

Attachment 6A

Annual Groundwater Management Plan



Report

Hitchcock Road Site

2011 Annual Groundwater Management Plan

27 JULY 2011

Prepared for
PF Formation
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Introduction

1.1 Introduction

PF Formation (PFF) is required under the Development Approval conditions set for the Maroota Hitchcock Road property area (Figure 1) to prepare an annual Water Management Plan (WMP) report to the Baulkham Hills Shire Council (BHSC). The WMP is part of the overall Environmental Management Plan and addresses the surface water and groundwater aspects of the sand extraction operations at the site.

URS Australia Pty Ltd (URS) has been retained by PFF to prepare the groundwater component of the above report, which is presented in the following sections.

The WMP for the year July 2010 to June 2011 also includes the monitoring data collected from 1996 to date for the Hitchcock Road site and for Portion 198.

Groundwater Management Facilities

2.1 General

At the Hitchcock Road site, groundwater is monitored at five locations:

1. monitoring bore PF167MW1, located in Portion 167;
2. monitoring bore PF166MW1, located in Portion 166;
3. supply dam PF167DAM, located in Portion 167;
4. monitoring bore PFL2HitchMW1, located in Lot 2; and
5. monitoring bore PFP214MW1, located in Portion 214.

In addition, groundwater pumpage and chemical records are also collected from the two water supply bores in Portion 198, i.e., PF198PB1 and PF198PB2 (Figure 1).

Groundwater monitoring has been carried out at the sites since 1996. Initially, water levels in bores PF166MW1 and PF167MW1 were measured manually at weekly intervals together with chemical field parameters such as pH and Electrical Conductivity (EC). The manual measurements continued until December 1998. In January 1999, the two bores were equipped with Dataflow Systems automatic data loggers.

Dataloggers have been downloaded quarterly between January 1999 and June 2000. Since June 2000, the dataloggers have been downloaded biannually. In January 2006, the old style Dataflow dataloggers were replaced with Solinst Levellogger 3001 units, capable of storing 40 000 readings in the memory, with a battery life span of around 10 years. The new Solinst dataloggers allow data annual downloading, a monitoring interval started on July 2006.

Groundwater samples for chemical analysis have been collected on the same day from the monitoring and pumping bores. The analytical results have been plotted on individual graphs that are continuously updated to assess possible trends with time.

Water samples from five bores (PF167MW1, PF166 MW1, PFL2HitchMW1, PFP214MW1 and PF198PB1) were collected and submitted for chemical analysis under Chain of Custody procedures to Australian Laboratory Services Pty Ltd. The laboratory reports are presented in Appendix B.

A groundwater sample from bore PF198PB2 could not be collected as the pump has been out of service since December 2009. The pump has been pulled out and replaced in July 2011.

The analytical list for all bores, which was discussed and agreed upon with the DLWC (now the NSW Office of Water) has included:

- pH, Electrical Conductivity and Total Dissolved Solids;
- Calcium, Magnesium, Sodium and Potassium;
- Chloride, Sulphate, Bicarbonate; and
- Oil and Grease.

2 Groundwater Management Facilities

2.1.1 Monitoring Bore PF167MW1

Groundwater monitoring at bore PF167MW1 commenced in March 1996. The data between March 1996 and December 1998 (manual collection) have been plotted in the graph of Figure 2, together with EC and rainfall records collected by PFF. An automated weather station has been installed by PFF in 2010.

Figure 3 presents the combined Dataflow and Solinst dataloggers records for bore PF167MW1. Some minor data gaps exist and a slight difference between the manual data and the start of the automatic recording is evident in the graph, which are due to the time intervening between the end of the manual and start of the automatic recording methods.

2.1.2 Monitoring Bore PF166MW1

Groundwater monitoring at bore PF166MW1 commenced in March 1998 in the same manner as for bore PF167MW1. The data between March 1998 and December 1998 (manual collection) have been plotted in the graph of Figure 4, together with EC and rainfall records collected by PFF.

The plots of bore PF167MW1 records collected after the installation of the Dataflow datalogger and those of the Solinst dataloggers are presented in Figure 5.

2.1.3 Monitoring Bore PFP214MW1

Bore PFP214MW1 was installed in March 2009 as part of an extended groundwater monitoring network following the Development Approval for Portion 214, located at the southern boundary of the Hitchcock Road site.

A datalogger was installed in the bore in early April 2009 (Solinst Levellogger Gold 3001, serial no. 51040540). Bore PFP214MW1 hydrograph is presented in Figure 6.

2.1.4 Monitoring Bore PFL2HitchMW1

Bore PFL2HitchMW1 was also installed in March 2009. This bore is located midway along the eastern boundary of the Hitchcock Site and monitors the full sequence of the Maroota Sand.

A datalogger was installed in the bore in early April 2009 (Solinst Levellogger Gold 3001, serial no. 510405840). Bore PFL2HitchMW1 hydrograph is presented in Figure 7.

2.1.5 Portion 167 Dam

At the early stages of the site development, an excavation (PF167DAM) was carried out to the top of the Hawkesbury Sandstone to an approximate level of 178 m AHD. The excavation collects groundwater and surface water run-off and was eventually licensed by the DLWC (No.10BL157308) as part of the water supply of the operation.

Water levels measured against surveyed pegs have been collected at the dam since September 1996 and pumpage records kept since January 1997.

Plots of the water levels in the dam and of the rainfall in the same period are presented in Figure 8 and a plot of the pumpage records in Figure 9.

2 Groundwater Management Facilities

Water quality in the dam is not monitored because the dam collects incident rainfall, run-off and groundwater and, as a result, water quality would vary according to the proportion of each component at the time of measurement.

2.1.6 Portion 198 Water Supply Bores

The two water supply bores in Portion 198 (PF198PB1 and PF198PB2) have been monitored manually since their installation in March 1998. Groundwater samples have been collected quarterly for the last four quarters to March 2000, biannually up to July 2006 and annually since then. Pumpage records are collected and totalised weekly.

As indicated earlier, the pump in bore PF198PB2 has been out of service since December 2009. A replacement unit has been installed in July 2011.

Water quality data have been plotted for selected parameters and the graphs are presented in Appendix A and the laboratory reports in Appendix B.

3 Data Assessment

Data Assessment

3.1 Groundwater Levels

Groundwater levels in the Maroota Sand measured in the monitoring bores indicate that the aquifer is variable and contains numerous perched watertables. The plots of bore PF167MW1, which taps the full saturated thickness of the Maroota Sand, and bore PF166MW1, which taps an unconfined aquifer perched at a higher elevation, indicate a rapid response to periods of sustained rainfall. Records for the two new monitoring bores, PFP214MW1 and PFL2HitchMW1, indicate a moderate response to rainfall.

The average yearly rainfall for the year July 2010 - June 2011 has been 976.8 mm, marginally above the long term average of 922.7mm. The rainfall data are reported from the BOM weather station No. 67014 located on Old Telegraph Road.

3.1.1 Bore PF167MW1

After a significant rain event in June 2007, the water level rose by 4.5 m to a level similar to the highest recorded value in mid 2000.

The unexpected rise in the water level in this bore exceeded the datalogger 10 m pressure sensor range and data were not recorded for the following six months. The datalogger suspension wire has been shortened by 3 m and the logger reset. However, the plot shows the July manual water level measurement at 182.44 m AHD, confirming the rising water level trend at this site. Since July 2008 the water level in this bore has followed a familiar pattern of decline with occasional small rises following major rainfall events.

3.1.2 Bore PF166MW1

Since June 2007, following a period of significant and sustained rainfall, the water level in this bore rose by 1.5 m, less than 1 m of the highest level recorded in the first half of 2002. This bore taps a perched aquifer with variable responses to major rainfall events, as evident from the general levelling out since January 2011.

3.1.3 Bore PFP214MW1

Bore PFP214MW1 taps the full thickness of the Maroota Sand towards its southern edge. Since its installation in March 2009, the water has shown a slow declining trend up to end of February 2011. Since that time the water level has risen marginally in response to significant rainfall.

3.1.4 Bore PFL2HitchMW1

Bore PFL2HitchMW1 is the deepest bore in the Hitchcock Road site, as it is located in the vicinity of the former trigonometric station, which is the highest elevation on the site and taps the full thickness of the Maroota Sand aquifer.

3 Data Assessment

The hydrograph shows that after an initial settlement period after drilling, the water level stabilised at an RL level of 189.6 m AHD without any significant response to the rainfall events. The lack of water level response is possibly due to the depth of the bore and to a possible higher clay content of the upper sequence and resulting lower permeability.

3.1.5 PF167Dam

Water levels in the PF167DAM, which was originally excavated to the base of the Maroota Sand within the deep palaeochannel, have been kept above 180 m AHD over the year to June 2011 period by regulating pumpage so as not to exceed this level. Due to the above average rainfall of the last two years there have been long periods when no water was extracted from this site.

The rainfall recorded at the PFF offices for the year to the end of June 2011 has been 976.6 mm, marginally above the yearly average of 922.7 mm. In November 2008, the water level in the dam rose to just above 183 m AHD, the highest level recorded at this site since monitoring started in September 1996. Pumping from this source was stopped in February 2010 in order not to exceed the licensed allowance. As a result, the water level has peaked to an RL of 183.1 m AHD in March 2010. During the first half of the year 2011, the level in the dam has remained at between 182.3 and 183.1 since.

The high level is considered to be the result of the combined effect of the February and May 2011 rainfall, of the reduced pumping from this source and general aquifer recovery and recharge.

Although water is pumped from the dam for a variety of purposes, such as dust suppression and irrigation of rehabilitated areas and, more recently, for sand slurring, records show that water levels return rapidly to the average values indicated above, even after higher levels are experienced after heavy rainfall and consequent run-off. Figure 8 shows these combined effects upon the water level in the dam. The records suggest that the Maroota Sand aquifer at the site is capable of sustaining the required pumpage even under the low rainfall recharge conditions and the additional demand posed upon it in the wider Maroota area by the many groundwater users.

3.1.6 Groundwater Quality

As indicated in Section 2.1, water quality in bores PF167MW1 and PF166MW1 has been monitored for pH and EC since monitoring started. Since June 1999 groundwater quality has been analysed for a range of analytical parameters and for Oil and Grease to obtain background data.

Since July 2009, groundwater quality data have also become available from the newly installed monitoring bores, PFP214MW1 and PFL2HitchMW1.

Historical and recent analytical results for the other samples from the monitoring sites are summarised in Tables 3-1 to 3-6, and have been plotted in the graphs presented in Appendix A. The laboratory reports are presented in Appendix B.

Figures 2 and 4 show plots of the EC together with water levels and rainfall for the initial monitoring period (March 1996 to January 1999 for bore PF167MW1 and March 1998 to January 1999 for bore PF166MW1), before the installation of the data loggers. The EC plots show a sympathetic variation with rainfall, indicating the effects of dilution generated by recharge (decrease in EC) and by lower water table. In the latter case, the improved EC is interpreted as the effect of aquifer recharge by fresher water.

3 Data Assessment

The plots confirm the dependence of the aquifer upon rainfall to maintain storage and supply. No analysis has been carried out of the water from the dam because extraneous influences, such as direct rainfall and run-off, make the water in the dam not representative of the groundwater at that site.

Groundwater quality has also been monitored at bores PF198PB1 and PF198PB2, the two processing plant water supply bores. The water in these bores is derived from the Hawkesbury Sandstone aquifer. Quality records are summarised in Tables 3-5 and 3-6 and have been plotted in the graphs presented in Appendix A. However, as the pump in bore PF198PB2 was out of service, a water sample could not be obtained during the current monitoring event.

The waters in the Maroota Sand aquifer monitoring bores are similar and have a characteristic meteoric composition, with low pH, low TDS and a Sodium-Chloride type. The samples were also analysed for Oil and Grease to monitor the possible effect of the sand extraction operations. Oil and Grease in the groundwater was detected in bore PF198PB1 in January 2006 (6 mg/L), in bore PF198PB2 in December 2001 (11 mg/L) and in bore PF166MW1 (6 mg/L). These appear to be isolated detections and, as no Oil and Grease has been detected in other sampling occasions, it is considered that such occurrences do not represent a cause of concern.

The deep Hawkesbury Sandstone pumping bores groundwater display a slightly different character from that in the shallow Maroota Sand aquifer in the Hitchcock Road area and from the shallow Hawkesbury Sandstone aquifer in other areas of Maroota. The deeper groundwater has a slightly higher TDS, pH and Bicarbonate content (PF198PB2) than the shallower Maroota Sand groundwater; however, its overall low salinity content and sodium-chloride meteoric composition indicate a dynamic groundwater regime with regular and rapid rainfall recharge.

Overall, all the site monitoring bores in both the Hawkesbury Sandstone and in the Maroota Sand show a marginal decrease in Total Dissolved Solids over time, the deeper bores showing a more constant character.

3.1.7 Quality Control

The laboratory quality control samples (laboratory duplicates, procedure blanks and control spikes) returned results within the required limits and acceptance criteria. The quality control data generated by the laboratory are presented with the laboratory certificates in Appendix B.

Based on the evaluation of the data, it is assessed that the accuracy and precision of the analytical data generated in the sampling round, as reported by the analytical laboratory, are acceptable as a basis for interpretation.

3 Data Assessment

Table 3-1 Bore PF167MW1 Chemical Analyses Summary

ANALYTE	Unit													
Date		2.6.99	8.9.99	21.12.99	9.3.00	28.11.00	21.6.01	19.12.01	26.6.02	23.1.03	9.7.03	30.1.04	29.6.04	15.12.04
pH		4.43	4.49	4.21	4.93	4.28	4.61	4.98	4.52	4.54	5.15	4.31	4.38	4.68
Electrical Conductivity, EC	µS/cm	164	190	201	179	184	170	188	215	199	204	225	221	240
Total Dissolved Solids, TDS	mg/L	118	90	105	115	207	120	108	121	101	116	157	110	143
Calcium, Ca	mg/L	3	3	5	6	3	6	6	5	3	4	4	5	5
Magnesium, Mg	mg/L	5	4	4	4	4	4	5	4	4	3	4	4	4
Sodium, Na	mg/L	16	18	16	15	18	16	18	25	20	19	22	23	26
Potassium, K	mg/L	2	2	3	3	3	5	4	5	2	2	2	3	3
Bicarbonate, HCO ₃	mg/L	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	<1	<1	<1
Sulphate, SO ₄	mg/L	9	11	35	32	16	15	15	14	9	13	12	10	13
Chloride, Cl	mg/L	36	11	35	32	35	36	47	58	4	48	51	53	50
Oil and Grease	mg/L	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5		<5	<5
Date		22.6.05	19.1.06	6.7.06	5.7.07	3.7.08	3.7.09	16.6.10	22.6.11					
pH		5.42	4.32	4.27	4.88	5.29	4.00	4.30	5.3					
Electrical Conductivity, EC	µS/cm	215	205	199	188	161	177	190	170					
Total Dissolved Solids, TDS	mg/L	137	141	119	76	100	104	111	101					
Calcium, Ca	mg/L	5	4	4	2	6	5	3	4					
Magnesium, Mg	mg/L	4	4	4	3	5	4	3	4					
Sodium, Na	mg/L	28	25	23	16	13	14	15	18					
Potassium, K	mg/L	3	3	3	2	4	4	2	4					
Bicarbonate, HCO ₃	mg/L	2	1	<1	<1	<1	<1	2	2.4					
Sulphate, SO ₄	mg/L	13	10	6	10	30	22.6	17.1	18					
Chloride, Cl	mg/L	56.6	57.4	53.1	36.1	26.4	34.8	39.9	29					
Oil and Grease	mg/L	<5	<5	<5	<5	<5	<5	<5	<5					

3 Data Assessment

Table 3-2 Bore PF166MW1 Chemical Analyses Summary

ANALYTE	Unit													
Date		1.6.99	8.9.99	21.12.99	9.3.00	29.11.00	21.6.01	19.12.01	26.6.02	23.1.03	9.7.03	30.1.04	29.6.04	15.12.04
pH		4.18	4.19	4.13	4.14	4.31	4.19	4.63	4.48	4.82	7.86	4.39	4.27	4.06
Electrical Conductivity, EC	µS/cm	222	240	230	214	266	194	228	219	203	221	193	235	203
Total Dissolved Solids, TDS	mg/L	118	108	137	170	460	115	210	280	128	134	204	280	120
Calcium, Ca	mg/L	1	1	1	1	1	1	1	2	1	1	<1	1	1
Magnesium, Mg	mg/L	6	6	6	5	6	5	6	6	5	4	5	5	4
Sodium, Na	mg/L	26	23	23	22	29	21	22	24	19	20	18	19	19
Potassium, K	mg/L	<1	<1	1	1	1	1	2	1	<1	<1	<1	1	1
Bicarbonate, HCO ₃	mg/L	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	<1	<1	<1
Sulphate, SO ₄	mg/L	1	7	1	1	16	2	1	2	<1	<1	2	<1	2
Chloride, Cl	mg/L	58	49	51	52	58	49	58	61	46	50	47	44	36
Oil and Grease	mg/L	<5	<5	<5	<5	<5	<5	<5	<5	6	<5	<5	5	<5
Date		22.6.05	19.1.06	6.7.06	5.7.07	3.7.08	3.7.09	16.6.10	22.6.11					
pH					4.76		3.58	4.06	4.22					
Electrical Conductivity, EC	µS/cm	DRY	DRY	DRY	163	NA	240	247	261					
Total Dissolved Solids, TDS	mg/L				98		140	141	172					
Calcium, Ca	mg/L						<1	<1	1					
Magnesium, Mg	mg/L						4	4	6					
Sodium, Na	mg/L						26	24	24					
Potassium, K	mg/L						2	2	3					
Bicarbonate, HCO ₃	mg/L						<1	<1	<1					
Sulphate, SO ₄	mg/L						2.21	1.77	1					
Chloride, Cl	mg/L						49.1	56.3	53					
Oil and Grease	mg/L						<5	<5	<5					

3 Data Assessment

Table 3-3 Bore PFL2HitchMW1 Chemical Analyses Summary

ANALYTE		Unit		
Date		3.7.2009	16.6.2010	22.6.2011
pH		3.96	4.1	4.1
Electrical Conductivity, EC	µS/cm	182	154	167
Total Dissolved Solids, TDS	mg/L	84	88	110
Calcium, Ca	mg/L	1	<1	<1
Magnesium, Mg	mg/L	2	2	2
Sodium, Na	mg/L	19	16	22
Potassium, K	mg/L	2	<1	<1
Bicarbonate, HCO ₃	mg/L	<1	<	<1
Sulphate, SO ₄	mg/L	7.88	4.06	5
Chloride, Cl	mg/L	40.3	36.9	32
Oil and Grease	mg/L	<5	<5	<5

3 Data Assessment

Table 3-4 Bore PFP214MW1 Chemical Analyses Summary

ANALYTE	Unit	3.7.2009	16.6.2010	22.6.2011
Date		3.7.2009	16.6.2010	22.6.2011
pH		4.19	4.16	4.31
Electrical Conductivity, EC	µS/cm	168	164	158
Total Dissolved Solids, TDS	mg/L	100	96	88
Calcium, Ca	mg/L	<1	<1	<1
Magnesium, Mg	mg/L	6	5	4
Sodium, Na	mg/L	18	15	18
Potassium, K	mg/L	1	<1	1
Bicarbonate, HCO ₃	mg/L	<1	<1	<1
Sulphate, SO ₄	mg/L	1.90	<0.5	<1
Chloride, Cl	mg/L	24.3	23.8	34
Oil and Grease	mg/L	<5	<5	<5

3 Data Assessment

Table 3-5 Bore PF198PB1 Chemical Analyses Summary

ANALYTE	Unit													
Date		1.6.99	8.9.99	21.12.99	9.3.00	28.11.00	21.6.01	19.12.01	26.6.02	23.1.03	9.7.03	30.1.04	29.6.04	15.12.04
pH		5.87	6.24	6.11	4.69	4.49	4.51	5.41	4.73	4.49	5.06	5	4.53	4.28
Electrical Conductivity, EC	µS/cm	161	170	169	141	182	179	204	199	243	199	160	291	197
Total Dissolved Solids, TDS	mg/L	124	116	98	97	107	102	116	112	139	102	116	174	88
Calcium, Ca	mg/L	1	<1	1	1	3	2	2	4	3	2	2	4	1
Magnesium, Mg	mg/L	4	6	5	3	3	4	4	4	4	3	2	5	2
Sodium, Na	mg/L	21	24	22	19	20	21	27	23	31	22	19	40	25
Potassium, K	mg/L	1	<1	1	1	2	5	5	3	3	2	2	3	2
Bicarbonate, HCO ₃	mg/L	13	29	22	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Sulphate, SO ₄	mg/L	4	4	4	2	8	8	3	7	4	8	6	9	8
Chloride, Cl	mg/L	39	35	36	36	40	49	60	58	64	49	43	83	42
Oil and Grease	mg/L	<5	<5	<5	<5	<5	<5	<5	<5	6	<5	<5	<5	<5
Date		22.6.05	19.1.06	6.7.06	5.7.07	3.7.08	3.7.09	16.6.10	22.6.11					
pH		5.22	5.74	5.16	No sample	4.59	3.94	4.43	5.52					
Electrical Conductivity, EC	µS/cm	157	158	155		144	174	163	170					
Total Dissolved Solids, TDS	mg/L	105	115	98		85	83	88	102					
Calcium, Ca	mg/L	1	2	1		<1	1	<1	2					
Magnesium, Mg	mg/L	2	4	3		2	2	2	4					
Sodium, Na	mg/L	23	21	20		18	19	16	21					
Potassium, K	mg/L	2	2	2		1	2	1	2					
Bicarbonate, HCO ₃	mg/L	1	12	5		<1	<1	<1	3.7					
Sulphate, SO ₄	mg/L	8	6	2		10	9.31	6.89	6					
Chloride, Cl	mg/L	47.1	43.4	43.8		31.1	38.8	41.1	36					
Oil and Grease	mg/L	<5	5	<5		<5	<5	<5	<5					

3 Data Assessment

Table 3-6 Bore PF198PB2 Chemical Analyses Summary

ANALYTE	Unit													
Date		1.6.99	8.9.99	21.12.99	9.3.00	29.11.00	21.6.01	19.12.01	26.6.02	23.1.03	9.7.03	30.1.04	29.6.04	15.12.04
pH		5.78	6.61	5.96	NA	4.80	5.24	5.99	6.33	5.96	4.84	5	5.78	5.39
Electrical Conductivity, EC	µS/cm	139	174	146	NA	152	130	141	151	146	162	160	136	156
Total Dissolved Solids, TDS	mg/L	126	102	85	NA	100	87	87	102	84	87	116	79	105
Calcium, Ca	mg/L	1	2	2	NA	<1	<1	<1	1	<1	<1	2	1	1
Magnesium, Mg	mg/L	5	5	5	NA	4	3	4	4	4	2	2	4	2
Sodium, Na	mg/L	18	19	18	NA	19	18	18	21	17	18	19	18	20
Potassium, K	mg/L	2	2	2	NA	1	1	2	2	1	<1	2	1	2
Bicarbonate, HCO ₃	mg/L	23	33	19	NA	4	3	13	8	16	<1	<1	9	2
Sulphate, SO ₄	mg/L	3	3	2	NA	1	1	3	2	<1	<1	6	1	4
Chloride, Cl	mg/L	31	28	31	NA	41	38	33	46	33	40	43	37	35
Oil and Grease	mg/L	<5	<5	<5	NA	<5	<5	11	<5	<5	<5	<5	<5	<5
Date		22.6.05	19.1.06	6.7.06	5.7.07	3.7.08	3.7.09	16.6.10	22.6.11					
pH		6.43	5.3	5.46	4.37	5.25	4.50	NA	NA					
Electrical Conductivity, EC	µS/cm	133	126	122	195	135	130							
Total Dissolved Solids, TDS	mg/L	87	104	79	88	79	79							
Calcium, Ca	mg/L	<1	<1	1	<1	1	<1							
Magnesium, Mg	mg/L	4	3	4	3	5	3							
Sodium, Na	mg/L	17	19	16	21	16	16							
Potassium, K	mg/L	2	1	2	1	2	2							
Bicarbonate, HCO ₃	mg/L	14	7	24	<1	24.4	9.2							
Sulphate, SO ₄	mg/L	4	1	1	4	2	2.78							
Chloride, Cl	mg/L	34.9	38.8	30.2	44.8	31.8	32.2							
Oil and Grease	mg/L	<5	<5	<5	<5	<5	<5							

3 Data Assessment

3.1.8 Portion 167 dam

Records of pump operation have been kept from PF167DAM since January 1997. Figure 9 shows the monthly summary of the pumpage from the dam and Table 3-7 shows the annual totals. Annual pumpage for the current year (48.9 ML) has been marginally below the licensed limit (50 ML/year).

