with negligible tilt; subsidence increases to the north west and south east of the wetland. Subsidence along the line of the wetland and the underlying pillars show subsidence increasing south west away from the wetland but by only 0.02 m. This would lend support to the observation from the transect data that the once dry habitat has been replaced by moister margin habitat. Looking at **Figure 32** 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. None of this would be expected to impact negatively on the wetland habitat.

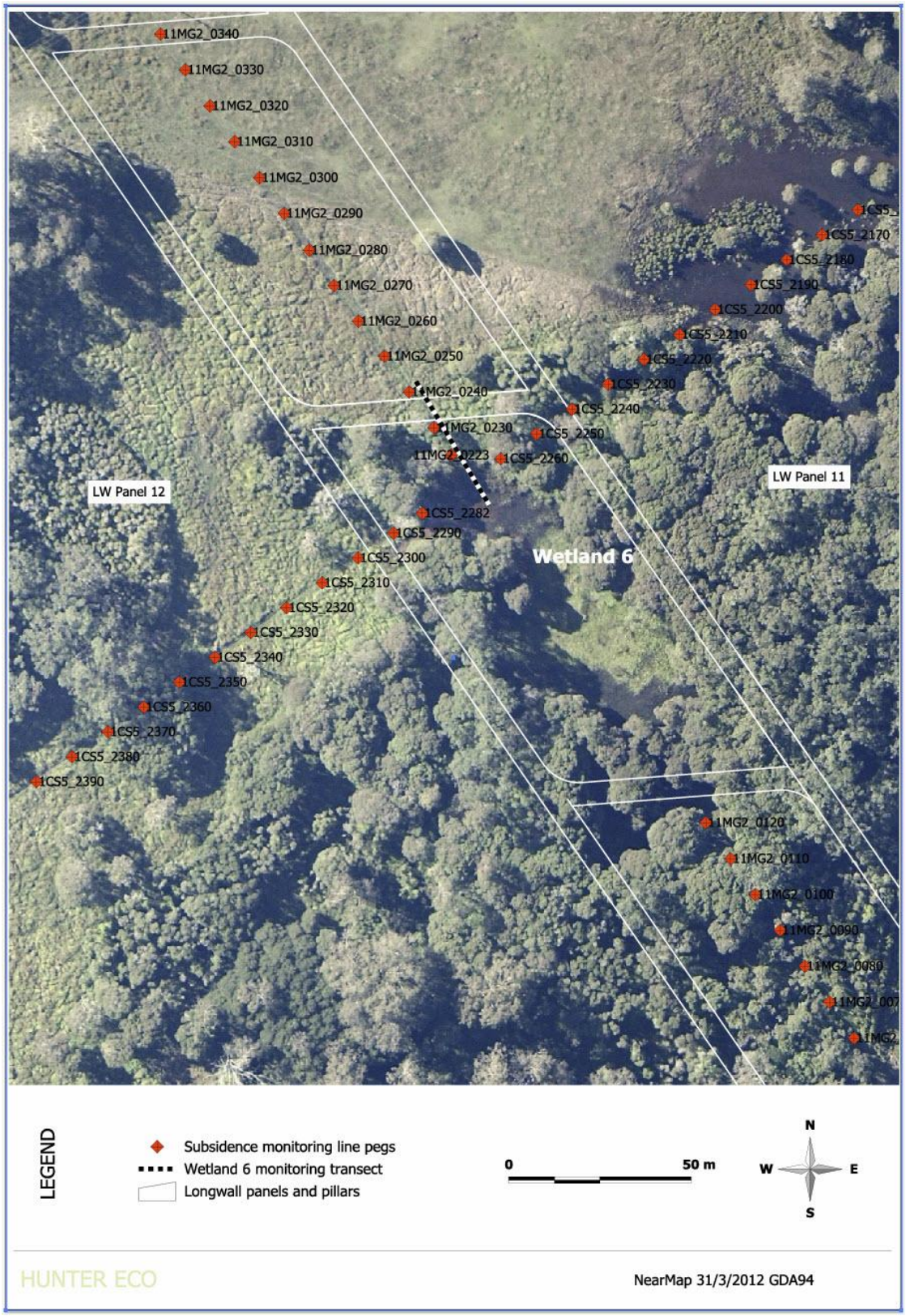


Figure 32 Wetland 6 subsidence monitoring lines and wetland monitoring transect

7.2 Wetland 8

There is a subsidence monitoring survey line running through a section of the overall wetland complex of which Wetland 8 is a part (**Figure 33**).