Table 3-7 Portion 167 Dam Annual Pumpage Records

YEAR	TOTAL, ML
1997	24.56
1998	24.24
1999 to May	16.84
1 June 1999 – 30 June 2000	66.3
1 July 2000 – 5 September 2000	31.4
5 September 2000 – 25 June 2001	Not used
25 June 2001 – 30 June 2001	1.0
1 July 2001 – 8 February 2002	59.2
8 February 2002 – 30 June 2002	Not used
30 June 2002 – 29 August 2002	Not used
29 August 2002 – 30 June 2003	65.2
1 July 2003 – 29 June 2004	73.1
1 July 2004 – 3 May 2005	57.5
7 October 2005 – 30 June 2006	25.4
1 July 2006 – 30 June 2007	21.3
1 July 2007 - 30 June 2008	21.5
1 July 2008 – 30 June 2009	42.2
1 July 2009 – 30 June 2010	56.2
1 July 2010 – 30 June 2011	48.9

3 Data Assessment

3.1.9 Water Supply Bores, Portion 198

Pumping records for the two water supply bores in Portion 198 for the year July 2010 to June 2011 are tabulated in Table 3-8 below. The total pumpage of 11.8 ML for the year has been significantly below the combined annual allocation of 60 ML. This lower consumption rate is due to the non-operational status of bore PF198PB2, higher rainfall and overall improved efficiency of the plant.

Table 3-8 Water Supply Bores Annual Pumpage Records

YEAR	BORE	TOTAL, ML
1 July 1999 – 30 June 2000	Bore PF198PB1	21.1
	Bore PF198PB2	35.6
1 July 2000- 30 June 2001	Bore PF198PB1	20.3
	Bore PF198PB2	29.0
1 July 2001 – 30 June 2002	Bore PF198PB1	25.1
	Bore PF198PB2	36.0
1 July 2002 – 30 June 2003	Bore PF198PB1	24.8
	Bore PF198PB2	47.8
1 July 2003 – 29 June 2004	Bore PF198PB1	22.9
	Bore PF198PB2	49.3
1 July 2004 – 29 June 2005	Bore PF198PB1	4.2
	Bore PF198PB2	18.7
5 July 2005 – 23 June 2006*	Bore PF198PB1	14.8
	Bore PF198PB2	8.9
24 June 2006 – 30 June 2007*	Bore PF198PB1	7.8
	Bore PF198PB2	19.9
1 July 2007 – 30 June 2008*	Bore PF198PB1	1.6
	Bore PF198PB2	22.9
1 July 2008 – 30 June 2009*	Bore PF198PB1	25.6
	Bore PF198PB2	16.0
1 July 2009 – 30 June 2010*	Bore PF198PB1	9.5
	Bore PF198PB2**	8.1
1 July 2010 – 30 June 2011*	Bore PF198PB1	11.8
	Bore PF198PB2**	NA

* Due to modifications carried out at the wash plant, these bores are no longer required for continuous supply.

** The pump in bore PF198PB2 has been out of service since December 2009, requiring additional pumpage from the PF167 DAM.

Conclusions

4.1 Conclusions

The assessment of the data collected on the groundwater levels and quality in the Maroota Hitchcock Road site, some of which represent the oldest data available to the groundwater study carried out by the DLWC (now The Office of Water) in the area, indicate that:

- water levels in the Maroota Sand aquifer respond rapidly to the rainfall pattern.
- since April 2002 the water table in bore PF167MW1 has fallen steadily in response to the lower rainfall, but it rose sharply after the rain events in June 2007 and in June 2008; followed by a characteristic slow decline pattern.
- water quality in the Maroota Sand aquifer varies, albeit marginally, with rainfall recharge.
- pumpage from the dam in Portion 167 for the year to the end of June 2011 (48.9 ML) has been below the licence limit of 50 ML/year.
- during the year 2010 – 2011, the water level in the Portion 167 dam has averaged 182.55 m AHD, a value higher than that of the long term average (181.08 m AHD) since September 1996. This high level is thought to be due to reduced pumping since February 2010, and to high run-off into the dam following high rainfall events in the first half of 2011.
- records indicate that the water level in the dam recovers rapidly upon cessation of pumping.
- groundwater pumpage from the deep water supply bores in Portion 198 (11.8 ML) has been effected only from bore PF198PB1, as the second production bore PF198PB2 has been out of operation since December 2009. The pump in this bore has been replaced in July 2011.
- the chemical composition of the groundwater in the deep aquifer of the Hawkesbury Sandstone (water supply bores in Portion 198) has an overall character that indicates that recharge occurs readily.
- the current sand extraction operations in the Hitchcock Road area operate in a manner that does not appear to have an adverse impact upon the groundwater sustainability, and meets the DA Approval Conditions.

The data collected during the year are available to the NSW Office of Water for their continued study in the area.

Limitations

5.1 Geotechnical & Hydro Geological Report

URS Australia Pty Ltd (URS) has prepared this report in accordance with the usual care and thoroughness of the consulting profession for the use of PF Formation and only those third parties who have been authorised in writing by URS to rely on the report. It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this report. It is prepared in accordance with the scope of work and for the purpose outlined in the Proposal dated 10 May 2011.

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

This report was prepared between 30 June 2010 and 27 July 2011 and is based on the conditions encountered and information reviewed at the time of preparation. URS disclaims responsibility for any changes that may have occurred after this time.

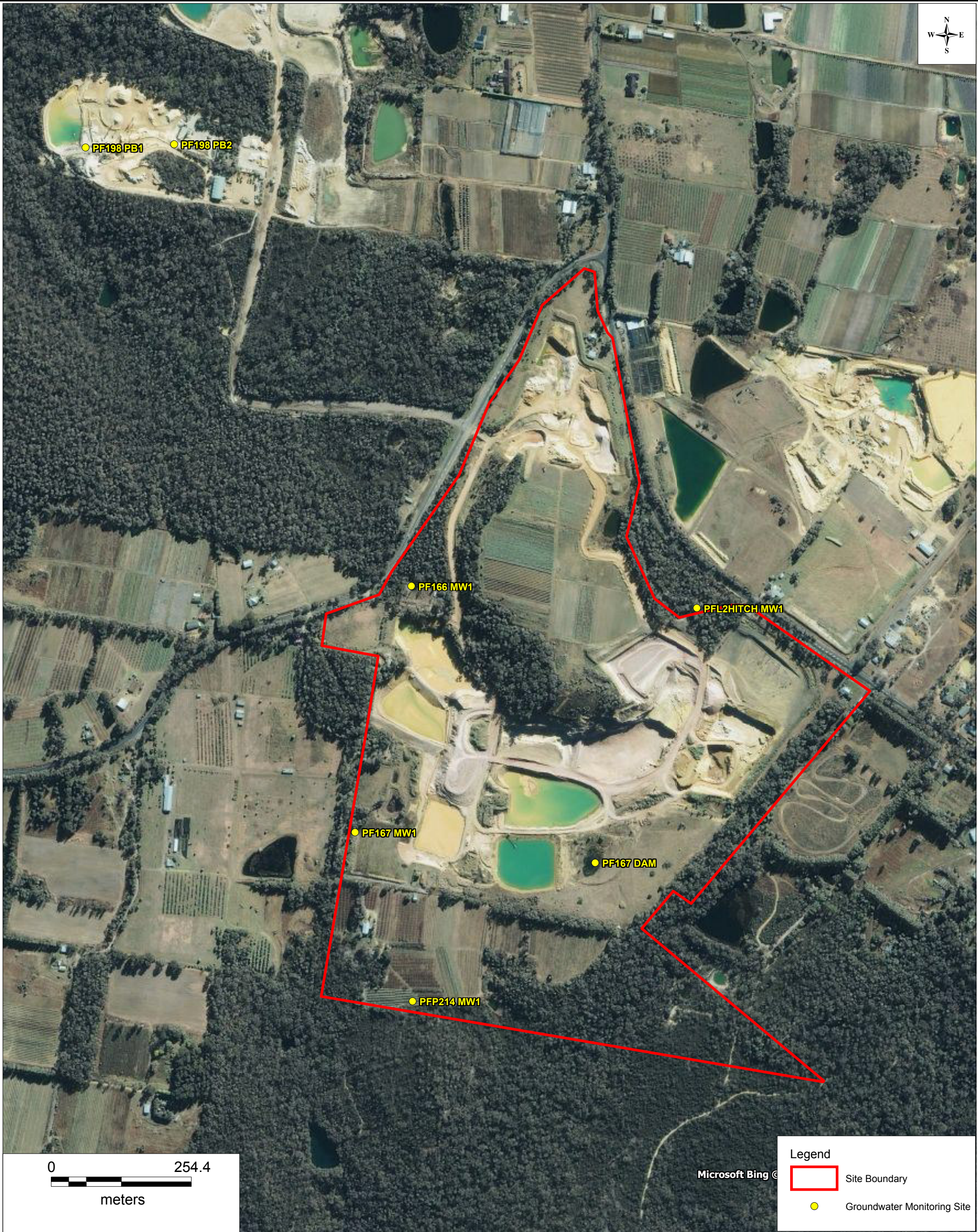
This report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties. This report does not purport to give legal advice. Legal advice can only be given by qualified legal practitioners.

This report contains information obtained by inspection, sampling, testing or other means of investigation. This information is directly relevant only to the points in the ground where they were obtained at the time of the assessment. The borehole logs indicate the inferred ground conditions only at the specific locations tested. The precision with which conditions are indicated depends largely on the frequency and method of sampling, and the uniformity of conditions as constrained by the project budget limitations. The behaviour of groundwater and some aspects of contaminants in soil and groundwater are complex. Our conclusions are based upon the analytical data presented in this report and our experience. Future advances in regard to the understanding of chemicals and their behaviour, and changes in regulations affecting their management, could impact on our conclusions and recommendations regarding their potential presence on this site.

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

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

Figures



Source: Aerial imagery from Bing Maps © 2010 Microsoft Corporation and its data suppliers.
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PF FORMATION

HITCHCOCK ROAD, SAND EXTRACTION
AND REHABILITATION PROJECT

HITCHCOCK ROAD
SITE LOCALITY PLAN





P.F.FORMATION
Bore PF167MW1 Groundwater Monitoring Data

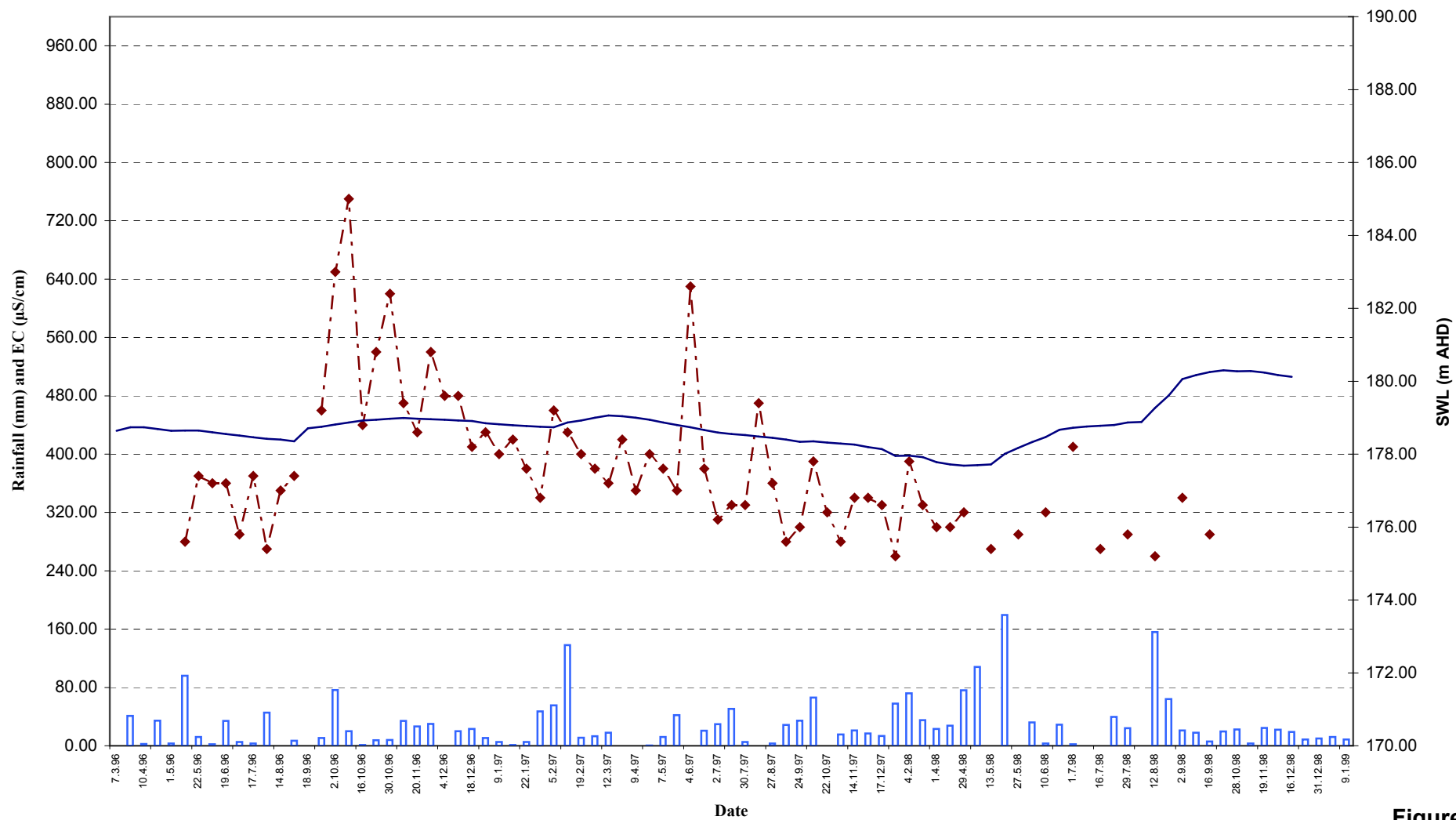
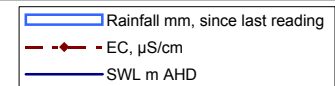


Figure 2



PF FORMATION
Bore PF167MW1 Groundwater Monitoring Data

□ Rainfall, mm
— Water level m AHD

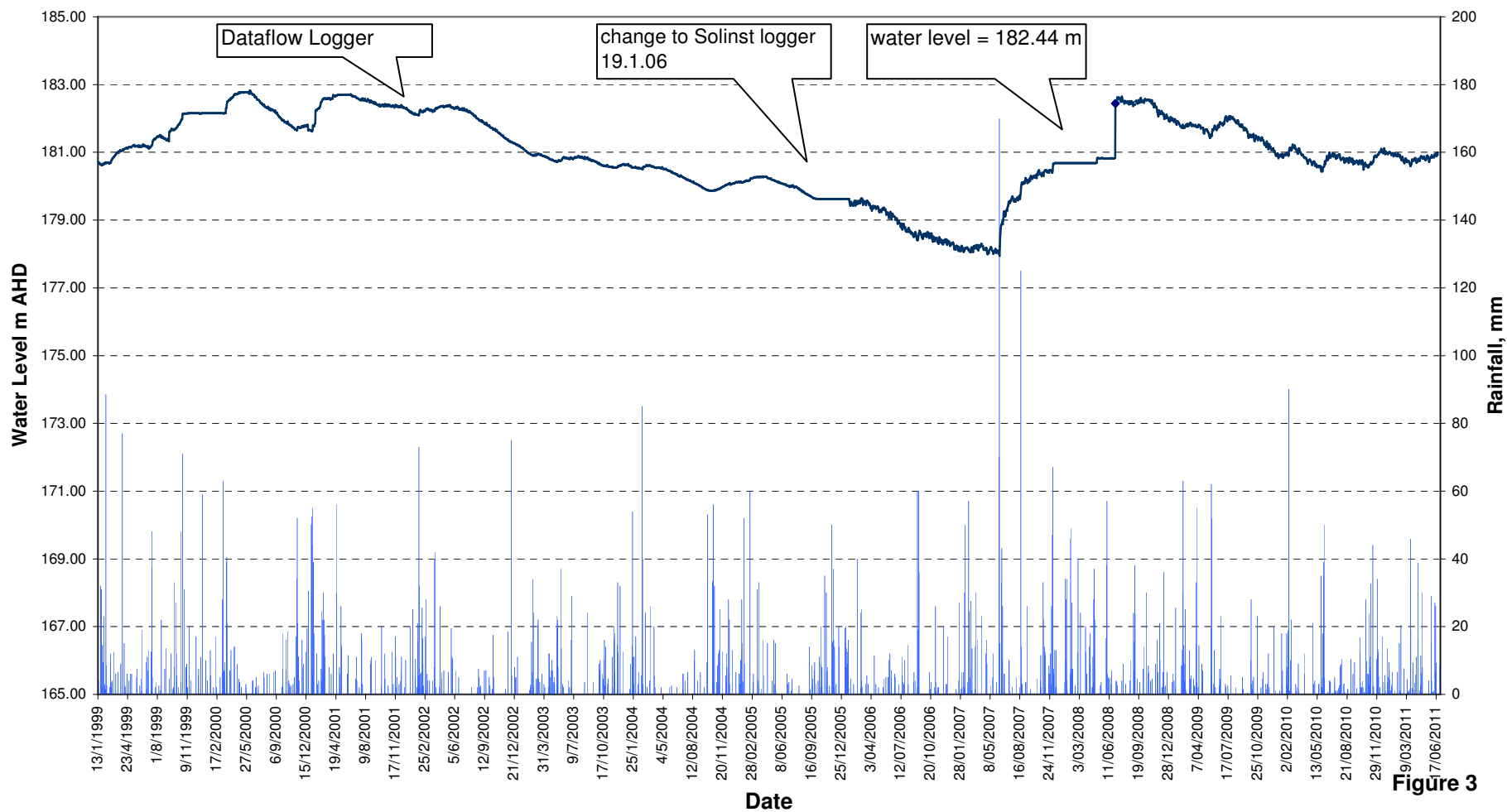


Figure 3



PF FORMATION
PF166MW1 Groundwater Monitoring Data

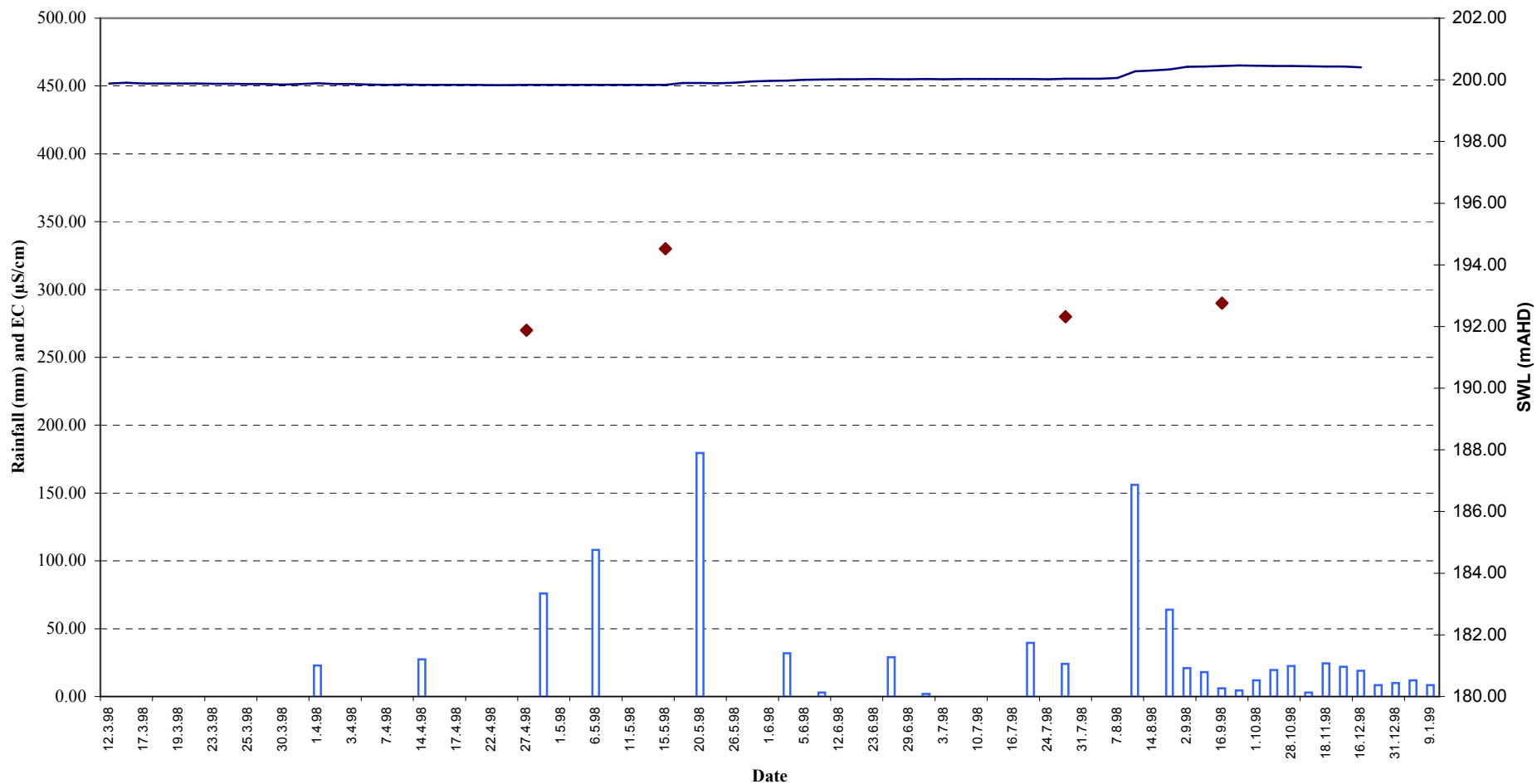
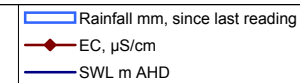


Figure 4



PF FORMATION
Bore PF166MW1 Groundwater Monitoring Data

□ Rainfall, mm
— Water Level m AHD

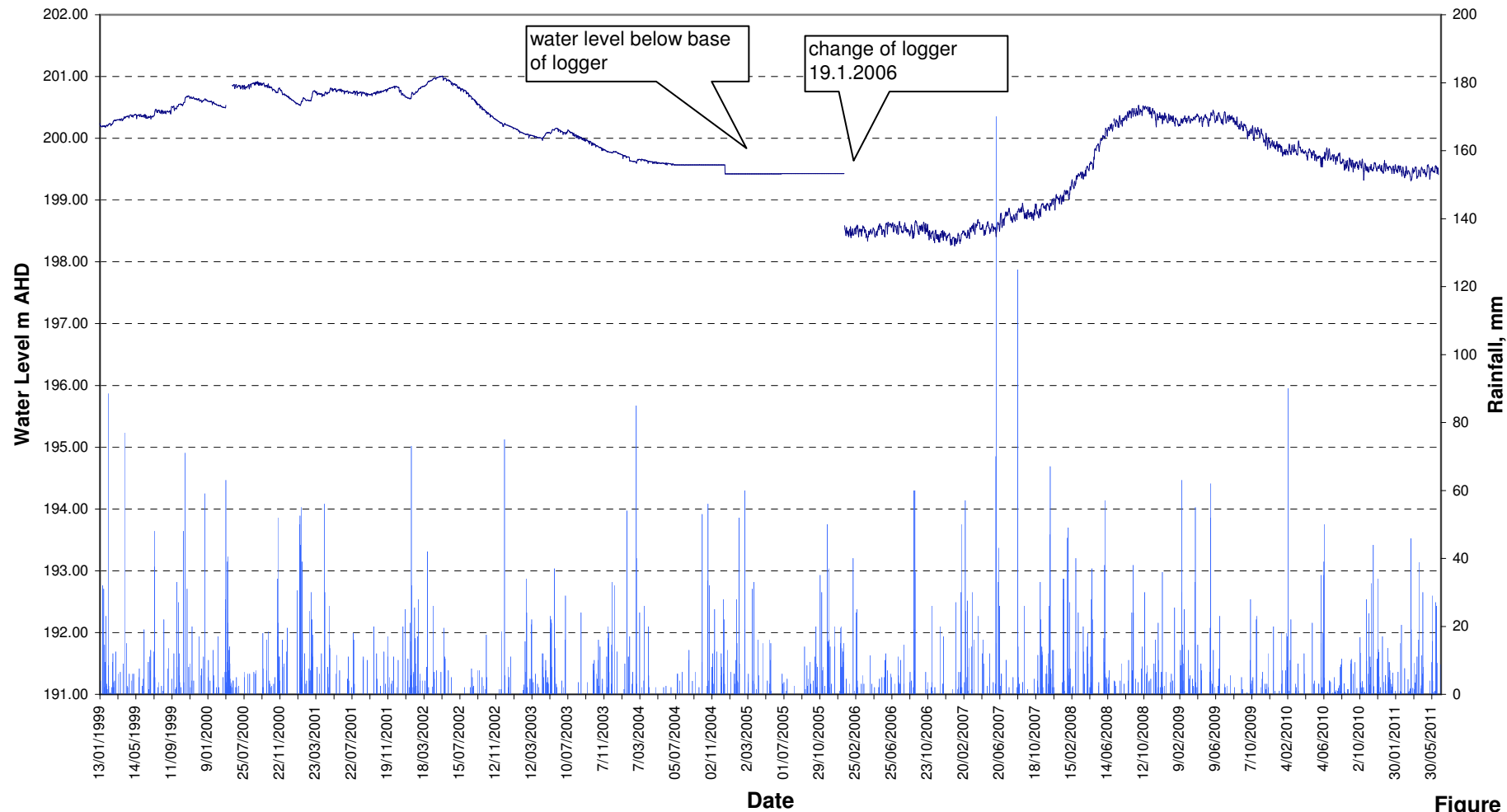


Figure 5



PF FORMATION
Bore PFP214MW1 Groundwater Monitoring Data

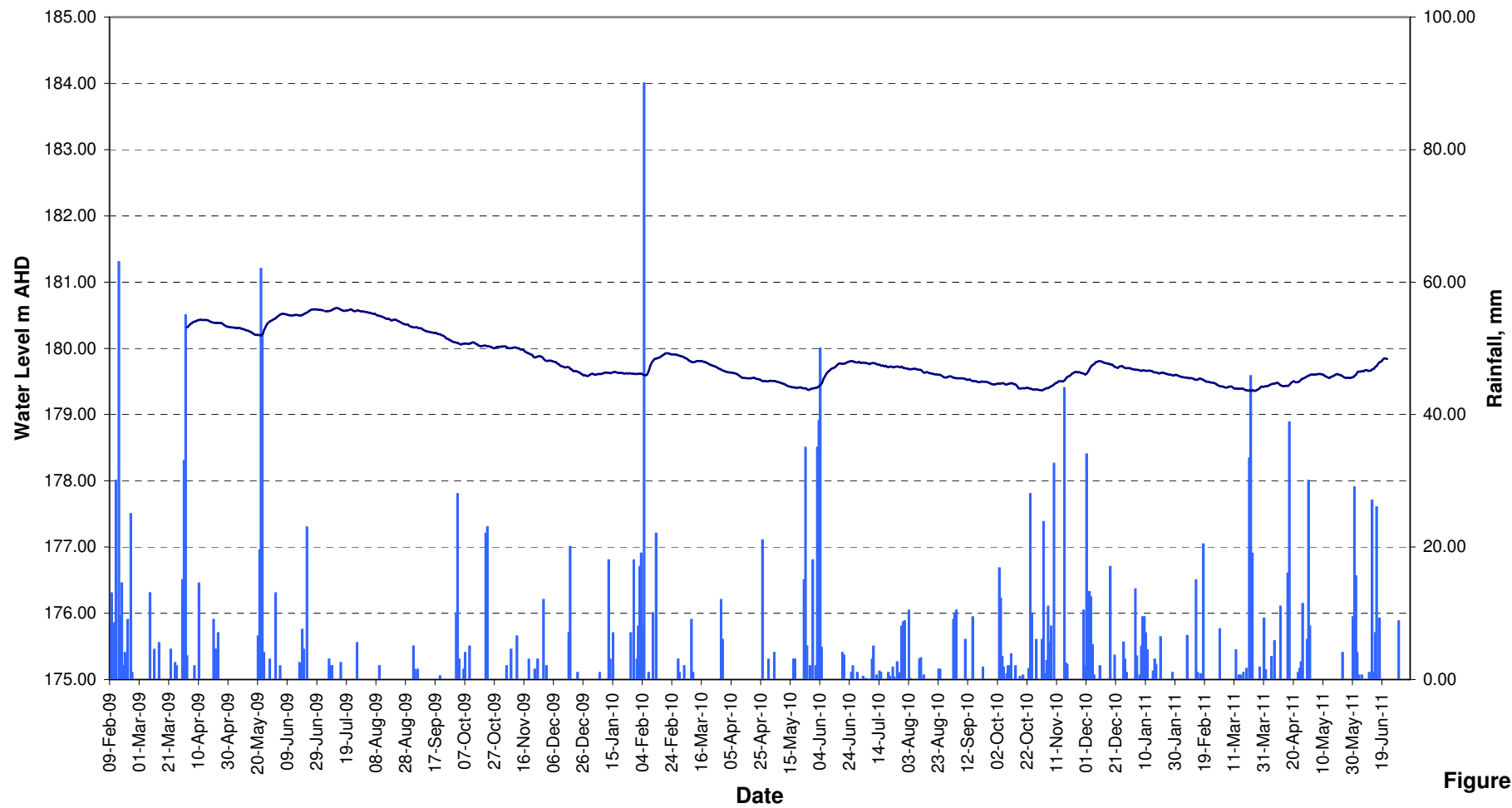
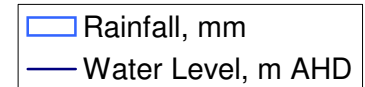


Figure 6



PF FORMATION
Bore PFL2HitchMW1 Groundwater Monitoring Data

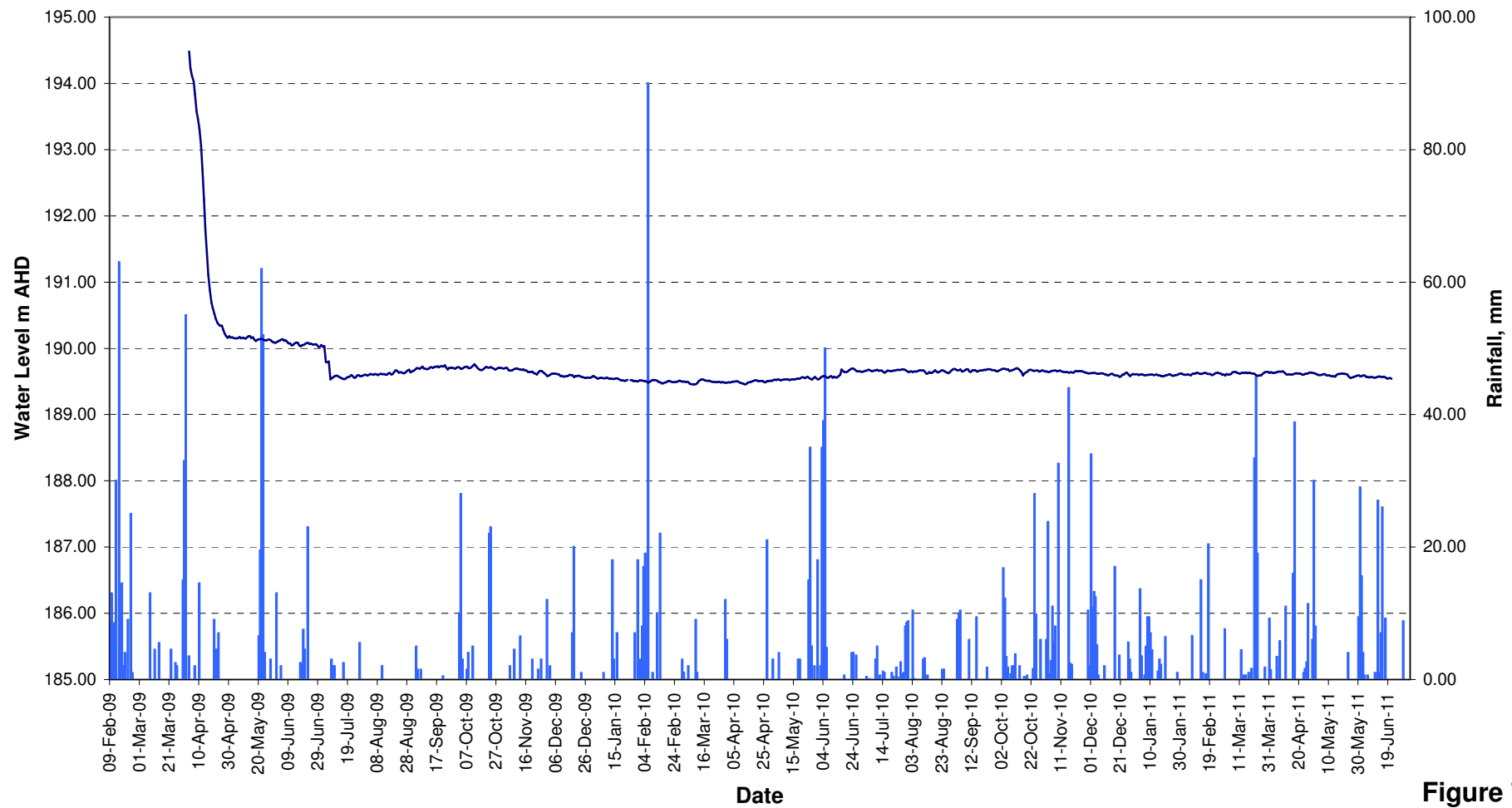
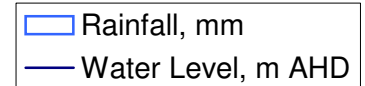


Figure 7



PF FORMATION
PF167DAM, Licence No. 10BL157308, Groundwater Monitoring Data

— Rainfall mm, since last reading
— WL m AHD

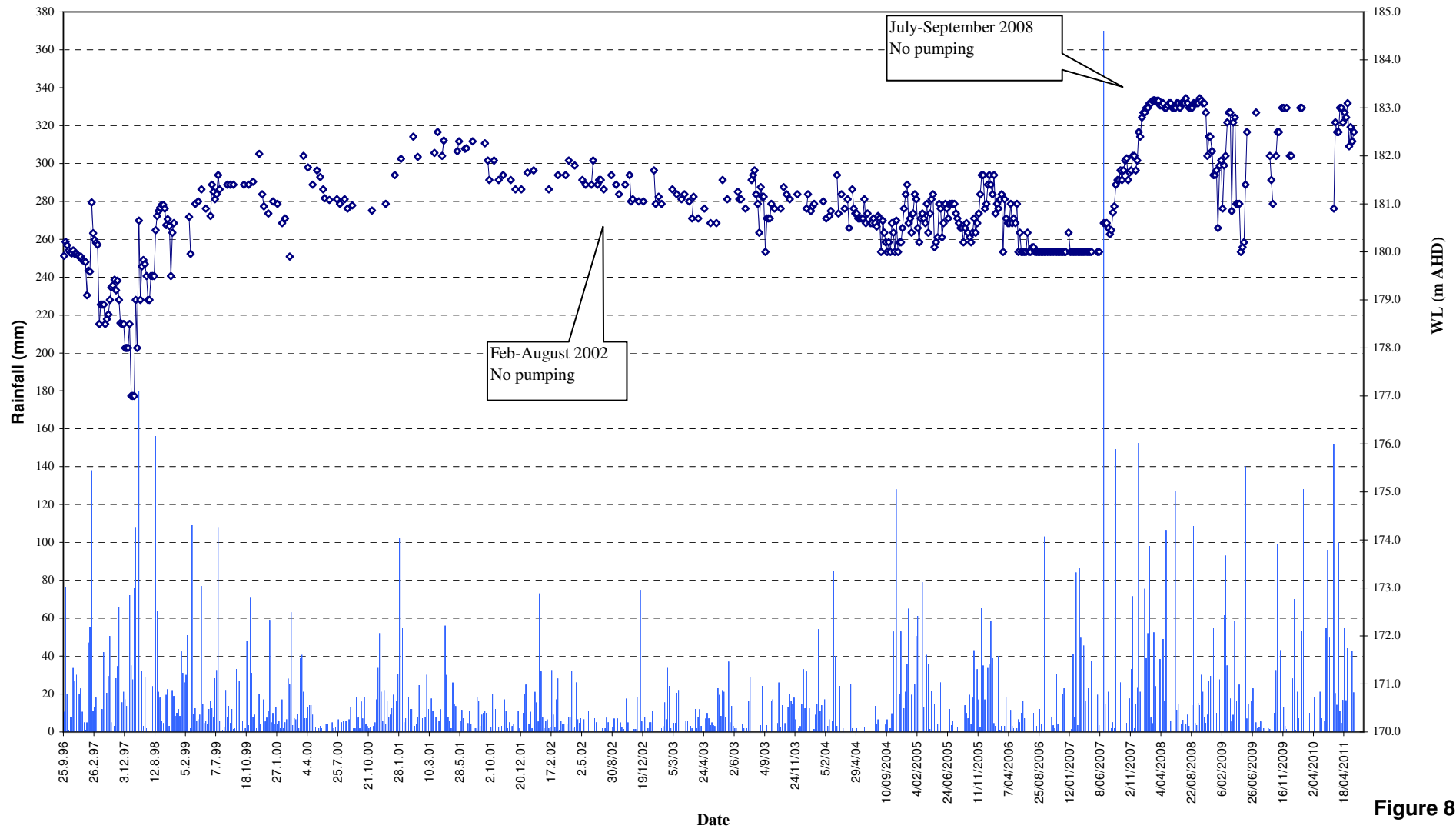


Figure 8



PF FORMATION
PF167DAM Monthly Pumpage Records

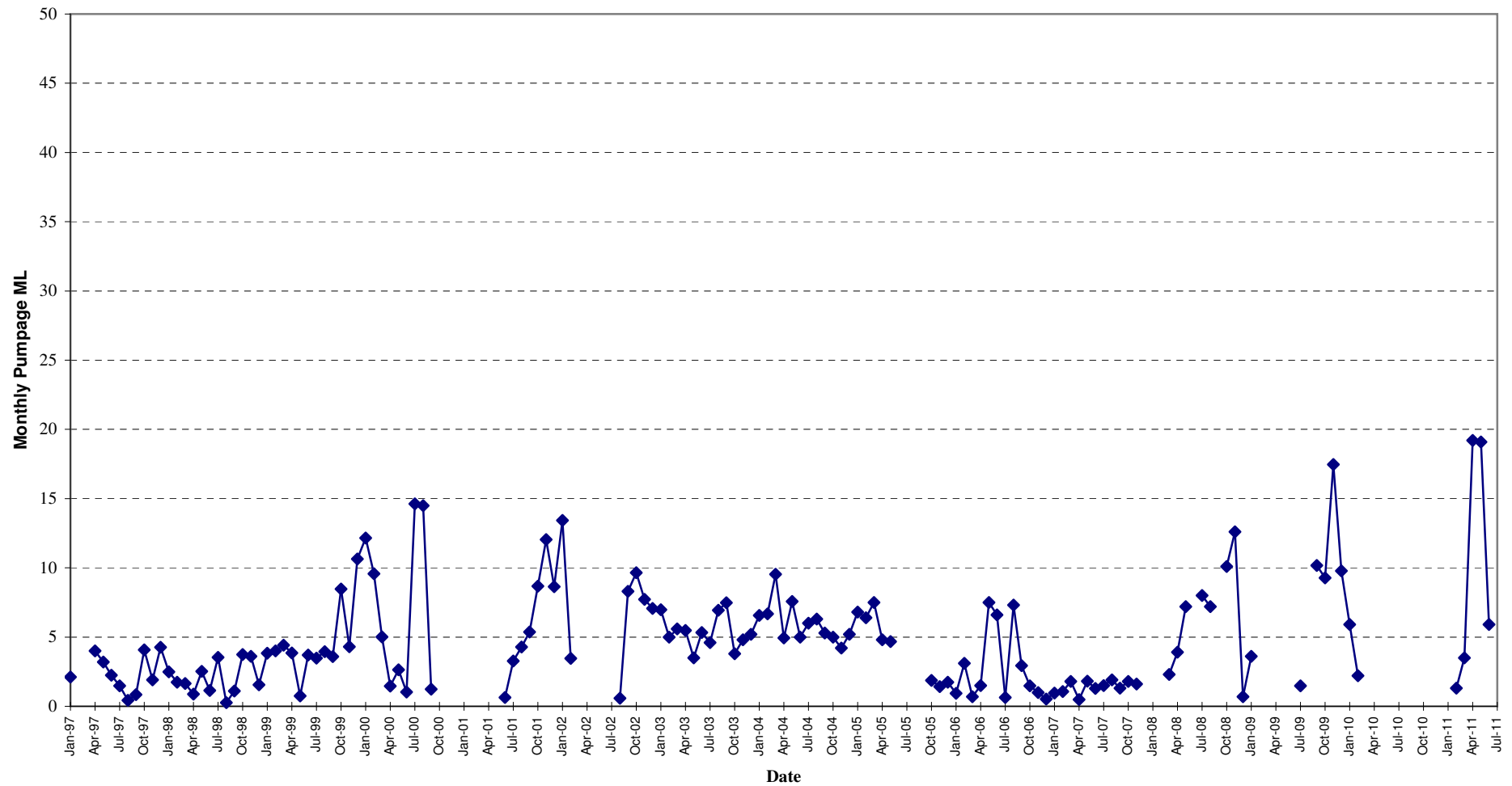


Figure 9

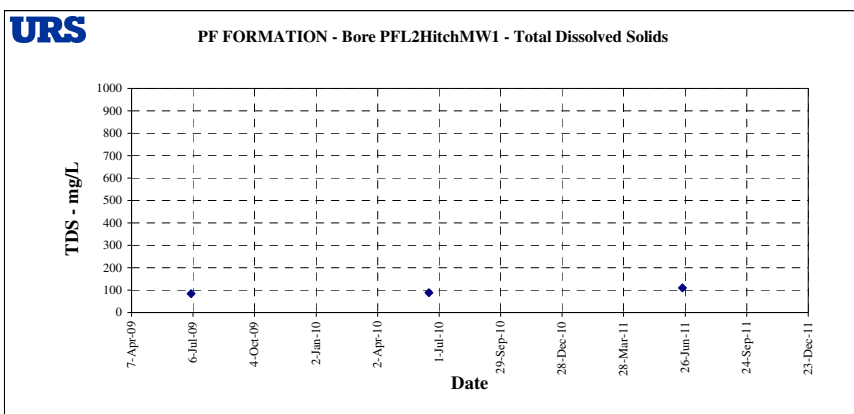
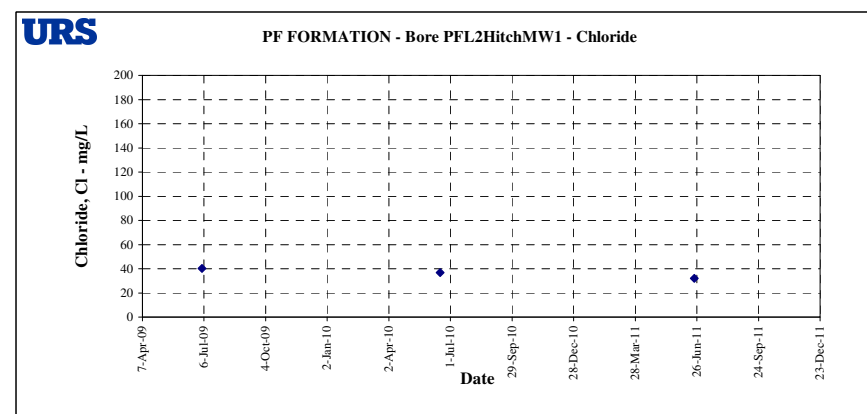
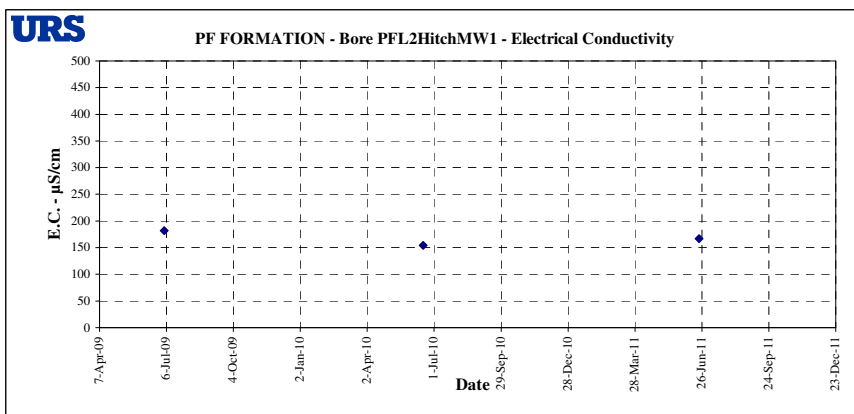
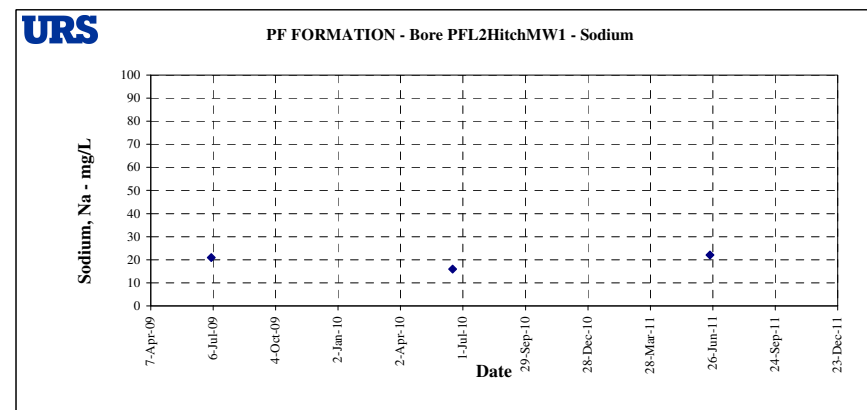
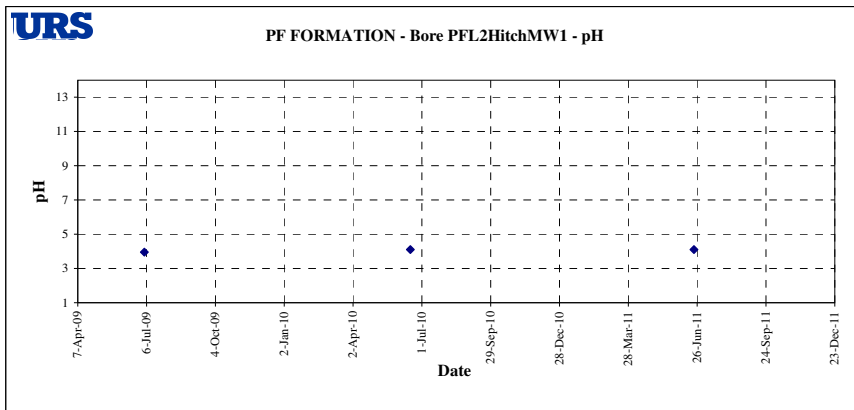
Appendix A Groundwater Water Quality Plots