No further survey data have been collected since 7 June 2012, included in the May 2012 report. These data showed subsidence at peg zero had increased from 0.173 m on 10 June 2011 to 0.207 m. At peg 13 it had increased from 0.488 m to 0.522 m. Tilt (2 – 6 mm/m) towards the west remains approximately the same. The main impact on water levels would come from increase in subsidence from the edge of the panel to the centre. As a consequence, water would be expected to move towards the deepest part. However, as noted in section 5.3 above there is a low barrier at the start of the monitoring transect preventing water from moving in that direction and, that water appears to have increased to the west and south west.

Taking into account the edge of the subsided panel and the fact that the land is dipping and tilting toward the centre, it is conceivable that the aquatic edge along the monitoring transect could contract rather than expand. There is no evidence of this happening in either the water edge or the habitat transition boundaries.

A similarity analysis was conducted to determine whether any difference in Wetland 8 aquatic habitat floristic content could have occurred since subsidence in early 2010. The bottom right panel in **Figure 34** shows a clear separation between the before and after subsidence periods for Wetland 8. The first step in exploring reasons for this was to apply the same analysis to all other wetlands to determine whether the effect was localised to Wetland 8 or more to be seen broadly across all wetlands. Examination of **Figure 34** shows that the pattern was in fact found to varying degrees in all other wetlands, thus eliminating the possibility of a subsidence impact on Wetland 8.

Section 6.5 has shown that there was no pattern over time for water analyte composition so that would be an unlikely explanation for this phenomenon. Section 5.2, Figure 6 provides the most likely explanation. The exceptional dry period in 2010 appears to have had a marked and lasting impact on aquatic habitat content in particular, a period that coincided with subsidence occurring under Wetland 8.