PF FORMATION - MAROOTA
BORE PFL2HitchMW1 GROUNDWATER ANALYTICAL SUMMARY

Analysis	Units	LOR	3.07.09	16.06.10	22-Jun-11
pH		0.01	3.96	4.1	4.1
Electrical Conductivity	µS/cm	1	182	154	167
Total Dissolved Solids	mg/L	1	84	88	110
Calcium	mg/L	1	<1	<1	<1
Magnesium	mg/L	1	2	2	2
Sodium	mg/L	1	21	16	22
Potassium	mg/L	1	<1	<1	<1
Bicarbonate	mg/L	1	<1	<1	<1
Sulphate	mg/L	1	7.88	7.06	5
Chloride	mg/L	1	40.3	36.9	32
Oil and Grease	mg/L	5	<5	<5	<5

LOR = Limit of Reporting

Average EC = 168 µS/cm
Average TDS = 94 mg/L
Average pH = 4

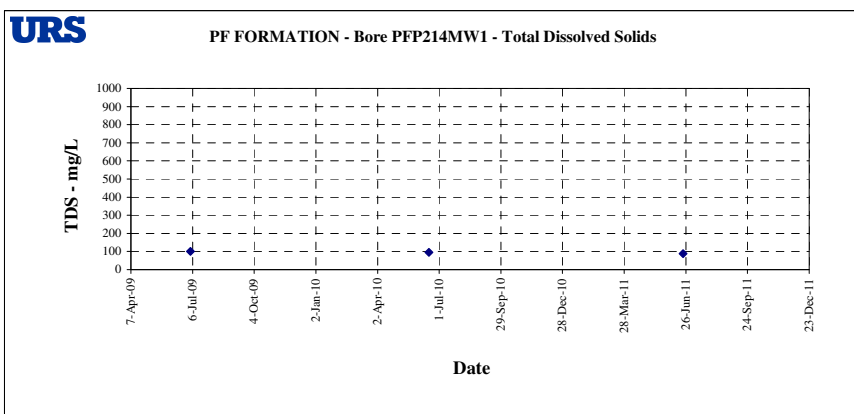
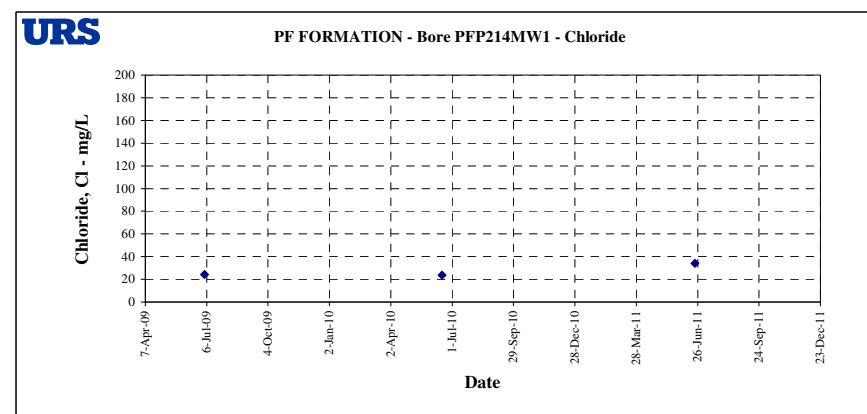
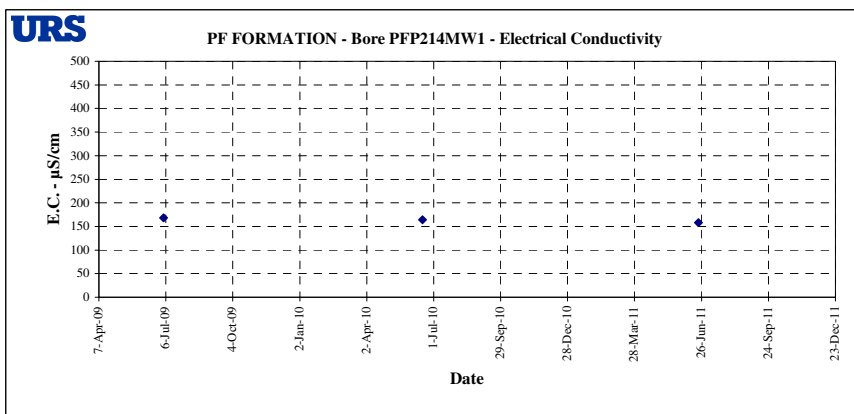
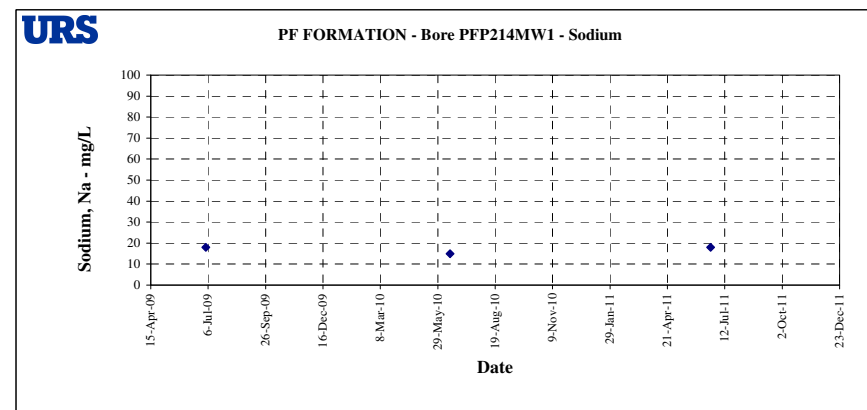
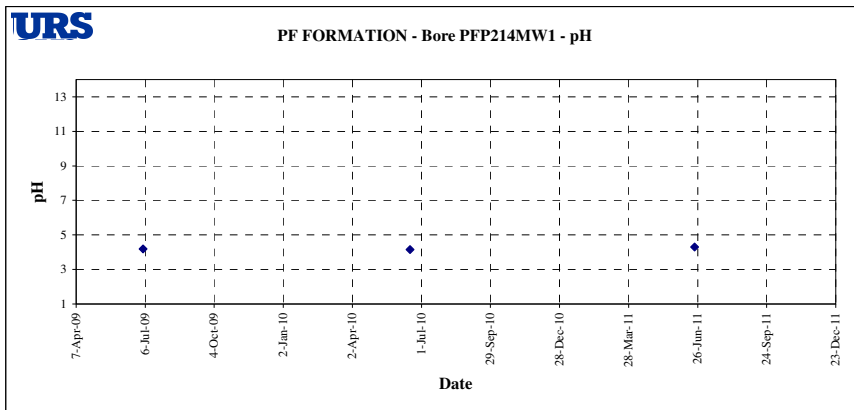


PF FORMATION - MAROOTA
BORE PFP214MW1 GROUNDWATER ANALYTICAL SUMMARY

Analysis	Units	LOR	3.07.09	16.06.10	22.06.11
pH		0.01	4.19	4.16	4.31
Electrical Conductivity	µS/cm	1	168	164	158
Total Dissolved Solids	mg/L	1	100	96	88
Calcium	mg/L	1	<1	<1	<1
Magnesium	mg/L	1	6	5	4
Sodium	mg/L	1	18	15	18
Potassium	mg/L	1	1	<1	1
Bicarbonate	mg/L	1	<1	<1	<1
Sulphate	mg/L	1	1.9	<0.5	<1
Chloride	mg/L	1	24.3	23.8	34
Oil and Grease	mg/L	5	<5	<5	<5

LOR = Limit of Reporting

Average EC = 163 µS/cm
Average TDS = 95 mg/L
Average pH = 4



PF FORMATION - MAROOTA
BORE PF198PB2 GROUNDWATER ANALYTICAL SUMMARY

Analysis	Units	LOR	1.06.99	8.09.99	21.12.99	28.11.00	21.06.01	20.12.01	26.06.02	23.01.03	9.07.03	30.01.04	29.06.04	15.12.04	22.06.05	19.01.06	6.07.06	5.07.07	3.07.08	3.07.09	16.06.10
pH		0.01	5.78	6.61	5.96	4.8	5.24	5.99	6.33	5.96	4.87	6.18	5.78	5.39	6.43	5.13	5.46	4.37	5.25	4.5	NA
Electrical Conductivity	µS/cm	1	139	174	146	152	130	141	151	146	162	133	136	156	133	126	122	195	135	130	
Total Dissolved Solids	mg/L	1	126	102	85	100	87	87	102	84	87	113	79	105	87	104	79	88	79	79	
Calcium	mg/L	1	1	2	2	<1	<1	<1	1	<1	<1	<1	1	1	<1	<1	1	0.01	1	<1	
Magnesium	mg/L	1	5	5	5	4	3	4	4	4	2	4	4	2	4	3	4	3	5	3	
Sodium	mg/L	1	18	19	18	19	18	18	21	17	18	15	18	20	17	19	16	21	16	16	
Potassium	mg/L	1	2	2	2	1	1	2	2	1	<1	1	1	2	2	1	2	1	2	2	
Bicarbonate	mg/L	1	23	33	19	4	3	13	8	16	<1	16	9	2	14	7	24	<1	24.4	9.6	
Sulphate	mg/L	1	3	3	2	1	1	3	2	<1	4	2	1	4	4	1	1	4	2	2.78	
Chloride	mg/L	1	31	28	31	41	38	33	46	33	40	31	37	35	34.9	38.8	30.2	44.8	31.8	32.2	
Oil and Grease	mg/L	5	<5	<5	<5	<5	<5	11	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	

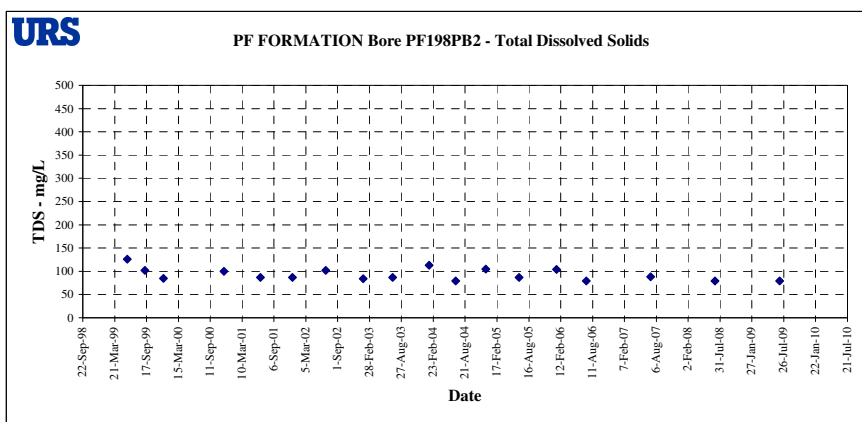
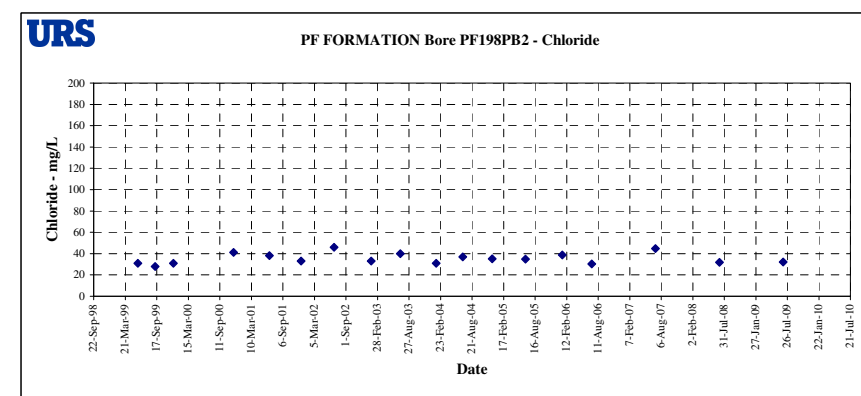
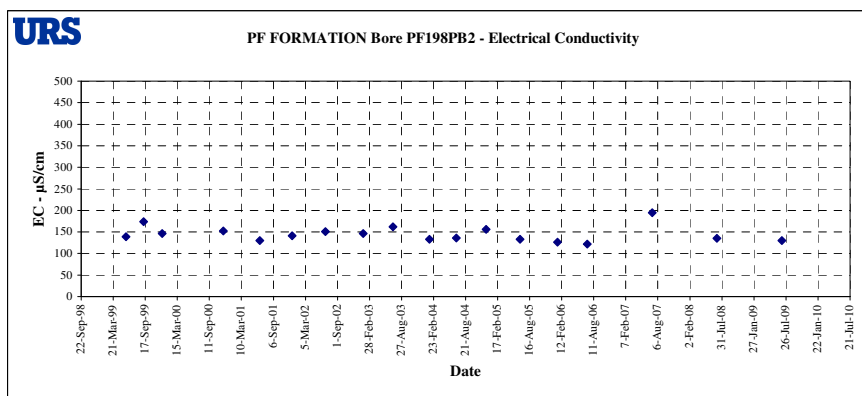
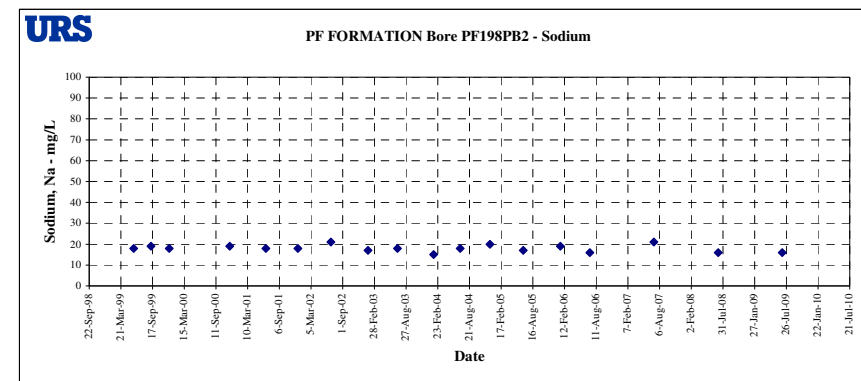
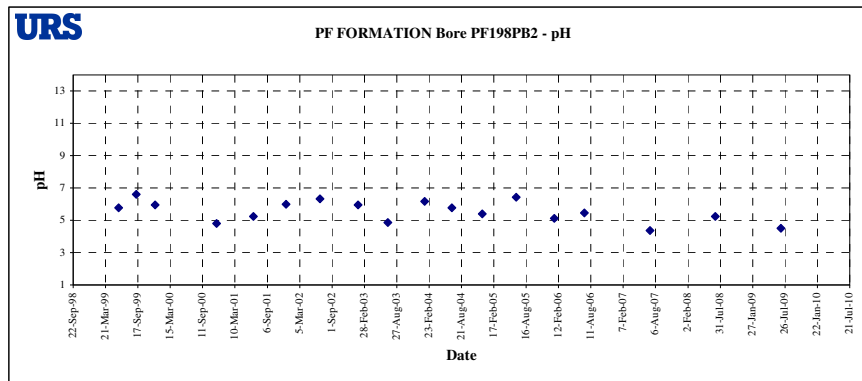
LOR = Limit of Reporting

Average EC = 145 µS/cm
Average TDS = 93 mg/L
Average pH = 6

Note: PF198PB2 could not be sampled in March 2000

22.06.11

NA



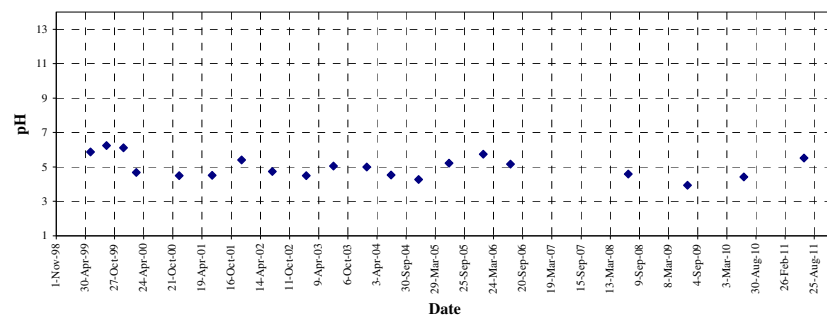
PF FORMATION - MAROOTA
BORE PF198PB1 GROUNDWATER ANALYTICAL SUMMARY

Analysis	Units	LOR	1.06.99	8.09.99	21.12.99	10.03.00	28.11.00	21.06.01	20.12.01	26.06.02	23.01.03	9.07.03	30.01.04	29.06.04	15.12.04	22.06.05	19.01.06	6.07.06	5.07.07	3.07.08	3.07.09	16.06.10	22.06.11
pH		0.01	5.87	6.24	6.11	4.69	4.49	4.51	5.41	4.73	4.49	5.06	5	4.53	4.28	5.22	5.74	5.16	NA	4.59	3.94	4.43	5.52
Electrical Conductivity	µS/cm	1	161	170	169	141	182	179	204	199	243	199	160	291	197	157	158	155		144	172	163	170
Total Dissolved Solids	mg/L	1	124	116	98	97	107	102	116	112	139	102	116	174	88	105	115	98		85	83	88	102
Calcium	mg/L	1	1	<1	1	1	3	2	2	4	3	2	2	4	1	1	2	1		<1	1	<1	2
Magnesium	mg/L	1	4	6	5	3	3	4	4	4	4	3	2	5	2	2	4	3		2	2	2	4
Sodium	mg/L	1	21	24	22	19	20	21	27	23	31	22	19	40	25	23	21	20		18	19	16	21
Potassium	mg/L	1	1	<1	1	1	2	5	5	3	3	2	2	3	2	2	2	2		1	2	1	2
Bicarbonate	mg/L	1	13	29	22	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	12	5		<1	<1	8.54	3.7
Sulphate	mg/L	1	4	4	4	2	8	8	3	7	4	8	6	9	8	8	6	2		10	9.31	6.1	6
Chloride	mg/L	1	39	35	36	36	40	49	60	58	64	49	43	83	42	47.1	43.4	43.8		34.1	38.8	48.4	36
Oil and Grease	mg/L	5	<5	<5	<5	<5	<5	<5	<5	<5	6	<5	<5	<5	<5	<5	5	<5		<5	<5	<5	<5

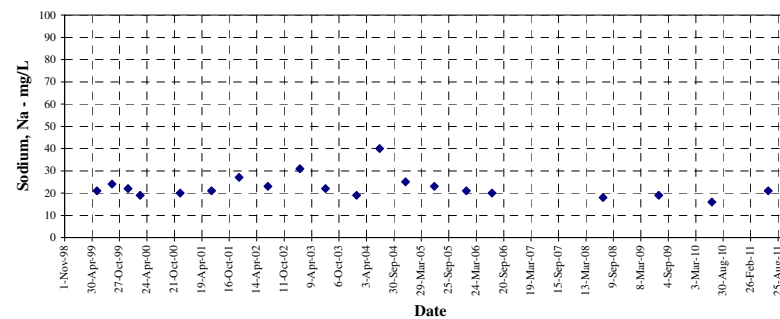
LOR = Limit of Reporting

Average EC = 181 µS/cm
Average TDS = 108 mg/L
Average pH = 5

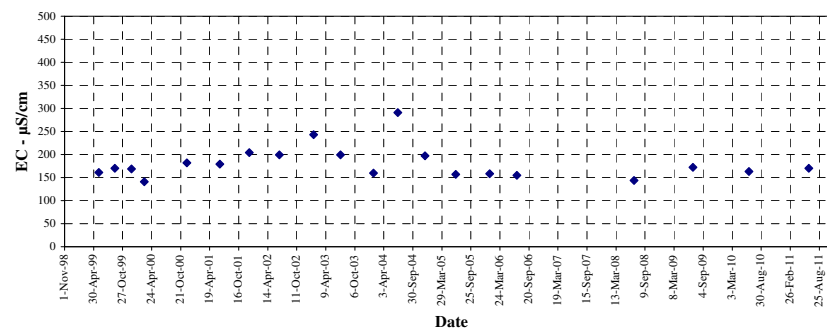
PF FORMATION Bore PF198PB1 - pH



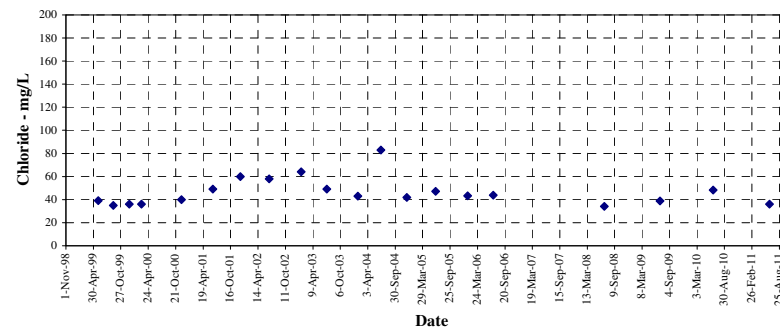
PF FORMATION Bore PF198PB1 - Sodium



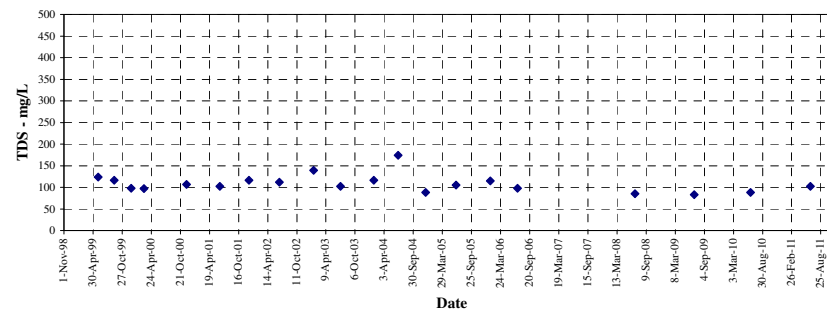
PF FORMATION Bore PF198PB1 - Electrical Conductivity



PF FORMATION Bore PF198PB1 - Chloride



PF FORMATION Bore PF198PB1 - Total Dissolved Solids



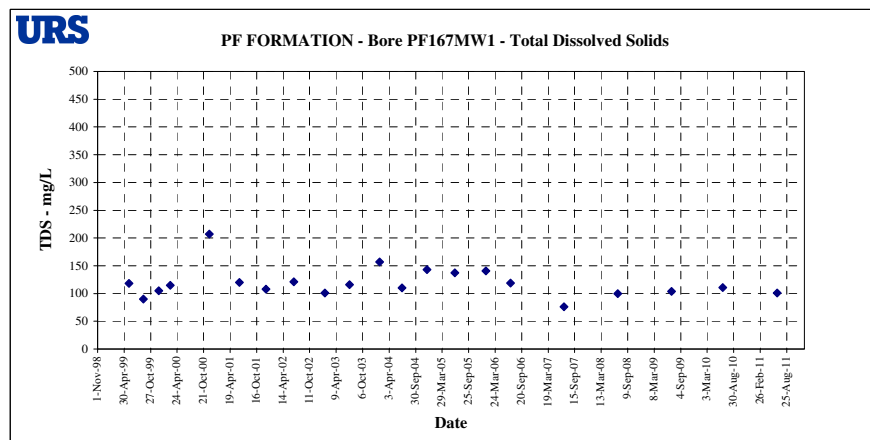
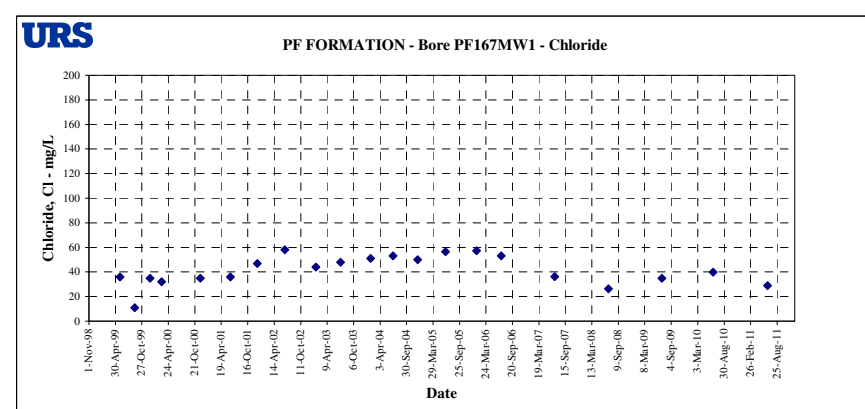
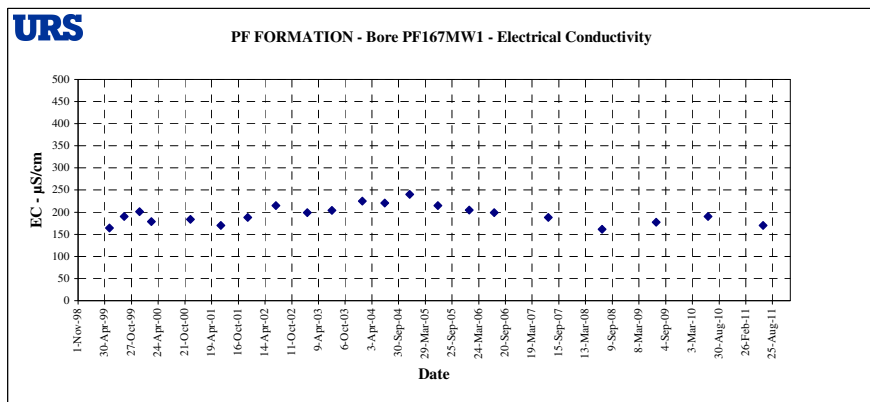
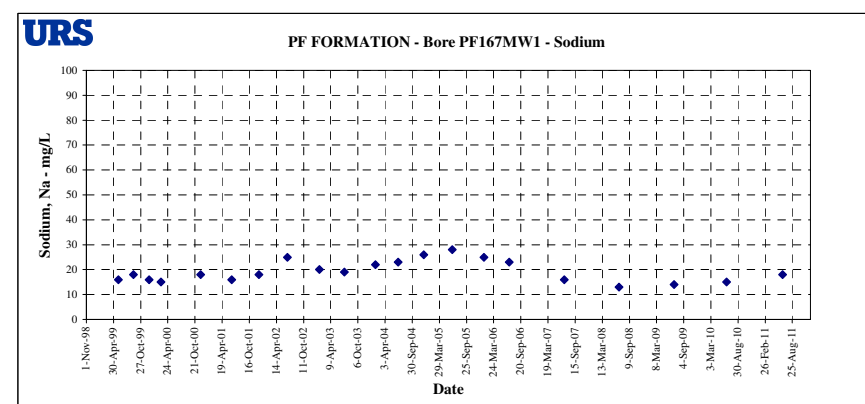
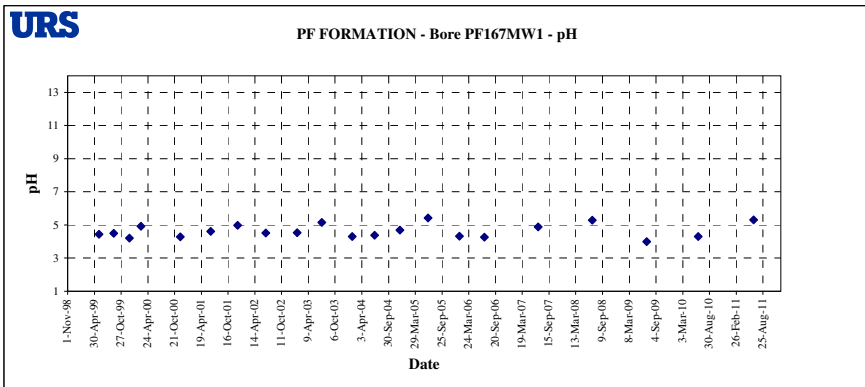
PF FORMATION - MAROOTA
BORE PF167MW1 GROUNDWATER ANALYTICAL SUMMARY

Analysis	Units	LOR	1.06.99	8.09.99	21.12.99	9.03.00	28.11.00	21.06.01	19.12.01	26.06.02	23.01.03	9.07.03	30.01.04	29.06.04	15.12.04	22.06.05	19.01.06	6.07.06	5.07.07	3.07.08	3.07.09	16.06.10	22.06.11
pH		0.01	4.43	4.49	4.21	4.93	4.28	4.61	4.98	4.52	4.54	5.15	4.31	4.38	4.68	5.42	4.32	4.27	4.88	5.29	4	4.3	5.3
Electrical Conductivity	µS/cm	1	164	190	201	179	184	170	188	215	199	204	225	221	240	215	205	199	188	161	177	190	170
Total Dissolved Solids	mg/L	1	118	90	105	115	207	120	108	121	101	116	157	110	143	137	141	119	76	100	104	111	101
Calcium	mg/L	1	3	3	5	6	3	6	6	5	3	4	4	5	5	5	4	4	2	6	5	3	4
Magnesium	mg/L	1	5	4	4	4	4	4	5	4	4	3	4	4	4	4	4	4	3	5	4	3	4
Sodium	mg/L	1	16	18	16	15	18	16	18	25	20	19	22	23	26	28	25	23	16	13	14	15	18
Potassium	mg/L	1	2	2	3	3	3	5	4	5	2	2	2	3	3	3	3	3	2	4	4	2	4
Bicarbonate	mg/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	<1	<1	<1	2	1	<1	<1	<1	<1	2.4	2.4
Sulphate	mg/L	1	9	<1	13	17	16	15	15	14	9	13	12	10	13	13	10	6	10	30	22.6	17.1	18
Chloride	mg/L	1	36	11	35	32	35	36	47	58	44	48	51	53	50	56.6	57.4	53.1	36.1	26.4	34.8	39.9	29
Oil and Grease	mg/L	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5

LOR = Limit of Reporting

Average EC = 195 µS/cm
Average TDS = 119 mg/L
Average pH = 5

N.B. = TDS value in November 2000 is unusually high because of the presence of particulate matter in the sample.



PF FORMATION - MAROOTA
BORE PF166MW1 GROUNDWATER ANALYTICAL SUMMARY

Analysis	Units	LOR	1.06.99	8.09.99	21.12.99	9.03.00	28.11.00	21.06.01	19.12.01	26.06.02	23.01.03	9.07.03	30.01.04	29.06.04	15.12.04	22.06.05	19.01.06	6.07.06	5.07.07	3.07.08	3.07.09	16.06.10	22.06.11
pH		0.01	4.18	4.19	4.13	4.14	4.31	4.19	4.63	4.48	4.82	7.86	4.39	4.27	4.06	DRY	DRY	DRY	4.76	DRY	3.58	4.06	4.22
Electrical Conductivity	µS/cm	1	222	240	230	214	266	194	228	219	203	221	193	235	203				163		240	247	261
Total Dissolved Solids	mg/L	1	118	108	137	170	460	115	210	280	128	134	204	280	120				98		140	141	172
Calcium	mg/L	1	1	1	1	1	1	1	1	2	1	1	<1	1	1						1	<1	1
Magnesium	mg/L	1	6	6	6	5	6	5	6	6	5	4	5	5	4						4	4	6
Sodium	mg/L	1	26	23	23	22	29	21	22	24	19	20	18	19	19						26	24	24
Potassium	mg/L	1	<1	<1	1	1	1	1	2	1	<1	<1	<1	1	1						2	2	3
Bicarbonate	mg/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	<1	<1	<1						<1	<1	<1
Sulphate	mg/L	1	1	7	1	1	16	2	1	2	<1	<1	2	<1	2						2.21	1.77	1
Chloride	mg/L	1	58	49	51	52	58	49	58	61	46	50	47	44	36						49.1	56.3	53
Oil and Grease	mg/L	5	<5	<5	<5	<5	<5	<5	<5	<5	6	<5	<5	5	<5						<5	<5	<5

LOR = Limit of Reporting

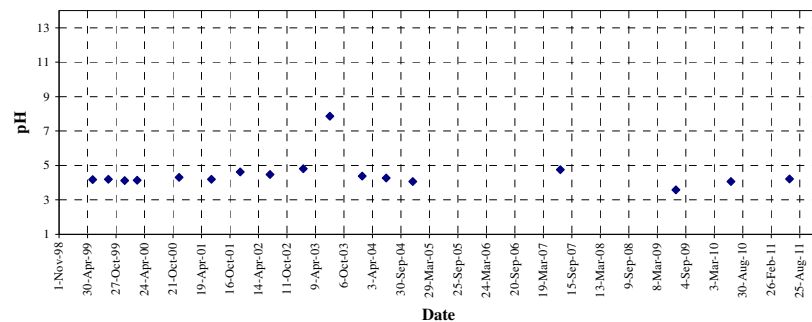
* field measurements

Average EC = 222 µS/cm
Average TDS = 177 mg/L
Average pH = 4

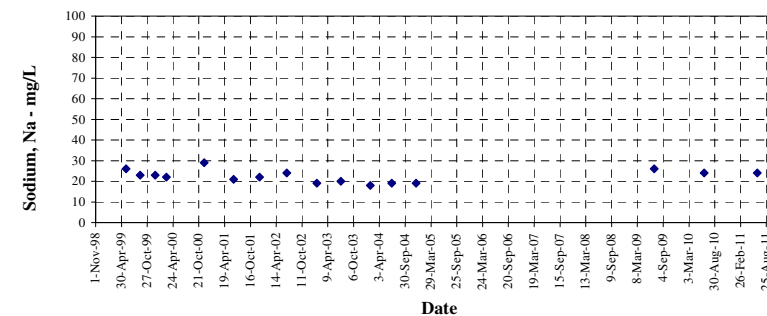
N.B. = TDS value in November 2000 is unusually high because of the presence of particulate matter in the sample.
NA = Not enough water for sample



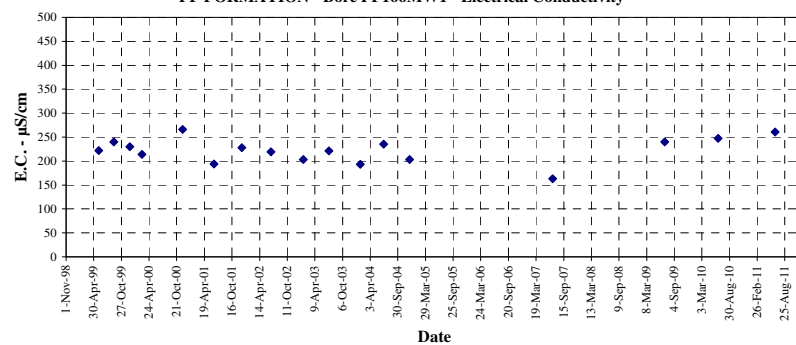
PF FORMATION - Bore PF166MW1 - pH



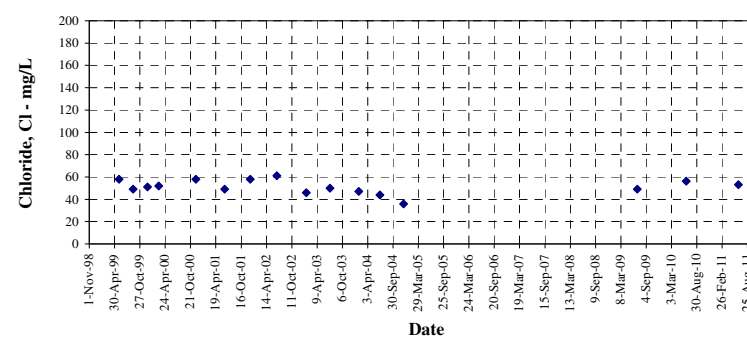
PF FORMATION - Bore PF166MW1 - Sodium



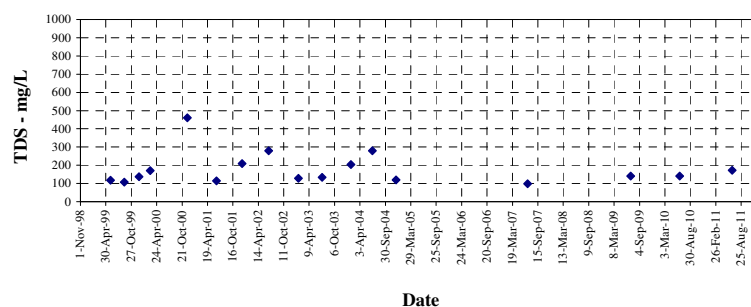
PF FORMATION - Bore PF166MW1 - Electrical Conductivity



PF FORMATION - Bore PF166MW1 - Chloride



PF FORMATION - Bore PF166MW1 - Total Dissolved Solids



Appendix B Analytical Laboratory Reports



Environmental Division

CERTIFICATE OF ANALYSIS

Work Order	: ES1113305	Page	: 1 of 3
Client	: URS AUSTRALIA (NSW) PTY LTD	Laboratory	: Environmental Division Sydney
Contact	: MR FABIO CAROSONE	Contact	: Angela Pavlovic
Address	: LEVEL 4, 407 PACIFIC HIGHWAY ARTARMON NSW, AUSTRALIA 2064	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: fabio_carosone@urscorp.com	E-mail	: angela.pavlovic@alsenviro.com
Telephone	: +61 89255500	Telephone	: +61 2 8784 8523
Facsimile	: +61 02 89255555	Facsimile	: +61 2 8784 8500
Project	: 43167726	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 22-JUN-2011
Sampler	: FC	Issue Date	: 30-JUN-2011
Site	: ----		
Quote number	: EN/001/10	No. of samples received	: 5
		No. of samples analysed	: 5

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results



NATA Accredited Laboratory 825

This document is issued in accordance with NATA accreditation requirements.

Accredited for compliance with ISO/IEC 17025.

Signatories

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

<i>Signatories</i>	<i>Position</i>	<i>Accreditation Category</i>
Ankit Joshi	Inorganic Chemist	Sydney Inorganics
Celine Conceicao	Spectroscopist	Sydney Inorganics
Sarah Millington	Senior Inorganic Chemist	Sydney Inorganics
Wisam Marassa	Metals Coordinator	Sydney Inorganics



General Comments

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

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

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

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

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.

LOR = Limit of reporting

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



Analytical Results

Sub-Matrix: WATER

Client sample ID

Client sampling date / time

				PF167MW1	PF166MW1	PFL2HITCHMW1	PFP214MW1	PF198PB1
				22-JUN-2011 11:00	22-JUN-2011 11:30	22-JUN-2011 12:00	22-JUN-2011 10:40	22-JUN-2011 08:30
Compound	CAS Number	LOR	Unit	ES1113305-001	ES1113305-002	ES1113305-003	ES1113305-004	ES1113305-005
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	5.30	4.22	4.10	4.31	5.52
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	170	261	167	158	170
EA015: Total Dissolved Solids								
^ Total Dissolved Solids @180°C	GIS-210-010	5	mg/L	101	172	110	88	102
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	2	<1	<1	<1	3
Total Alkalinity as CaCO3	----	1	mg/L	2	<1	<1	<1	3
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	18	1	5	<1	6
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	1	mg/L	29	53	32	34	36
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	4	1	<1	<1	2
Magnesium	7439-95-4	1	mg/L	4	6	2	4	4
Sodium	7440-23-5	1	mg/L	18	24	22	18	21
Potassium	7440-09-7	1	mg/L	4	3	<1	1	2
EN055: Ionic Balance								
^ Total Anions	----	0.01	meq/L	1.23	1.52	1.01	0.96	1.20
^ Total Cations	----	0.01	meq/L	1.41	1.66	1.12	1.14	1.39
EP020: Oil and Grease (O&G)								
^ Oil & Grease	----	5	mg/L	<5	<5	<5	<5	<5



Environmental Division

QUALITY CONTROL REPORT

Work Order	: ES1113305	Page	: 1 of 6
Client	: URS AUSTRALIA (NSW) PTY LTD	Laboratory	: Environmental Division Sydney
Contact	: MR FABIO CAROSONE	Contact	: Angela Pavlovic
Address	: LEVEL 4, 407 PACIFIC HIGHWAY ARTARMON NSW, AUSTRALIA 2064	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: fabio_carosone@urscorp.com	E-mail	: angela.pavlovic@alsenviro.com
Telephone	: +61 89255500	Telephone	: +61 2 8784 8523
Facsimile	: +61 02 89255555	Facsimile	: +61 2 8784 8500
Project	: 43167726	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Site	: ----	Date Samples Received	: 22-JUN-2011
C-O-C number	: ----	Issue Date	: 30-JUN-2011
Sampler	: FC	No. of samples received	: 5
Order number	: ----	No. of samples analysed	: 5
Quote number	: EN/001/10		

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

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits



NATA Accredited Laboratory 825

This document is issued in accordance with NATA accreditation requirements.

Accredited for compliance with ISO/IEC 17025.

Signatories

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

<i>Signatories</i>	<i>Position</i>	<i>Accreditation Category</i>
Ankit Joshi	Inorganic Chemist	Sydney Inorganics
Celine Conceicao	Spectroscopist	Sydney Inorganics
Sarah Millington	Senior Inorganic Chemist	Sydney Inorganics
Wisam Marassa	Metals Coordinator	Sydney Inorganics



General Comments

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

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

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

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

Key :
Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
RPD = Relative Percentage Difference
= Indicates failed QC



Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR:- No Limit; Result between 10 and 20 times LOR:- 0% - 50%; Result > 20 times LOR:- 0% - 20%.