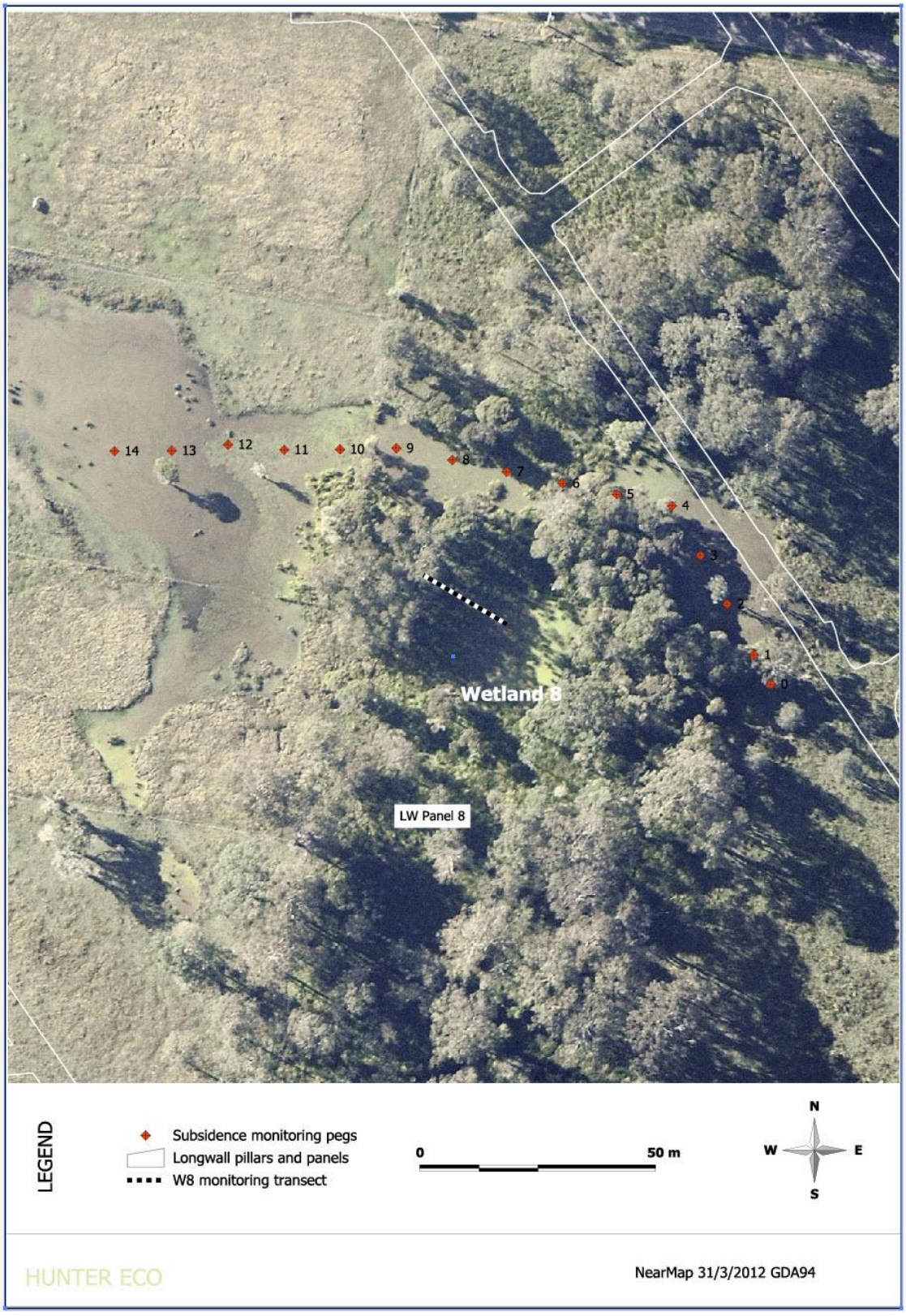


Figure 33 Wetland 8 subsidence monitoring line and wetland monitoring transect

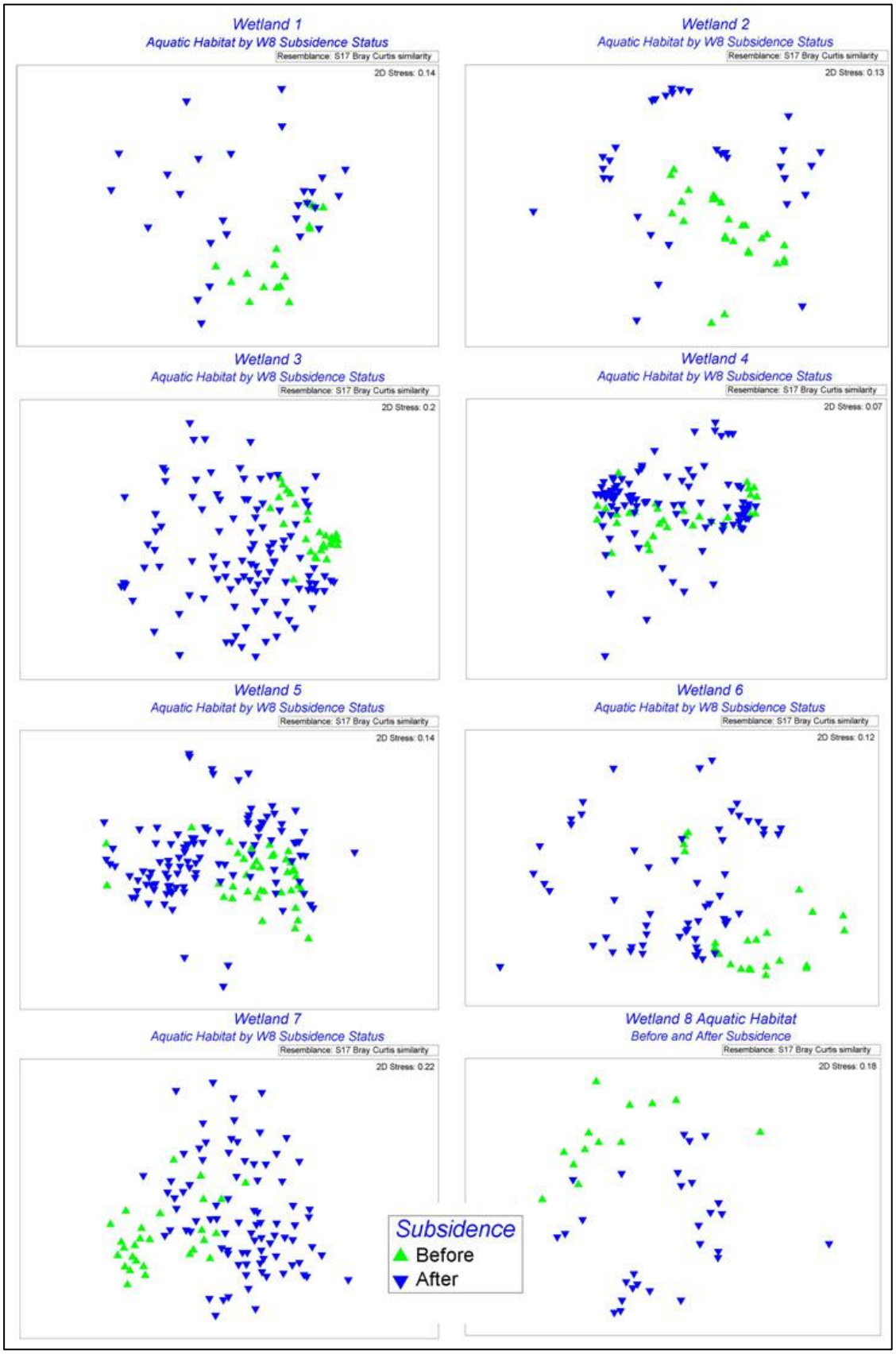


Figure 34 MDS plots showing the similarity of floristic content for all wetlands for before and after Wetland 8 subsidence occurring

8 Management actions

The Mandalong mine Wetland Management Plan (Driscoll 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 November 2012 can be explained as being from causes other than mining subsidence. Even though Wetland 8 has experienced subsidence for almost two years there is, as yet, no clear evidence of change that could be attributed to subsidence.

Table 5 Responses to the WMP triggers

Trigger	Result at November 2012	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.	See Section 5.5 for discussion concluding that this was likely to be within the bounds of natural variation. No subsidence impact was detected.
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 8 wetlands started in April 2009 so as at November 2012 the total monitoring period has been 3.5 years, eight 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 an increasing rainfall trend up to May 2012 after which it has fallen substantially which is now reflected in the low water levels in all wetlands.

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 with panel 12 recently 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 two 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). Section 5.1 shows that the

proportion of weeds to native species over time has reduced significantly for Wetlands 6 and 7 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 has recovered at the south eastern end of Wetland 6, away from the monitoring transect. The extent of this species was much the same in May 2012.