Sub-Matrix: **WATER**

Sub-Matrix: WATER				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EA005P: pH by PC Titrator (QC Lot: 1842263)									
ES1113201-001	Anonymous	EA005-P: pH Value	----	0.01	pH Unit	9.15	9.13	0.2	0% - 20%
ES1113306-001	Anonymous	EA005-P: pH Value	----	0.01	pH Unit	4.22	4.45	5.3	0% - 20%
EA010P: Conductivity by PC Titrator (QC Lot: 1842262)									
ES1113201-001	Anonymous	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	4200	4190	0.3	0% - 20%
ES1113306-001	Anonymous	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	208	207	0.5	0% - 20%
EA015: Total Dissolved Solids (QC Lot: 1846178)									
ES1113267-010	Anonymous	EA015H: Total Dissolved Solids @180°C	GIS-210-010	5	mg/L	472	468	0.8	0% - 20%
ES1113305-004	PFP214MW1	EA015H: Total Dissolved Solids @180°C	GIS-210-010	5	mg/L	88	100	12.8	0% - 20%
EA015: Total Dissolved Solids (QC Lot: 1846302)									
ES1113202-001	Anonymous	EA015H: Total Dissolved Solids @180°C	GIS-210-010	5	mg/L	14700	14800	0.4	0% - 20%
ES1113308-001	Anonymous	EA015H: Total Dissolved Solids @180°C	GIS-210-010	5	mg/L	123	135	9.0	0% - 20%
ED037P: Alkalinity by PC Titrator (QC Lot: 1842265)									
ES1113245-001	Anonymous	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.0	No Limit
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	0.0	No Limit
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	105	104	1.0	0% - 20%
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	105	104	1.0	0% - 20%
ES1113306-003	Anonymous	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.0	No Limit
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	0.0	No Limit
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	<1	<1	0.0	No Limit
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	<1	<1	0.0	No Limit
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QC Lot: 1844051)									
ES1113305-001	PF167MW1	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	18	18	0.0	0% - 50%
EW1101922-002	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	3	3	0.0	No Limit
ED045G: Chloride Discrete analyser (QC Lot: 1844050)									
ES1113305-001	PF167MW1	ED045G: Chloride	16887-00-6	1	mg/L	25	25	0.0	0% - 20%
EW1101922-002	Anonymous	ED045G: Chloride	16887-00-6	1	mg/L	22	20	8.6	0% - 20%
ED093F: Dissolved Major Cations (QC Lot: 1844049)									
ES1113305-001	PF167MW1	ED093F: Calcium	7440-70-2	1	mg/L	4	4	0.0	No Limit
		ED093F: Magnesium	7439-95-4	1	mg/L	4	4	0.0	No Limit
		ED093F: Sodium	7440-23-5	1	mg/L	18	19	6.9	0% - 50%
		ED093F: Potassium	7440-09-7	1	mg/L	4	4	0.0	No Limit
EW1101922-003	Anonymous	ED093F: Calcium	7440-70-2	1	mg/L	<1	<1	0.0	No Limit
		ED093F: Magnesium	7439-95-4	1	mg/L	2	2	0.0	No Limit
		ED093F: Sodium	7440-23-5	1	mg/L	17	17	0.0	0% - 50%



Sub-Matrix: WATER				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
ED093F: Dissolved Major Cations (QC Lot: 1844049) - continued									
EW1101922-003	Anonymous	ED093F: Potassium	7440-09-7	1	mg/L	<1	<1	0.0	No Limit



Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Sample (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **WATER**

Sub-Matrix: WATER				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike Concentration	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result		LCS	Low	High
EA010P: Conductivity by PC Titrator (QCLot: 1842262)								
EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	<1	2000 µS/cm	107	86.3	112
EA015: Total Dissolved Solids (QCLot: 1846178)								
EA015H: Total Dissolved Solids @180°C	GIS-210-010	5	mg/L	<5	293 mg/L	106	70	130
EA015: Total Dissolved Solids (QCLot: 1846302)								
EA015H: Total Dissolved Solids @180°C	GIS-210-010	5	mg/L	<5	293 mg/L	109	70	130
ED037P: Alkalinity by PC Titrator (QCLot: 1842265)								
ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	----	200 mg/L	89.3	80.2	108
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 1844051)								
ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	25 mg/L	98.1	70	130
ED045G: Chloride Discrete analyser (QCLot: 1844050)								
ED045G: Chloride	16887-00-6	1	mg/L	<1	1000 mg/L	98.2	70	130
ED093F: Dissolved Major Cations (QCLot: 1844049)								
ED093F: Calcium	7440-70-2	1	mg/L	<1	50 mg/L	99.6	88	110
ED093F: Magnesium	7439-95-4	1	mg/L	<1	50 mg/L	96.4	90	110
ED093F: Sodium	7440-23-5	1	mg/L	<1	50 mg/L	98.0	81	107
ED093F: Potassium	7440-09-7	1	mg/L	<1	50 mg/L	99.2	89	109
EP020: Oil and Grease (O&G) (QCLot: 1847275)								
EP020: Oil & Grease	----	5	mg/L	<5	5000 mg/L	94.2	81.6	107



Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: WATER

Sub-Matrix: WATER				Matrix Spike (MS) Report			
				Spike Concentration	Spike Recovery (%)	Recovery Limits (%)	
					MS	Low	High
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number				
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 1844051)							
ES1113305-001	PF167MW1	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	10 mg/L	100	70	130
ED045G: Chloride Discrete analyser (QCLot: 1844050)							
ES1113305-001	PF167MW1	ED045G: Chloride	16887-00-6	250 mg/L	118	70	130



Environmental Division

INTERPRETIVE QUALITY CONTROL REPORT

Work Order	: ES1113305	Page	: 1 of 6
Client	: URS AUSTRALIA (NSW) PTY LTD	Laboratory	: Environmental Division Sydney
Contact	: MR FABIO CAROSONE	Contact	: Angela Pavlovic
Address	: LEVEL 4, 407 PACIFIC HIGHWAY ARTARMON NSW, AUSTRALIA 2064	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: fabio_carosone@urscorp.com	E-mail	: angela.pavlovic@alsenviro.com
Telephone	: +61 892555500	Telephone	: +61 2 8784 8523
Facsimile	: +61 02 89255555	Facsimile	: +61 2 8784 8500
Project	: 43167726	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Site	: ----		
C-O-C number	: ----	Date Samples Received	: 22-JUN-2011
Sampler	: FC	Issue Date	: 30-JUN-2011
Order number	: ----		
Quote number	: EN/001/10	No. of samples received	: 5
		No. of samples analysed	: 5

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

This Interpretive Quality Control Report contains the following information:

- Analysis Holding Time Compliance
- Quality Control Parameter Frequency Compliance
- Brief Method Summaries
- Summary of Outliers



Analysis Holding Time Compliance

The following report summarises extraction / preparation and analysis times and compares with recommended holding times. Dates reported represent first date of extraction or analysis and precludes subsequent dilutions and reruns. Information is also provided re the sample container (preservative) from which the analysis aliquot was taken. Elapsed period to analysis represents number of days from sampling where no extraction / digestion is involved or period from extraction / digestion where this is present. For composite samples, sampling date is assumed to be that of the oldest sample contributing to the composite. Sample date for laboratory produced leachates is assumed as the completion date of the leaching process. Outliers for holding time are based on USEPA SW 846, APHA, AS and NEPM (1999). A listing of breaches is provided in the Summary of Outliers.

Holding times for leachate methods (excluding elutriates) vary according to the analytes being determined on the resulting solution. For non-volatile analytes, the holding time compliance assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These soil holding times are: Organics (14 days); Mercury (28 days) & other metals (180 days). A recorded breach therefore does not guarantee a breach for all non-volatile parameters.

Matrix: **WATER**

Evaluation: * = Holding time breach ; ✓ = Within holding time.

Method		Sample Date	Extraction / Preparation			Analysis		
Container / Client Sample ID(s)			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA005P: pH by PC Titrator								
Clear Plastic Bottle - Natural PF167MW1, PFL2HITCHMW1, PF198PB1	PF166MW1, PFP214MW1,	22-JUN-2011	---	22-JUN-2011	----	23-JUN-2011	22-JUN-2011	✖
EA010P: Conductivity by PC Titrator								
Clear Plastic Bottle - Natural PF167MW1, PFL2HITCHMW1, PF198PB1	PF166MW1, PFP214MW1,	22-JUN-2011	---	20-JUL-2011	----	23-JUN-2011	20-JUL-2011	✔
EA015: Total Dissolved Solids								
Clear Plastic Bottle - Natural PF167MW1,	PFP214MW1	22-JUN-2011	----	----	----	26-JUN-2011	29-JUN-2011	✔
Clear Plastic Bottle - Natural PF166MW1, PF198PB1	PFL2HITCHMW1,	22-JUN-2011	----	----	----	27-JUN-2011	29-JUN-2011	✔
ED037P: Alkalinity by PC Titrator								
Clear Plastic Bottle - Natural PF167MW1, PFL2HITCHMW1, PF198PB1	PF166MW1, PFP214MW1,	22-JUN-2011	---	06-JUL-2011	----	23-JUN-2011	06-JUL-2011	✔
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Clear Plastic Bottle - Natural PF167MW1, PFL2HITCHMW1, PF198PB1	PF166MW1, PFP214MW1,	22-JUN-2011	---	20-JUL-2011	----	24-JUN-2011	20-JUL-2011	✔
ED045G: Chloride Discrete analyser								
Clear Plastic Bottle - Natural PF167MW1, PFL2HITCHMW1, PF198PB1	PF166MW1, PFP214MW1,	22-JUN-2011	---	20-JUL-2011	----	24-JUN-2011	20-JUL-2011	✔

Page : 3 of 6
 Work Order : ES1113305
 Client : URS AUSTRALIA (NSW) PTY LTD
 Project : 43167726



Matrix: **WATER**

Evaluation: ✖ = Holding time breach ; ✔ = Within holding time.

Method		Sample Date	Extraction / Preparation			Analysis		
Container / Client Sample ID(s)			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
ED093F: Dissolved Major Cations								
Clear Plastic Bottle - Natural PF167MW1, PF166MW1, PFL2HITCHMW1, PFP214MW1, PF198PB1		22-JUN-2011	---	29-JUN-2011	----	24-JUN-2011	29-JUN-2011	✔
EP020: Oil and Grease (O&G)								
Amber Glass Bottle - Sulfuric Acid PF167MW1, PF166MW1, PFL2HITCHMW1, PFP214MW1, PF198PB1		22-JUN-2011	----	----	----	27-JUN-2011	20-JUL-2011	✔



Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(where) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **WATER** Evaluation: ✖ = Quality Control frequency not within specification ; ✔ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	Method	QC	Regular	Actual	Expected	Evaluation	
Laboratory Duplicates (DUP)							
Alkalinity by PC Titrator	ED037-P	2	12	16.7	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Chloride by Discrete Analyser	ED045G	2	20	10.0	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Conductivity by PC Titrator	EA010-P	2	15	13.3	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Major Cations - Dissolved	ED093F	2	20	10.0	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
pH by PC Titrator	EA005-P	2	15	13.3	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	20	10.0	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Dissolved Solids (High Level)	EA015H	4	37	10.8	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Laboratory Control Samples (LCS)							
Alkalinity by PC Titrator	ED037-P	1	12	8.3	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Chloride by Discrete Analyser	ED045G	2	20	10.0	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Conductivity by PC Titrator	EA010-P	1	15	6.7	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Major Cations - Dissolved	ED093F	1	20	5.0	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Oil and Grease	EP020	1	20	5.0	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	20	5.0	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Dissolved Solids (High Level)	EA015H	2	37	5.4	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Method Blanks (MB)							
Chloride by Discrete Analyser	ED045G	1	20	5.0	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Conductivity by PC Titrator	EA010-P	1	15	6.7	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Major Cations - Dissolved	ED093F	1	20	5.0	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Oil and Grease	EP020	1	20	5.0	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	20	5.0	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Dissolved Solids (High Level)	EA015H	2	37	5.4	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Matrix Spikes (MS)							
Chloride by Discrete Analyser	ED045G	1	20	5.0	5.0	✓	ALS QCS3 requirement
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	20	5.0	5.0	✓	ALS QCS3 requirement



Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
pH by PC Titrator	EA005-P	WATER	APHA 21st ed. 4500 H+ B. This procedure determines pH of water samples by automated ISE. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Conductivity by PC Titrator	EA010-P	WATER	APHA 21st ed., 2510 B This procedure determines conductivity by automated ISE. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Total Dissolved Solids (High Level)	EA015H	WATER	APHA 21st ed., 2540C A gravimetric procedure that determines the amount of 'filterable' residue in an aqueous sample. A well-mixed sample is filtered through a glass fibre filter (1.2um). The filtrate is evaporated to dryness and dried to constant weight at 180+/-5C. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Alkalinity by PC Titrator	ED037-P	WATER	APHA 21st ed., 2320 B This procedure determines alkalinity by automated measurement (e.g. PC Titrate) using pH 4.5 for indicating the total alkalinity end-point. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	WATER	APHA 21st ed., 4500-SO4 Sulfate ions are converted to a barium sulfate suspension in an acetic acid medium with barium chloride. Light absorbance of the BaSO4 suspension is measured by a photometer and the SO4-2 concentration is determined by comparison of the reading with a standard curve. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Chloride by Discrete Analyser	ED045G	WATER	APHA 21st ed., 4500 Cl - G. The thiocyanate ion is liberated from mercuric thiocyanate through sequestration of mercury by the chloride ion to form non-ionised mercuric chloride. In the presence of ferric ions the liberated thiocyanate forms highly-coloured ferric thiocyanate which is measured at 480 nm APHA 21st edition seal method 2 017-1-L april 2003
Major Cations - Dissolved	ED093F	WATER	APHA 21st ed., 3120; USEPA SW 846 - 6010 The ICPAES technique ionises the 0.45um filtered sample atoms emitting a characteristic spectrum. This spectrum is then compared against matrix matched standards for quantification. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Ionic Balance by PCT DA and ICPAES	EN055 - PG	WATER	APHA 21st Ed. 1030F. The Ionic Balance is calculated based on the major Anions and Cations. The major anions include Alkalinity, Chloride and Sulfate which determined by PCT and DA. The Cations are determined by ICPAES. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Oil and Grease	EP020	WATER	APHA 21st ed., 5520 B Oil & grease is a gravimetric procedure to determine the amount of oil & grease residue in an aqueous sample. The sample is serially extracted three times n-hexane. The resultant extracts are combined, dehydrated and concentrated prior to gravimetric determination. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)



Summary of Outliers

Outliers : Quality Control Samples

The following report highlights outliers flagged in the Quality Control (QC) Report. Surrogate recovery limits are static and based on USEPA SW846 or ALS-QWI/EN/38 (in the absence of specific USEPA limits). This report displays QC Outliers (breaches) only.

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

- For all matrices, no Method Blank value outliers occur.
- For all matrices, no Duplicate outliers occur.
- For all matrices, no Laboratory Control outliers occur.
- For all matrices, no Matrix Spike outliers occur.

Regular Sample Surrogates

- For all regular sample matrices, no surrogate recovery outliers occur.

Outliers : Analysis Holding Time Compliance

This report displays Holding Time breaches only. Only the respective Extraction / Preparation and/or Analysis component is/are displayed.

Matrix: **WATER**

Method	Extraction / Preparation			Analysis		
	Date extracted	Due for extraction	Days overdue	Date analysed	Due for analysis	Days overdue
EA005P: pH by PC Titrator						
Clear Plastic Bottle - Natural PF167MW1, PF166MW1, PFL2HITCHMW1, PFP214MW1, PF198PB1	----	----	----	23-JUN-2011	22-JUN-2011	1

Outliers : Frequency of Quality Control Samples

The following report highlights breaches in the Frequency of Quality Control Samples.

- No Quality Control Sample Frequency Outliers exist.

30/6

30/6

Sam 22/6/11 1740



URS Australia Pty Ltd
Level 4, 407 Pacific Highway
Artarmon NSW 2064
Australia

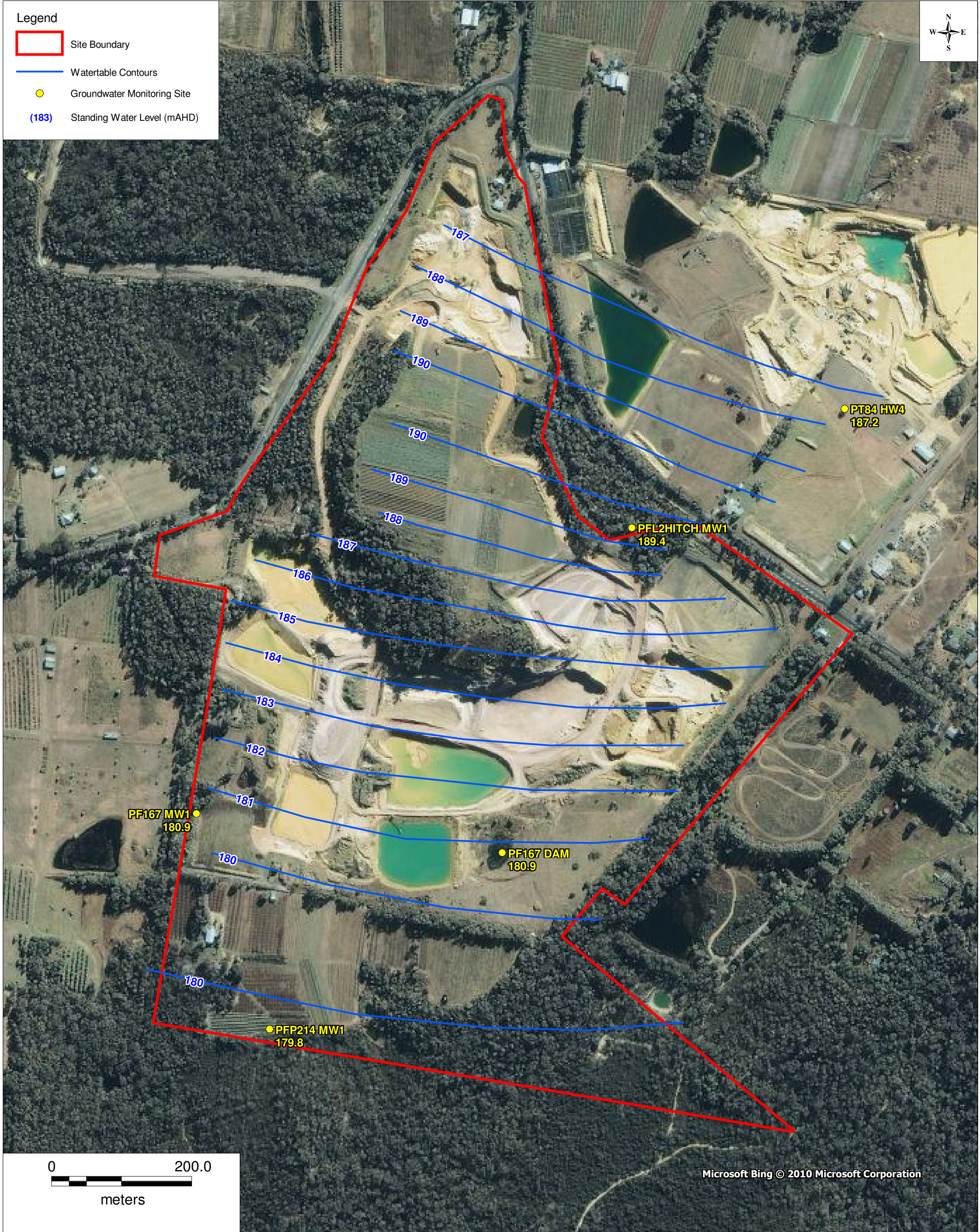
T: 61 2 8925 5500

F: 61 2 8925 5555

www.ap.urscorp.com

Attachment 6B

Water Table Contours

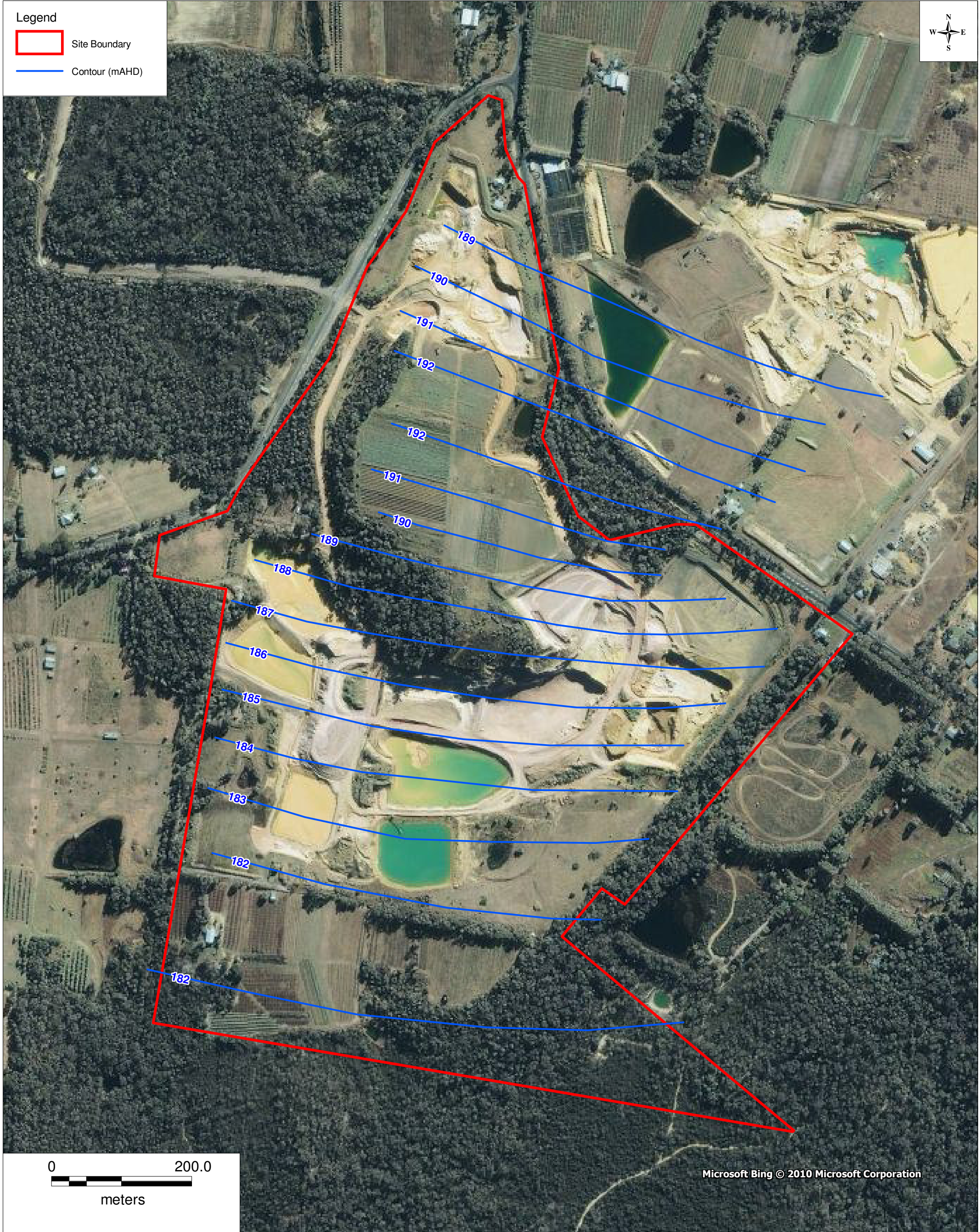


Source: Aerial imagery from Bing Maps © 2010 Microsoft Corporation and its data suppliers.
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Attachment 6C

Depth of Mining Plan



Source: Aerial imagery from Bing Maps © 2010 Microsoft Corporation and its data suppliers.
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PF FORMATION

HITCHCOCK ROAD, SAND EXTRACTION
AND REHABILITATION PROJECT

HITCHCOCK ROAD SITE
DEPTH OF MINING CONTOURS
@ 22/06/2011



Attachment 6D

Quarterly Water Testing Results



MATERIALS TECHNICAL SERVICES
BORAL RESOURCES (NSW) PTY LTD
ABN 51 000 756 507

Unit 4, 3-5 Gibbon Road
Baulkham Hills NSW 2153 Australia
PO Box 400, Winston Hills NSW 2153
Telephone 61 2 9624 9900
Facsimile 61 2 9624 9999

Test Report

CLIENT: P.F.FORMATION

FILE No.: 250/10

ADDRESS: 1774 WISEMANNS FERRY ROAD, MAROOTA, NSW 2756

PROJECT: Testing of Water Samples from P.F. Formation

REQUEST No.: 39955

TEST PROCEDURE: APHA 4500 H⁺B - pH Value
 APHA 2130 B - Turbidity
 APHA 5520 C - Oil & Grease by Infra Red
 APHA 4500 D - Total Suspended Solid Dried at 103-105 °C
 APHA 2510 B - Conductivity

Laboratory Sample No.:	107856	107857
Date Sampled:	6.09.10	6.09.10
Date Received:	6.09.10	6.09.10
Sample Description:	Water - Downstream - Lot 198 - 12:30pm	Water - Pit 4 Causeway Crossing - 12:30pm
Field No.:	1	2

TEST RESULTS

pH	6.2	6.6
Turbidity (NTU)	2.3	2.6
Oil & Grease (mg/L)*	<1	<1
Total Suspended Solid (mg/L)	2.3	7.2
Conductivity (µm/cm)	199	330

Samples submitted by the Client.

NOTE: * Solvent used in the determination of Solvent Extractable Matter for Oil & Grease analysis:
 Polychlorotrifluoroethylene (S316)

J. Graham, File.

JUSTIN DOWSE

Approved Signatory Date 9/09/10 Serial No. 89377

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 Accredited for compliance with ISO/IEC 17025

NATA Accredited Laboratory
 Number: 9968



MATERIALS TECHNICAL SERVICES
BORAL RESOURCES (NSW) PTY LTD
ABN 51 000 756 507

Unit 4, 3-5 Gibbon Road
Baulkham Hills NSW 2153 Australia
PO Box 400, Winston Hills NSW 2153
Telephone 61 2 9624 9900
Facsimile 61 2 9624 9999

Test Report

CLIENT: P.F.FORMATION

FILE No.: 250/10

ADDRESS: 1774 WISEMANNS FERRY ROAD, MAROOTA, NSW 2756

PROJECT: Testing of Water Samples from P.F. Formation

REQUEST No.: 41169

TEST PROCEDURE: APHA 4500 H⁺B - pH Value
 APHA 2130 B - Turbidity
 APHA 5520 C - Oil & Grease by Infra Red
 APHA 4500 D - Total Suspended Solid Dried at 103-105 °C
 APHA 2510 B - Conductivity

Laboratory Sample No.: 110865
 Date Sampled: 2.12.10
 Date Received: 2.12.10
 Sample Description: Water -
 Downstream -
 Lot 198 -
 11:00am

Field No.: 1

TEST RESULTS

pH 5.1
 Turbidity (NTU) 5.0
 Oil & Grease (mg/L)* <1
 Total Suspended Solid (mg/L) 3.7
 Conductivity (µm/cm) 208

Samples submitted by the Client.

NOTE: This NATA report replaces NATA report number 91985

* Solvent used in the determination of Solvent Extractable Matter for Oil & Grease analysis:
 Polychlorotrifluoroethylene (S316)

J. Graham, File.



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COMPETENCE

Approved Signatory  JUSTIN DOWSE
 Date 13/12/10 Serial No. 91997

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NATA Accredited Laboratory
 Number: 9968

MATERIALS TECHNICAL SERVICES
BORAL RESOURCES (NSW) PTY LTD
ABN 51 000 756 507Unit 4, 3-5 Gibbon Road
Baulkham Hills NSW 2153 Australia
PO Box 400, Winston Hills NSW 2153
Telephone 61 2 9624 9900
Facsimile 61 2 9624 9999**Test Report**

CLIENT: P.F.FORMATION

FILE No.: 250/11

ADDRESS: 1774 WISEMANNS FERRY ROAD, MAROOTA, NSW 2756

PROJECT: Testing of Water Samples from P.F. Formation

REQUEST No.: 42153

TEST PROCEDURE: APHA 4500 H⁺B - pH Value
APHA 2130 B - Turbidity
APHA 5520 C - Oil & Grease by Infra Red
APHA 4500 D - Total Suspended Solid Dried at 103-105 °C
APHA 2510 B - Conductivity

Laboratory Sample No.: 113483
Date Sampled: 1.03.11
Date Received: 2.03.11
Sample Description: Water -
Downstream -
Lot 198 -
12:00pm

Field No.: 1

TEST RESULTS

pH 5.4
Turbidity (NTU) 5.3
Oil & Grease (mg/L)* <1
Total Suspended Solid (mg/L) 1.7
Conductivity (µm/cm) 182

Samples submitted by the Client.

NOTE: This NATA report replaces NATA report number 93609

* Solvent used in the determination of Solvent Extractable Matter for Oil & Grease analysis:
Polychlorotrifluoroethylene (S316)

J. Graham, File.

ACCREDITED FOR
TECHNICAL
COMPETENCE

Approved Signatory

Date 8/03/11

Serial No.

JUSTIN DOWSE

93637

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NATA Accredited Laboratory
Number: 9968



To: P.F.Formation Telephone: 0245 668365
Joshua Graham Facsimile: 0245 668349
1774 Wisemans Ferry Road E-mail: josh@pfformation.com.au
Maroota NSW 2756 Mobile

From: Steven Humphreys Mobile: 0429 959874
Water Care After Hours: 0245 721512
188 Cabbage Tree Road, Facsimile: 0245 722026
Grose Vale. 2753 E-mail: water.care@bigpond.com.au

The analysis of the samples collected on June 28th, 2011 from the P.F. Formation site on Wiseman's Ferry Road and Old Northern Road Maroota gave the following results;

	Downstream Lot 198
pH units	4.94
Conductivity uS/cm	214
Total Dissolved Solids mg/L	141
Turbidity NTU	2.58
Non Filterable Residue mg/L	< 2.0
Oil & Grease mg/L	6

< indicates less than

> indicates greater than

mg/L indicates milligrams per Litre uS/cm microseimens per centimetre

NTU indicates Nephelometric Units

District mean is derived from all analysis carried out by Water Care on creeks in the Hawkesbury district since 1992.

Comments: Nil

Explanation

If you have any further questions please contact me. *Steven Humphreys*

Chapter Seven

REHABILITATION

Introduction

A Landscape Management Plan has been prepared in compliance with the requirements of the current Project Approval and was approved by the Department of Planning on 26 August 2010. The following section therefore describes the current phase of site rehabilitation followed by responses to the issues raised in the court orders where appropriate. Reference is also made to the biodiversity offset strategy which is described in more detail in the Landscape Management Plan.

Earth bunding and rehabilitation

Bund construction and planting work has been completed in most areas, mainly sections of the northern and southern boundaries of the triangular shaped, northern portion of the site bounded by Old Northern Road and Wisemans Ferry Road.

Sections along Old Northern Road have been completed but were referred to in the Independent Environmental Audit as an area where improvement is required. The screen planting should be improved and PF Formation will work in with the tenant of the house to reshape the area and commence planting in the next year.

Visual assessment

The periphery works will, in time provide an acceptable screen to ameliorate the visual impacts of the sand extraction operations. However, most parts of the extraction area are not visible from the external roads although material stockpiled adjacent to the slurry plant at the northern extremity of the site can be seen by drivers travelling south along Old Northern Road. The area along Old Northern Road will be the main area of focus once the Spring 2011 planting of the SHTW rehabilitation area is completed.

Conclusions

The works as proposed ensure that satisfactory screening and rehabilitation of the boundary areas of the Hitchcock Road site is achieved. The proposed method of earth bunding and planting will, in time, ameliorate the visual impacts of the site operations. In conjunction with further rehabilitation work, the site can be returned to a natural state on the completion of sand extraction.

Rehabilitation Issues

Rate of rehabilitation

Rehabilitation of the site is taking place generally in phase with the overall staging program. The removal of material from the first phases has been completed and extraction has continued as shown on the Site Plan at **Attachment 2A**.

Rehabilitation of the project is dependent on three main factors:

- Material for backfilling does not become available until topsoil and overburden are removed from later phases as similar material from the first phase area is used to form peripheral mounds and the earthworks required for the tailings dams.

- Substantial parts of the operational area are occupied by a series of basins required for surface water treatment. These require capping prior to any major rehabilitation-taking place in the area. This cannot be undertaken until new basins are developed as part of the next phase development which in turn serve the whole project. In addition, capping cannot take place until the ponds are sufficiently dry to accommodate heavy vehicles with safety. This can take up to three years.

The timing of the rehabilitation of the initial phases is therefore dependent on a substantial start being made on the next phase. Activity to date has focussed on the provision of the peripheral mounds which are required for acoustic and visual reasons. These have been constructed, so far, in those areas particularly sensitive to these impacts. This work has now been completed.

A number of the early tailings dams have been capped and the area is in the process of rehabilitation. This is particularly the case in the western part of the site immediately to the south of the former Crown Road where several silt ponds have been capped and the ground contours reconfigured. 4 hectares of the eastern part has been seeded under the guidance of Greening Australia and Parsons Brinckerhoff.

Maintenance of vegetated conservation zones and rehabilitated areas

Conservation zones identified in the Landscape Management Plan are regularly inspected as required in the Environmental Strategy (**Strategy 7.1**). These areas are signposted and the areas suitably protected. All existing vegetation around the periphery of the site will be protected within setbacks and buffer zones.

The peripheral bunds constructed to date have been planted. These are regularly inspected and the area maintained.

Retention and protection of vegetation within buffer zones

All existing vegetation within the defined buffer zones will be retained and protected. A setback with a minimum depth of 30 metres is being maintained along Hitchcock Road and all existing vegetation within this area will be retained.

Integration of the site rehabilitation with the surrounding terrain

Operations have been undertaken on the Hitchcock Road site under the previous consent since November 1998. These have inevitably concentrated on the site works required for the development including retention basins and the construction of the peripheral bunds. It is too early in the life of the development, with more than 20 years of life remaining, to consider the establishment of the final landform in any detail. The area to the south of the former Crown Road has been reformed with final batter slopes which give an indication of the way in which the final landform will integrate with the surrounding area.

The final landform of the Hitchcock Road site will be influenced by the depth of extraction, the location of commercially available resource and the volume of overburden, mainly clay, available for re-contouring the extracted areas. Sand has been extracted from part of the site to the depth allowed in the previous consent and part of this area has been rehabilitated.

The existing topography and setbacks is also shown on the Site Survey Plan. Two final landforms have been developed in response to the requirements of the proposed biodiversity offset strategy.

- Strategy A comprises a large gently sloping basin with steeper side slopes along the boundary to Old Northern Road. Some of the levels have been amended to reflect changes in the extraction areas to minimise vegetation removal.
- Strategy B accommodates the retention of the woodland on the highest slopes of the site. As the high point is retained, the landform would comprise steeper slopes from those in Strategy A with substantial inward facing slopes in the northern section of the site with a large more gently sloping area in the centre. The area to the south (Lot 214 DP752039) would be the same in both strategies. This strategy is constrained by the volume of overburden available for the reshaping of the site profile so that steep slopes are unavoidable.

A decision on which strategy is to be implemented will be dependent on the success achieved in creating a re-vegetated area containing a community with the characteristics of that to be removed from the area adjacent to the former trig reserve, namely *Sydney Hinterland Transition Woodland*. This process is described in more detail in the Landscape Management Plan.

Vegetative cover

In 2010 Greening Australia were commissioned to prepare a plan of management for the rehabilitation area of 2.4 hectares previously planted and for the additional area of 1.6 hectares to be rehabilitated. Based on that plan of management the additional area will be planted in Spring 2011 to give an area subject to SHTW rehabilitation exceeding 4 hectares.

Flora and fauna monitoring program

Regular monitoring of flora and fauna is a requirement of the Environmental Strategy. Results to date are encouraging. A report prepared by Parson Brinkerhoff was completed in July 2010. They recommended that the next external assessment is not required until 2012 and the report is appended as **Attachment 7A**. Substantial supplementary planting as they recommended has been completed in 2010/11.

Conservation of threatened species, populations and ecological communities

It is a requirement of the Environmental Strategy that all those areas to be retained and defined as needing protection will be clearly identified. Signs have been placed at intervals around the areas needing protection.

Construction of acoustic and visual bunding

Construction of the peripheral bunds has already been noted. Improvements are required along Old Northern Road to better screen the sand slurry plant.

Compliance with current environmental laws, standards and practices

All the necessary management controls and related actions are in conformity with all relevant current laws, standards and practices as indicated in the document.

Conclusion

The site rehabilitation is necessarily more in focus in the latter stages of the development. 4 hectares of Sydney Hinterland Transition Woodland has been planted on site. Parsons Brinckerhoff have monitored 2.4 hectares of this area by reviewing plant species within four fixed (20 x 20 metre) quadrants. In general the revegetation areas appear to be regenerating well. Recommendations to improve the re-vegetation is outlined in the Executive Summary in **Attachment 7A** and have been implemented during the year.

Attachment 7A

Monitoring of Revegetation

Monitoring of revegetation at Hitchcock Road, Maroota

August 2010

PF Formation



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Signed:



Approved by: Martin Predavec- Technical Executive Ecology

Signed:



Date: 2 August 2010

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Executive summary

Expansion of PF Formation's existing sand mine at Hitchcock Road required clearing of 3.7 hectares of Sydney Hinterland Transition Woodland. It was proposed to offset this clearing with revegetation and re-creation of this community within a 7.9 hectare area on the western boundary of the site where mining has been completed. To date an area of 3 hectares has been replanted. The objectives of revegetation within the Hitchcock Road site are to:

- rehabilitate and revegetate quarried areas
- revegetate with native vegetation characteristic of the community to be removed from adjacent to the trig reserve, namely Sydney Hinterland Transition Woodland
- re-create the existing characteristics of this community, to provide an area suitable for offsetting the clearing of this community at that time.

The Department of Planning has requested that the success of this revegetation be monitored regularly and assessed against defined criteria (five, ten and fifteen year targets) to provide some certainty that this revegetation will ultimately result in the creation of a naturally regenerating patch of Sydney Hinterland Transition Woodland. Monitoring of the rehabilitation of previously mined areas is required as part of annual environmental reporting.

This report aims to:

- present the results of the monitoring survey
- analyse the results against the criteria for monitoring the success of rehabilitation and progress towards five year targets
- provide recommendations on management actions required to assist in successful re-creation of Sydney Hinterland Transition Woodland within the site and to meet the long-term goals.

A site inspection was undertaken on 5 July 2010. Four fixed quadrats (20 x 20 metres) were set up, one within the 2004 and three within the 2006 revegetation area. Within each quadrat, every species of plant present was recorded and its cover abundance estimated.

In general the revegetation areas appear to be regenerating well:

- the 2004 revegetation area met all targets except that the shrub cover was lower than the target set
- although the results from the 2006 revegetation area were variable, it should be noted that it is not yet five years since this area was revegetated. Results to date indicate that:
 - vegetation height targets were met including canopy and ground cover height and cover targets
 - natural regeneration was observed
 - native species diversity and characteristic species diversity is below target values and shrub cover too sparse and shrub and canopy not present in some areas.

Despite some good regeneration, some measures to improve the revegetation were identified. Recommendations include:

- Review proposed planting list for appropriateness, restricting species to those characteristic to Sydney Hinterland Transition Woodland or occurring within the trig reserve.
- Undertake supplementary planting in the 2006 revegetation area. This should focus on shrub species and *Eucalyptus* spp. where canopy species are absent.
- Ensure that any supplementary planting or new rehabilitation areas are planted haphazardly rather than in rows.
- Consider spraying exotic grasses where they occur densely.
- Implement erosion control measures. This could include additional planting.
- Undertake monitoring of the site in two years time.
- Keep records of all management actions (including revegetation, erosion control, rehabilitation and weeding) undertaken along with any subsequent outcomes observed during monitoring.
- Develop a revegetation plan for future areas to be revegetated. This should take into consideration the successful methods used to date and recommendations for improvement.

1. Introduction

This report presents the findings of monitoring of a rehabilitation area within the sandmining operations at Hitchcock Road, Maroota.

1.1 Background

Expansion of an existing PF Formation sand mine at Hitchcock Road required clearing of 3.7 hectares of Sydney Hinterland Transition Woodland. It was proposed to offset this clearing with revegetation and re-creation of this community within a 7.9 hectare area on the western boundary of the site where quarrying has been completed. To date an area of 3 hectares has been replanted (approximately 1 hectares in 2004 and 2 hectares in 2006) with the aim to recreate the vegetation to be removed near the former trig reserve (see Appendix A for more detail).

The Department of Planning has requested that the success of this revegetation be monitored regularly and assessed against defined criteria to provide some certainty that this revegetation will ultimately result in the creation of a naturally regenerating patch of Sydney Hinterland Transition Woodland.

Monitoring of the rehabilitation of previously mined areas is required as part of annual environmental reporting. This monitoring needs to be undertaken annually by independent consultants (not those undertaking the revegetation works), including assessment against the success criteria developed for rehabilitation within the site, as included in the consent conditions for the project.

1.2 Objectives of revegetation

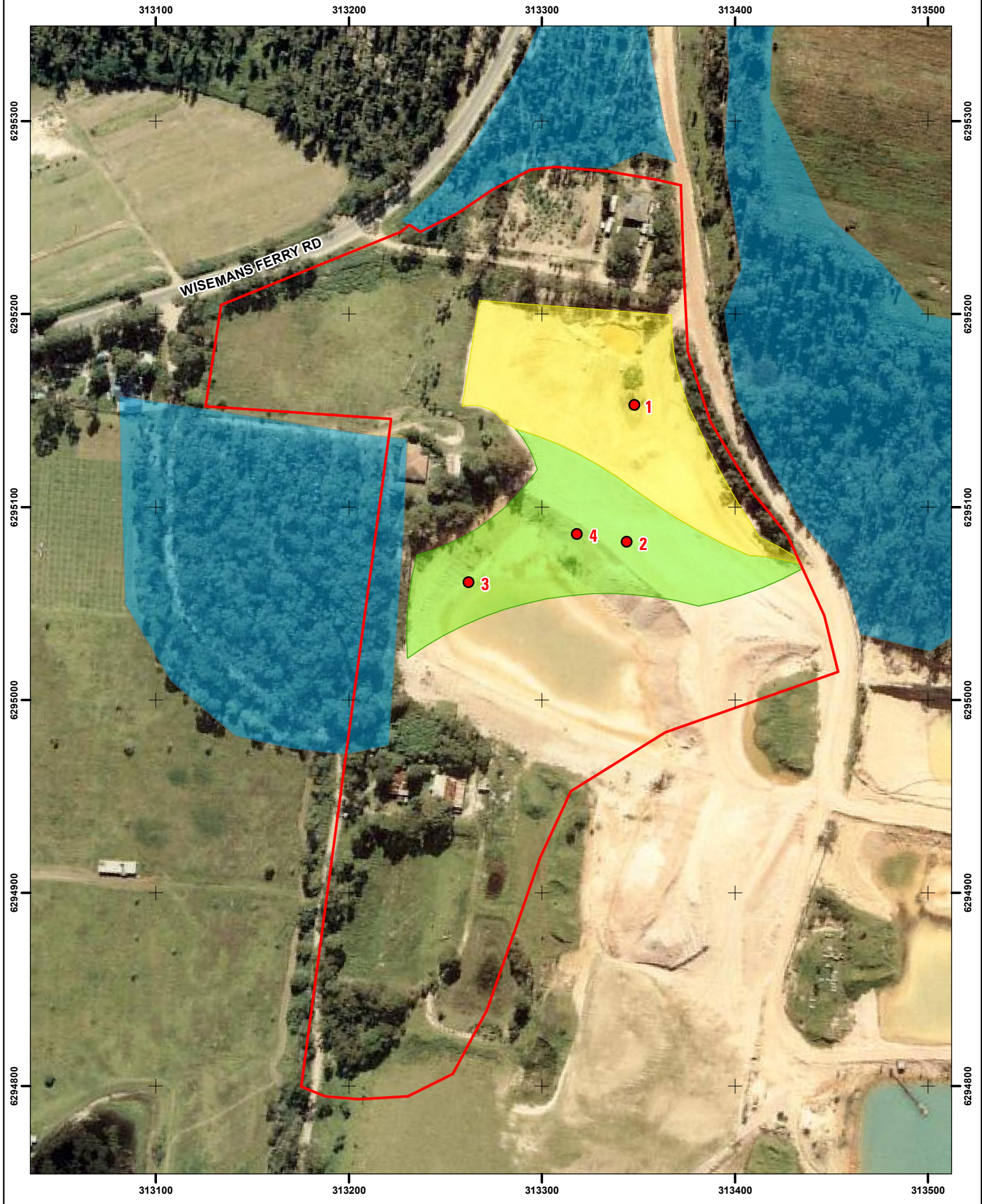
The objectives of revegetation within the Hitchcock Road site are to:

- rehabilitate and revegetate quarried areas
- revegetate with native vegetation characteristic of the community to be removed from adjacent to the trig reserve, namely Sydney Hinterland Transition Woodland
- re-create the existing characteristics of this community, to provide an area suitable for offsetting the clearing of this community at that time.

1.3 Aims of report

The aims of this report are to:

- present the results of the monitoring survey
- analyse the results against the criteria for monitoring the success of rehabilitation and progress towards five year target (Table 2-2)
- provide recommendations on management actions required to assist in successful re-creation of Sydney Hinterland Transition Woodland within the site and to meet the long-term goals.



Quadrats

Future proposed revegetation area

2004 revegetation area

2006 revegetation area

Sydney Hinterland Transition Woodland

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& survey sites

Project:
Monitoring of revegetation at Hitchcock
Road Sand Mine, Maroota

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PF Formation

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2. Methodology

2.1 Nomenclature

Names of plants used in this document follow Harden (Harden 1992, 1993, 2000, 2002) with updates from PlantNet (Royal Botanic Gardens 2010) and the Australian Plant Census (Council of Heads of Australasian Herbaria 2010). Scientific names are used in this report for species of plant. Scientific and common names (where available) are provided in plant lists in Appendices A and B. Introduced species are identified within the text with an asterisk following the name, for example *Lantana camara**

2.2 Field survey

A site inspection was undertaken on 5 July 2010. Fixed quadrats (20 x 20 m) were set up with edges running in a north-south, east west direction. Quadrats were marked with stakes at the north western and south western corners of the quadrat.

Within each quadrat, every species of plant present was recorded and its cover abundance estimated using a modified braun blanquet scale:

1. <5%- rare or few individuals
2. <5% common
3. 5-25%
4. 25-50%
5. 50-75%
6. 75-100%

Additional information recorded at each quadrat site included:

- centre and south western corner of quadrat using GPS
- slope and aspect,
- landform
- soil type
- evidence of disturbance, condition
- evidence of canopy recruitment, natural regeneration
- fauna habitat values
- photographs from the south western corner of the quadrat (to the north, north east, east, south and west).

The location of quadrats is summarised in Table 2-1.

Table 2-1 Quadrat survey locations

Stratification	Quadrat identifier	Centre of site ¹		South West corner ²	
		Easting	Northing	Easting	Northing
2004 rehabilitation area	1	313348	6295163	313335	6295148
2006 rehabilitation area	2	313343	6295082	313333	6295087
	3	313262	6295061	313253	6295059
	4	313318	6295086	313306	6295077

Notes:

1) UTM, WGS 84

2) Location of photopoint and stake marking the south western corner of quadrat

2.3 Criteria to assess rehabilitation success

Field surveys were undertaken in 2008 of the vegetation to be cleared to provide data on the typical characteristics of the community provide baseline information against which the revegetation program can be assessed (Parsons Brinckerhoff 2008).