Game camera monitoring of Wetland 2 in late November 2011 confirmed deer moving through the wetland on two occasions over two weeks. Camera monitoring of Wetland 6 from late December 2011 to early January 2012 showed considerable deer activity. Camera monitoring of Wetland 7 in February 2012 revealed no deer activity.

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. By November 2012 fencing of the large wetland that contains monitored Wetlands 4 and 5 was complete.

10 References

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Appendix 1 Cumulative floristics at November 2012

Family and Species	1	2	3	4	5	6	7	8
Amaranthaceae								
Alternanthera denticulata		✓			✓	✓		✓
Apiaceae								
Centella asiatica	✓	✓		✓	✓	✓	✓	✓
*Cyclospermum leptophyllum**								✓
Daucus glochiatus								✓
*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.								✓
Phylidraceae								
Philydrum lanuginosum	✓		✓	✓	✓		✓	
Plantaginaceae								
*Plantago lanceolata**		✓		✓	✓		✓	✓
Poaceae								
*Andropogon virginicus**			✓		✓			
*Axonopus fissifolius**	✓	✓	✓	✓	✓	✓	✓	✓
*Briza minor**					✓		✓	✓
*Cynodon dactylon**	✓	✓	✓	✓	✓		✓	✓
Dichelachne rara				✓				
Echinochloa colona						✓		
Eragrostis alveiformis				✓				
Hemarthria uncinata						✓		
Lachnagrostis filiformis						✓		
*Lolium perenne**								✓
Microlaena stipoides					✓			
Panicum bisulcatum	✓			✓	✓	✓		✓
Panicum obseptum		✓	✓	✓	✓	✓	✓	
*Paspalum dilatatum**	✓	✓	✓	✓	✓	✓	✓	✓
Paspalum distichum	✓		✓	✓	✓	✓	✓	✓
*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 nigrans**					✓			
Verbenaceae								
*Verbena bonariensis**								✓
Salviniaceae								
Azolla pinnata	✓	✓	✓	✓	✓	✓	✓	✓
Total Species	**41**	**27**	**38**	**34**	**50**	**41**	**46**	**55**

✓ = new in November 2012

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**	4	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
Cyperaceae	*Carex appressa*	0	0	0	0	0	0	0	0	0	0	0	4	3	6	5	1	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Cynodon dactylon**	4	5	5	6	6	6	5	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Asteraceae	*Epaltes australis*	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
Cyperaceae	*Isolepis inundata*	0	0	0	0	0	0	3	3	2	3	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncaceae	*Juncus cognatus**	3	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
Juncaceae	*Juncus polyanthemus*	0	0	0	0	0	0	0	0	0	0	0	2	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncaceae	*Juncus usitatus*	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
Poaceae	*Panicum bisulcatum*	1	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
Poaceae	*Paspalum dilatatum**	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	*Paspalum distichum*	0	0	0	0	0	0	0	4	5	5	6	3	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Asteraceae	*Taraxacum officinale**	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
		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**																					
Poaceae	*Axonopus fissifolius**	1	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	6	6	6	6	6	6	6	6	6	6	6	6	6	6
Cyperaceae	*Carex appressa*	3	3	6	6	5	5	2	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Apiaceae	*Centella asiatica*	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Cynodon dactylon**	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyperaceae	*Eleocharis sphaecelata*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0
Apiaceae	*Hydrocotyle tripartita*	1	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	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Panicum obseptum*	1	2	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polygonaceae	*Persicaria praetermissa*	1	0	1	1	2	3	2	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Plantaginaceae	*Plantago lanceolata**	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rosaceae	*Rubus discolor**	2	3	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	3	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Juncaginaceae	*Triglochin microtuberosa*	0	0	0	0	0	0	2	0	0	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	4	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyperaceae	*Carex appressa*	0	0	1	5	1	2	5	0	0	0	0	0	0	3	1	1	0	0	0	0	0	0
Poaceae	*Cynodon dactylon**	1	3	1	0	0	0	0	0	0	0	0	0	0	2	2	1	0	2	0	1	0	1
Cyperaceae	*Cyperus exaltatus*	0	0	0	0	1	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	2	2	0	0	2	4	5	6	6	3	2	1	0	0	0
Juncaceae	*Juncus cognatus**	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	2	1	0	0	0	0	0	0	1	0	0	0	1	1	3
Juncaceae	*Juncus prismatocarpus*	0	0	0	0	0	0	1	3	3	3	3	2	1	0	0	0	0	1	1	1	1	1
Onagraceae	*Ludwigia peploides subsp. montevidensis*	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
Haloragaceae	*Myriophyllum crispatum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
Hydrocharitaceae	*Ottelia ovalifolia subsp. ovalifolia*	0	0	0	0	1	3	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0
Poaceae	*Panicum obseptum*	0	0	0	0	4	4	2	5	3	2	0	2	2	1	1	0	4	0	0	0	3	2
Poaceae	*Paspalum distichum*	0	0	0	0	0	0	0	0	0	2	4	2	2	1	1	0	0	0	3	0	0	0
Polygonaceae	*Persicaria praetermissa*	0	0	1	2	3	2	4	3	2	3	1	0	1	2	2	1	2	2	3	4	4	3
Polygonaceae	*Persicaria strigosa*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Phylidraceae	*Philydrum lanuginosum*	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	1	4	3	5	4	4
Ranunculaceae	*Ranunculus inundatus*	0	0	3	2	1	0	0	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	0	0	0
Iridaceae	*Sisyrinchium iridifolium**	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Asteraceae	*Taraxacum officinale**	1	0	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	1	0	0	0	0	0	0	0	0	0	0	0	0
Lentibulariaceae	*Utricularia gibba*	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
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
		DRY			M	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**																																				
Poaceae	*Axonopus fissifolius**	2	2	1	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	0	0	0	0
Cyperaceae	*Carex appressa*	0	0	1	1	1	6	6	4	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	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
Poaceae	*Cynodon dactylon**	5	5	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	0	0	0	0	0	0	0
Cyperaceae	*Cyperus flavidus*	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	0	0
Poaceae	*Eragrostis alveiformis*	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	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	1	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	0	0	0	0	0	0
Apiaceae	*Hydrocotyle laxiflora*	0	0	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
Juncaceae	*Juncus cognatus**	0	1	1	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	0	0	0	0
Juncaceae	*Juncus polyanthemus*	0	0	3	0	1	0	0	0	0	0	1	2	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	1	0	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
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	1	1	3	5	6	5	4	5	6	6	6	5	5	5	5
Juncaginaceae	*Maundia triglochinoides*	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	1	1	0	0	2	2	3	3
Haloragaceae	*Myriophyllum crispatum*	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	3	3	1	1	2	1	1	1	1
Poaceae	*Panicum obseptum*	0	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	0	0	0	0
Poaceae	*Paspalum distichum*	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	1	1	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0
Polygonaceae	*Persicaria praetermissa*	0	0	0	0	0	0	1	3	4	5	6	6	6	6	6	6	6	6	6	6	6	6	6	6	5	4	1	3	3	2	0	0	0	0	0	0	0
Ranunculaceae	*Ranunculus inundatus*	0	0	0	0	0	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
Poaceae	*Dichelachne rara*	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	0
Poaceae	*Panicum bisulcatum*	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
		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	*Axonopus fissifolius**	0	0	0	1	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
Azollaceae	*Azolla pinnata*	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	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	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	4	4	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
Apiaceae	*Hydrocotyle laxiflora*	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	*Isolepis prolifera**	0	0	0	0	0	0	1	5	5	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncaceae	*Juncus articulatus**	0	1	3	3	4	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	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 usitatus*	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	2	1	2	0
Marsileaceae	*Marsilea mutica*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	6	6	6	6	6	6	6	6	6	5	2	1	1	3	1	1	1
Poaceae	*Microlaena stipoides*	0	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	1	2	1	1	2	3	3	3	2	2	2	3	2	1	1	2	2	2	0	4	4	4
Poaceae	*Panicum bisulcatum*	0	0	0	0	1	4	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
Poaceae	*Paspalum distichum*	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
Polygonaceae	*Persicaria praetermissa*	0	0	0	0	0	3	4	4	4	3	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Plantaginaceae	*Plantago lanceolata**	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
Ranunculaceae	*Ranunculus inundatus*	0	0	0	0	0	0	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
Rosaceae	*Rubus discolor **	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
Poaceae	*Sacciolepis indica*	2	3	2	3	3	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
Asteraceae	*Senecio madagascariensis**	1	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**	1	2	3	3	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
Cyperaceae	*Tetraria capillaris*	1	0	1	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
Iridaceae	*Sisyrinchium iridifolium**	0	1	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
Lemnaceae	*Spirodela polyrhiza*	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	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**																																
Cyperaceae	*Carex appressa*	0	0	0	0	1	1	4	2	3	4	4	4	4	4	4	3	1	3	3	3	4	4	0	0	0	0	0	0	0	0	0	0	0
Cyperaceae	*Carex gaudichaudiana*	6	6	6	6	5	5	2	1	3	2	2	2	2	2	2	4	5	3	3	3	3	3	1	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	0	1	2	3	2	3	4	0	0	0	0	0
Apiaceae	*Hydrocotyle bonariensis**	0	0	0	0	0	0	0	0	0	0	0	0	1	3	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncaceae	*Juncus polyanthemus*	0	1	1	0	0	1	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
Poaceae	*Panicum bisulcatum*	0	1	0	2	1	1	1	3	3	1	1	1	1	0	2	2	0	0	0	2	1	0	1	1	1	0	0	0	0	0	0	0	0
Poaceae	*Paspalum distichum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	1	1	1	0	0	0	0	0	0
Polygonaceae	*Persicaria decipiens*	0	0	0	0	0	0	1	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
Polygonaceae	*Persicaria strigosa*	0	1	1	1	2	3	3	2	2	2	2	1	2	2	0	1	4	4	2	2	2	1	0	0	0	0	0	0	0	0	0	0	0
Ranunculaceae	*Ranunculus inundatus*	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	2	1	1	1	1	0	1	1	0	0	0	0	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**																		
Poaceae	*Axonopus fissifolius**	3	3	3	2	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	1	1	1	1	0	0	0	0	0	1	1
Apiaceae	*Centella asiatica*	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Cynodon dactylon**	2	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyperaceae	*Cyperus sesquiflorus**	0	0	0	1	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	0	0	0	0	1	1	1	2	3	3	2	3
Clusiaceae	*Hypericum gramineum*	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncaceae	*Juncus articulatus**	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncaceae	*Juncus cognatus**	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncaceae	*Juncus polyanthemus*	0	0	0	1	0	0	0	0	0	0	0	1	1	2	0	1	0	0	0
Juncaceae	*Juncus prismatocarpus*	0	0	0	0	1	0	0	0	0	1	1	2	1	2	2	3	3	0	0
Onagraceae	*Ludwigia peploides subsp. montevidensis*	0	0	0	0	1	0	0	0	0	1	0	1	0	0	1	1	0	0	0
Haloragaceae	*Myriophyllum crispatum*	0	0	0	0	2	4	4	6	4	1	1	1	1	0	1	1	2	2	4
Hydrocharitaceae	*Ottelia ovalifolia subsp. ovalifolia*	0	0	0	0	2	2	2	1	0	0	0	0	1	0	0	1	2	1	1
Poaceae	*Paspalum dilatatum**	2	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	5	5	3	2	1	0	1	0	0	0	0	1	1	2	1
Polygonaceae	*Persicaria praetermissa*	0	0	1	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
Phylidraceae	*Philydrum lanuginosum*	0	0	0	0	0	2	5	2	1	3	3	3	3	3	3	1	2	3	0
Plantaginaceae	*Plantago lanceolata**	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ranunculaceae	*Ranunculus inundatus*	0	0	0	0	2	2	1	0	1	1	0	0	0	0	0	0	0	0	0
Polygonaceae	*Rumex sp**	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Asteraceae	*Senecio madagascariensis**	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Setaria sphacelata**	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Iridaceae	*Sisyrinchium iridifolium**	1	1	3	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	0	0	0	0	0	1	1	1	1	1	0	0	0
Asteraceae	*Taraxacum officinale**	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fabaceae (Faboideae)	*Trifolium repens**	1	0	1	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	1	1
Polygonaceae	*Persicaria decipiens*	1	1	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0
		DRY				M	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**																
Poaceae	*Axonopus fissifolius**	2	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyperaceae	*Carex appressa*	0	1	0	3	6	5	4	3	1	0	0	0	0	0	0	0	0
Casuarinaceae	*Casuarina glauca*	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Apiaceae	*Centella asiatica*	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Asteraceae	*Epaltes australis*	0	0	0	0	0	0	0	0	0	3	3	1	1	0	1	0	0
Juncaceae	*Juncus polyanthemus*	0	0	0	0	0	0	1	0	1	2	3	0	3	0	0	0	0
Juncaginaceae	*Juncus usitatus*	0	1	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0
Fabaceae (Faboideae)	*Lotus corniculatus**	0	1	0	1	0	2	1	3	0	0	0	0	0	0	0	0	0
Onagraceae	*Ludwigia peploides subsp. montevidensis*	0	0	0	0	0	0	0	0	0	0	0	3	3	3	3	3	3
Poaceae	*Paspalum distichum*	0	0	0	0	0	0	0	0	5	2	2	2	2	1	1	0	3
Polygonaceae	*Persicaria decipiens*	0	0	0	0	0	0	0	0	0	2	1	3	2	2	3	2	3
Polygonaceae	*Persicaria praetermissa*	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0
Plantaginaceae	*Plantago lanceolata**	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Asteraceae	*Senecio madagascariensis**	1	1	2	1	0	0	0	0	0	0	1	0	0	0	0	0	0
Juncaginaceae	*Triglochin microtuberosa*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
		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-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-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-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-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-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-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-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	-	-	-	-	-	-		-	-	

Centennial Coal

Centennial Coal Company Limited
P O Box 1000
Toronto NSW 2283
www.centennialcoal.com.au