The criteria for assessment and the target values for these goals are provided in Table 2-2 on the following page.

Table 2-2 Criteria to monitor success of revegetation

Category	Criteria	Target			Condition of vegetation to be removed
		5 years	10 years	15 years	
Native species	Native species diversity (average number per 400 m ² quadrat)	20	35	40	46
	Average number of characteristic species for the site occurring within 400 m ²	15	20	27	34.5 (+/- 1.5)
	Native species cover (% of species in 400 m ² quadrat)	>50	>85	>95	99
Weeds	Weed abundance (% of vegetation cover in 400 m ² quadrat)	<50	<15	<5	<1
	Invasive or Noxious weed species (e.g. Lantana, Blackberry, exotic vines)	Controlled	Controlled	Controlled	Restricted
Vegetation structure	Vegetation structure	Canopy, shrublayer and groundcover species present. However, structure limited, generally consisting of low canopy and ground cover.	Canopy, shrublayer and groundcover species present. Structure beginning to develop.	Well structured and includes canopy, mid-storey and ground cover units	Well structured and includes canopy, mid-storey and ground cover units
Canopy ^a	Average canopy height (m)	4	8	12	12-16
	Native canopy cover (minimum % cover) [modified braun blanquet scale] ^b	5 [3]	5 [3]	5 [3]	5 [3]
Shrub layer ^a	Native shrub cover (minimum % cover) [modified braun blanquet scale] ^b	10 [3]	15 [3]	25 [4]	32.5 (+/-7.5) [4]
	Average shrub layer height (m)	0.5	1	1	1.25
Ground cover	Native ground cover (minimum % cover) [modified braun blanquet scale] ^b	5 [3]	10 [3]	10 [3]	15 (+/-5) [3]

Category	Criteria	Target			Condition of vegetation to be removed
		5 years	10 years	15 years	
Ecosystem function	Habitat values	Vegetation structure beginning to develop.	Woodland birds recorded. Habitat structure beginning to develop, including groundcover such as leaf litter and fallen timber.	Woodland birds recorded. Habitat structure beginning to develop, including groundcover such as leaf litter and fallen timber.	Provides minimal habitat for fauna, however, many woodland birds present. Well structured habitat, includes moderate levels of leaf litter and fallen timber.
	Natural regeneration indicating dispersal of seed into site and/or presence of soil seed bank	Yes	Yes	Yes	Yes
Native species	Native species diversity (average number per 400m ² quadrat)	20	35	40	46
	Average number of characteristic species for the site occurring within 400m ²	15	20	27	34.5 (+/- 1.5)
	Native species cover (% of species in 400m ² quadrat)	>50	>85	>95	99
Weeds	Weed abundance (% of vegetation cover in 400m ² quadrat)	<50	<15	<5	<1
	Invasive or Noxious weed species (e.g. Lantana, Blackberry, exotic vines)	Controlled	Controlled	Controlled	Restricted
Vegetation structure	Vegetation structure	Canopy, shrublayer and groundcover species present. However, structure limited, generally consisting of low canopy and ground cover.	Canopy, shrublayer and groundcover species present. Structure beginning to develop.	Well structured and includes canopy, mid-storey and ground cover units	Well structured and includes canopy, mid-storey and ground cover units
Canopy ^a	Average canopy height (m)	4	8	12	12-16
	Native canopy cover (minimum % cover) [modified braun blanquet scale] ^b	5 [3]	5 [3]	5 [3]	5 [3]

Category	Criteria	Target			Condition of vegetation to be removed
		5 years	10 years	15 years	
Shrub layer ^a	Native shrub cover (minimum % cover)	10	15	25	32.5 (+/-7.5)
	[modified braun blanquet scale] ^b	[3]	[3]	[4]	[4]
	Average shrub layer height (m)	0.5	1	1	1.25
Ground cover	Native ground cover (minimum % cover)	5	10	10	15 (+/-5)
	[modified braun blanquet scale] ^b	[3]	[3]	[3]	[3]
Ecosystem function	Habitat values	Vegetation structure beginning to develop.	Woodland birds recorded. Habitat structure beginning to develop, including groundcover such as leaf litter and fallen timber.	Woodland birds recorded. Habitat structure beginning to develop, including groundcover such as leaf litter and fallen timber.	Provides minimal habitat for fauna, however, many woodland birds present. Well structured habitat, includes moderate levels of leaf litter and fallen timber.
	Natural regeneration indicating dispersal of seed into site and/or presence of soil seed bank	Yes	Yes	Yes	Yes

Notes:

a) cover of canopy species and shrubs may be higher initially due to successional changes with dense growth potentially occurring initially particularly due to the presence of colonising species.
Natural thinning is expected as colonising species senesce and canopy species mature, however, some thinning of vegetation may be required after 10 years if too dense.

b) Modified braun blanquet scale:

1. <5%- rare or few individuals
2. <5% common
3. 6-25%
4. 26-50%
5. 51-75%
6. 76-100%

3. Results

Photos of the vegetation within the former trig reserve and the rehabilitation area quadrat sites are provided in Appendix B. Species recorded, vegetation structure and other environmental characteristics of the quadrat sites are summarised in Appendix C.

3.1 Species of plant

A total of 74 species of plant was recorded within the site of which 60 (81%) are native. A full list of species recorded within each quadrat and the vegetation structure and is provided in Appendix C.

Fourteen introduced species were recorded within the rehabilitation area. One of these is listed as noxious under the *Noxious Weeds Act 1993* within the Hawkesbury River County Council noxious weed control area (includes Baulkham Hills Local Government Area): *Ageratina adenophora** (Crofton Weed) has a noxious weed rating of 4 meaning that the growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority. These are:

- Mechanical control: small areas can be dug out by hand; crowns must be removed to prevent re-growth. Heavy infestations can be controlled by regular slashing to prevent the plant from flowering.
- Chemical control- herbicide applications are most effective during late summer and autumn. Roundup®, Brushoff®, Tordon 75-D® and Banvel M® are registered for the control of crofton weed. Directions provided on herbicide label (Hawkesbury River County Council undated).

No Weed of National Significance was recorded.

3.2 Assessment against criteria

The results of the field survey were assessed against the criteria for successful revegetation, using the five year target (Table 3-1).

Generally, the targets were met for the 2004 revegetation area, except that the shrub cover was too sparse.

The results for the 2006 revegetation area were variable. Although vegetation height targets were met and canopy and ground cover targets were met and natural regeneration observed, native species diversity and characteristic species diversity is below target values and shrub cover too sparse and shrub and canopy not present in some areas.

Table 3-1 Criteria to monitor success of revegetation

Category	Criteria	Five year target	2004 revegetation area	2006 revegetation area
Native species	Native species diversity (average number per 400 m ² quadrat)	20	28	17
	Average number of characteristic species for the site occurring within 400 m ²	15	17	13
	Native species cover (% of species in quadrat that are native)	>50	88%	73%
Weeds	Weed abundance (% of vegetation cover in 400m ² quadrat)	<50	10	Variable (5-72%) Generally low, however high in patches.
	Invasive or Noxious weed species (e.g. Lantana, Blackberry, exotic vines)	Controlled	Controlled	Controlled
Vegetation structure	Vegetation structure	Canopy, shrublayer and groundcover species present. However, structure limited, generally consisting of low canopy and ground cover.	Yes	Generally true, however, some patches lack a canopy, shrub layer sparse to absent in patches
Canopy ^a	Average canopy height (m)	4	8	4.5
	Native canopy cover (minimum % cover) [modified braun blanquet scale] ^a	5 [3]	30 [4]	7 [3]
Shrub layer ^a	Native shrub cover (minimum % cover) [modified braun blanquet scale] ^a	10 [3]	2 [2]	3 [2]
	Average shrub layer height (m)	0.5	1.5m	1.6
Ground cover	Native ground cover (minimum % cover) [modified braun blanquet scale] ^a	5 [3]	23 [4]	39 [4]
	Natural regeneration indicating dispersal of seed into site and/or presence of soil seed bank	Yes	Yes	Yes (except in small localised areas)

Notes: green font indicates that target has been met or exceeded; red font indicates target hasn't been met.

4. Discussion and recommendations

In general the rehabilitation areas appear to be regenerating well:

- the 2004 revegetation area met all targets except that the shrub cover was lower than the target set
- although the results for the 2006 revegetation area were variable, it should be noted that it is not yet five years since this area was revegetated. To date indicate that:
 - vegetation height targets were met including canopy and ground cover height and cover targets
 - natural regeneration observed
 - native species diversity and characteristic species diversity is below target values and shrub cover too sparse and shrub and canopy not present in some areas.

Despite some good regeneration, some areas for improvement were identified and are summarised in **Error! Reference source not found.**

Table 4-1 Observations of the rehabilitation and recommendations to improve success

Observation	Recommendation
Native species- composition and diversity	
A number of species planted within the site have not been previously recorded within the Trig reserve or within Sydney Hinterland Transition Woodland.	Review proposed planting list for appropriateness, restricting species to those characteristic to Sydney Hinterland Transition Woodland or occurring within the trig reserve.
Native species diversity and number of characteristic species within 2006 revegetation area was below target	Supplementary planting should be undertaken in a haphazard pattern. This should focus on shrub species and <i>Eucalyptus</i> spp. where canopy species are absent. Plantings should be of species characteristic of Sydney Hinterland Transition Woodland. See Appendix C for suitable species.
<i>Natural regeneration</i> - was observed to be occurring within the site, both as seed dispersed into the site or from a seed bank as well as recruitment from the seed of plantings	None.
Weeds	
Weed abundance was generally low and restricted to the groundcover. Exotic grasses were dominant in patches.	Consider spraying exotic grasses where they occur densely.

Observation	Recommendation
Vegetation structure- Canopy, shrub layer and groundcover	
Plantings were generally done in rows, with a single or limited number of species planted for a section of the row or grid. Although some natural regeneration was noted outside the planted grid pattern, this method of planting has resulted in an artificial structure and patchy distribution of species.	Ensure that any supplementary planting or new rehabilitation areas are planted haphazardly rather than in rows.
<i>Canopy</i> growth was generally good with height and cover targets met overall. However, due to planting of single or limited number of species in an area, some areas lacked canopy species.	Supplementary planting should be undertaken in a haphazard pattern in areas lacking canopy species (i.e. lacking <i>Eucalyptus</i> spp., or <i>Syncarpia glomulifera</i>).
<i>Shrub layer</i> - Although the shrublayer height met the target, the shrublayer was sparse and did not meet the five year target for cover (% foliage cover).	Undertake supplementary planting of suitable shrub species, in a haphazard pattern.
<i>Groundcover</i> : generally good native cover.	Consider spraying exotic grasses where they occur densely.
Erosion	
Some erosion was observed within the 2006 revegetation area	Implement erosion control measures. This could include additional planting.
Monitoring and record keeping	
Monitoring has not been undertaken annually as recommended. However, based on the limited work undertaken and natural regeneration of the area, this has been appropriate.	Given that additional management of the site is unlikely to occur until next autumn and the rehabilitation is generally on target, monitoring next year is not considered necessary. Monitoring in two years time would be sufficient.
<i>Record keeping</i> of works done to date has been neglected.	Records of all management actions (including revegetation, erosion control, rehabilitation and weeding) undertaken are kept along with any subsequent outcomes observed during monitoring. This should include: <ul style="list-style-type: none"> • details of the area worked • the type of work carried out • any problems encountered • recommendations for changes in management.

Observation	Recommendation
Revegetation planning	
Revegetation has been undertaken with little documented planning	<p>A revegetation plan is developed for future areas to be revegetated. This should take into consideration the successful methods used to date and recommendations for improvement. The plan should outline the revegetation strategy for the site, including:</p> <ul style="list-style-type: none"> • identification of areas to be revegetated • topsoil storage requirements and methods of use • site preparation methods • techniques for planting including timing, use of mulch and watering • species to be used in future planting to ensure that ground cover and shrub layer species are represented • weed control methods • erosion control methods.

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Appendix A

Revegetation works to date

Revegetation works to date

To date an area of 3 hectares has been replanted with the aim to recreate the vegetation to be removed near the former trig reserve. The revegetation area is on the western boundary of the site (Figure 1-1) and further revegetation scheduled to the south as quarrying is completed. The revegetation area occurs adjacent to remnant vegetation, both within and adjacent to the site. This adjacent vegetation provides a potential seed source for natural seed dispersal into the revegetation area.

Greening Australia were commissioned to propagate tubestock from cuttings and seed from collected vegetation within the former trig reserve of the quarry to enable the revegetation of quarried areas. The first collection period occurred from late 2000 to February 2002.

Rehabilitation and revegetation has commenced with further revegetation scheduled to the south as quarrying is completed. In 2004 over one hectare of the quarry that had been previously extracted and used as a silt pond was reshaped and prepared for rehabilitation by PF Formation staff. The top soil had been stored from an adjacent area with Sydney Hinterland Transition Woodland and was spread over the site. Further seed collected over the previous 4 years was broadcast over the site in June 2004 to augment the natural soil borne native seed bank.

In 2006 an additional area of approximately two hectares that had been previously mined was prepared for revegetation. The stored top soil was distributed over the site. Greening Australia then provided over 10,000 seedlings and supervised the planting in September to November 2006 (Photo 1). An irrigation system was installed to water the plantings over that summer.

Following planting of the site, regular visual assessments of the site have been undertaken but manual weed removal has been minimal and no poisoning has been used. Observations of the establishment of revegetation within the site, suggest that weeds initially took over the site, providing soil stability but within 12 months native plants stabilized. The native plants start growing rapidly 1 to 2 years following planting and the weeds begin to die off (pers comm. P Cummins, PF Formation).

Top soil including seed bank has been stored for the next revegetation area, adjoining existing vegetated areas and the 2006 revegetated areas.



Photo 1 Revegetation works in 2006 showing planting into topsoil. Foreground area was planted in 2004

Appendix B

Photos

Vegetation within former trig site (2008)



Quadrat 1- 2004 rehabilitation area

North



East



North East- into centre of quadrat



South



West



Quadrat 2- 2006 rehabilitation

North



East



North East- into quadrat



South



West



Quadrat 3 - 2006 rehabilitation

North



East



North East- into quadrat



South



West



Quadrat 4 - 2006 rehabilitation

North



East



North East- into quadrat



South



West



Appendix C

Quadrat results

Table C. 1 **Vegetation structure**

Vegetation layer	Height: range (median) m	% foliage cover	Dominant species
Quadrat 1			
T1	4-10 (8)	30	<i>Acacia parramattensis</i> , <i>Allocasuarina littoralis</i> , <i>Eucalyptus oblonga</i> , <i>Angophora costata</i> , <i>Eucalyptus ?saligna</i>
S1	0.8-2 (1.5)	10	<i>Daviesia?</i> , <i>Acacia parramattensis</i> , <i>Allocasuarina littoralis</i> , <i>Eucalyptus spp.</i>
G1	0-0.6 (0.3)	30	<i>Entolasia stricta</i> , <i>Hypochaeris radicata</i> , <i>Paspalum dilatatum</i> , <i>Lomandra longifolia</i>
Notes:	Few weeds, good regeneration. Thin layer of leaf litter and some dead grass; No weedy shrubs, weeds present only in groundcover layer; good soil health- lots of mushrooms, soil lichens and moss; fauna habitat poor- no hollows or timber, limited groundcover, leaf litter developing; lots of birds present.		
Quadrat 2			
T1	4-8 (5)	10	<i>Acacia parramattensis</i> , <i>Angophora costata</i>
S1	1-3 (2)	10	<i>Syncarpia glomulifera</i> , <i>Hakea dactyloides</i> , <i>Hakea sericea</i>
G1	0-0.8 (0.3)	90	<i>Kikuyu</i> , <i>Senecio madagascariensis</i> , <i>Themeda australis</i> , <i>Andropogon virginicus</i> , <i>Paspalum dilatatum</i>
Notes:	Weeds dominating the groundcover; lots of native seedlings, especially of <i>Hakea sericea</i> , Poor soil health- no cryptograms or fungi; <i>Themeda australis</i> dominant in patches; poor fauna habitat - no hollows or timber, grass is dense		
Quadrat 3			
T1	2.5-5 (4)	10	<i>Acacia linifolia</i> , <i>Eucalyptus eugenioides</i> , <i>Allocasuarina littoralis</i>
S1	1-1.5 (1.2)	20	<i>Leptospermum trinervium</i> , <i>Eucalyptus eugenioides</i> , <i>Allocasuarina littoralis</i> , <i>Acacia brownii</i>
G1	0-0.8 (0.5)	80	<i>Eragrostis brownii</i> , <i>Entolasia stricta</i> , <i>Themeda australis</i> , <i>Andropogon virginicus</i> , <i>Lomandra longifolia</i>
Notes:	Few weeds, only occasional introduced grass; good regeneration of natives including seedlings from seedbank and mature plantings; good soil health- soil lichens and moss common; fauna habitat poor- no hollows or timber, sparse understory, limited leaf litter.		
Quadrat 4			
T1	-	-	-
S1	1-3 (1.6)	8	<i>Banksia ericifolia</i> , <i>Acacia spp.</i> , <i>Leptospermum trinervium</i>
G1	0-0.8 (0.2)	60	<i>Kikuyu</i> , <i>Themeda australis</i> , <i>Hypochaeris radicata</i> , <i>Andropogon virginicus</i>
Notes:	Some erosion evident; no eucalypts present; single species planted in rows; poor recruitment; fauna habitat poor- no hollows or timber, limited groundcover and leaf litter		

Notes: T1= Tree layer; S1= Shrub layer; G1=Groundcover

Table C. 2

Groundcover, vegetation cover, slope and aspect

Characteristic	Quadrat			
	1	2	3	4
Ground cover (% cover)				
Bare soil	5	6	13	33
Litter	57	2	5	0
Timber	1	0	0	0
Rock	5	2	1	5
Cryptogram	2	0	1	2
Vegetation	30	90	80	60
Ground cover vegetation (% cover)				
Native ground cover- grasses	20	15	70	25
Native ground cover- shrubs	2	2	5	2
Native ground cover- other	1	1	0	2
Exotic	7	72	5	30
Vegetation cover (% cover)				
Total native groundcover	23	18	75	24
Native overstorey	30	10	10	0
Native midstorey	10	10	20	8
Exotic cover (all layers)	10	72	5	30
Slope (degrees)	3	6	8	6
Aspect	S	S	SE	SE

Table C. 3 Species recorded

Scientific name	Common name	Exotic	Recorded within trig reserve	Species of Sydney Hinterland transition woodland	Quadrat			
					1	2	3	4
<i>Acacia brownii</i>	Heath Wattle			Y			2	2
<i>Acacia decurrens</i>	Black Wattle							
<i>Acacia falcata</i>				Y	1			
<i>Acacia fimbriata</i>	Fringed Wattle						3	1
<i>Acacia hispidula</i>				Y				
<i>Acacia linifolia</i>	Flax-leaved Wattle		Y	Y	1		1	
<i>Acacia longifolia</i>				Y				
<i>Acacia myrtifolia</i>	Red-stemmed Wattle		Y	Y	1			
<i>Acacia parramattensis</i>	Parramatta Wattle		Y	Y	4	3		
<i>Acacia parvipinnula</i>				Y				
<i>Acacia saligna</i>	Golden Wreath Wattle	*						
<i>Acacia suaveolens</i>	Sweet Wattle		Y	Y				1
<i>Acacia terminalis</i>	Sunshine Wattle		Y	Y	1	1	1	1
<i>Acacia trinervata</i>				Y				
<i>Acacia ulicifolia</i>	Heath Wattle		Y	Y			2	
<i>Acianthus fornicatus</i>	Pixie Caps		Y	Y				
<i>Actinotus helianthi</i>				Y				
<i>Ageratina adenophora</i>	Crofton Weed	*	Y					
<i>Allocasuarina littoralis</i>	Black Sheoak		Y	Y	4		3	2
<i>Allocasuarina torulosa</i>								
<i>Andropogon virginicus</i>	Whisky Grass	*				2	2	2
<i>Angophora bakeri</i>	Narrow-leaved Apple		Y	Y				
<i>Angophora costata</i>	Sydney Red Gum		Y	Y	2	3	2	
<i>Anisopogon avenaceus</i>				Y				
<i>Araujia sericifera</i>	Moth Vine	*	Y					

Scientific name	Common name	Exotic	Recorded within trig reserve	Species of Sydney Hinterland transition woodland	Quadrat			
					1	2	3	4
<i>Aristida benthamii</i>				Y				
<i>Aristida vagans</i>	Threeawn Speargrass		Y	Y				
<i>Aristida warburgii</i>				Y				
<i>Astroloma humifusum</i>				Y				
<i>Astroloma pinifolium</i>				Y				
<i>Austrodanthonia fulva</i>				Y				
<i>Austrodanthonia tenuior</i>				Y				
<i>Austrostipa pubescens</i>			Y	Y				
<i>Banksia ericifolia</i>	Heath Banksia							2
<i>Banksia integrifolia</i>								2
<i>Banksia oblongifolia</i>						2		1
<i>Banksia spinulosa</i> var. <i>spinulosa</i>				Y				
<i>Billardiera scandens</i>	Appleberry		Y	Y				
<i>Boronia polygalifolia</i>			Y					
<i>Bossiaea lenticularis</i>			Y	Y				
<i>Bossiaea lenticularis</i>					1			
<i>Bossiaea obcordata</i>			Y	Y				
<i>Bossiaea rhombifolia</i> subsp. <i>rhombifolia</i>				Y				
<i>Breynia oblongifolia</i>	Coffee Bush		Y					
<i>Brunoniella pumilio</i>	Dwarf Blue Trumpet		Y	Y	1			
<i>Bursaria spinosa</i>	Native Blackthorn							
<i>Caesia parviflora</i>				Y				
<i>Callistemon linearis</i>				Y				
<i>Callistemon rigidus</i>				Y				
<i>Cassytha glabella</i>				Y				

Scientific name	Common name	Exotic	Recorded within trig reserve	Species of Sydney Hinterland transition woodland	Quadrat			
					1	2	3	4
<i>Cassytha pubescens</i>				Y				
<i>Caustis flexuosa</i>				Y				
<i>Ceratopetalum apetalum</i>	Coachwood		Y					
<i>Cheilanthes sieberi</i>				Y				
<i>Clematis aristata</i>			Y					
<i>Comesperma ericinum</i>	Pyramid flower		Y					
<i>Conyza bonariensis</i>	Flaxleaf Fleabane	*	Y					
<i>Corymbia eximia</i>				Y				
<i>Corymbia gummifera</i>	Red Bloodwood		Y	Y				
<i>Cyathochaeta diandra</i>				Y				
<i>Cynodon dactylon</i>	Common Couch					3		4
<i>Daviesia acicularis</i>				Y				
<i>Daviesia corymbosa</i>				Y	2			
<i>Daviesia genistifolia</i>	Broom Bitter Pea			Y			1	
<i>Daviesia squarrosa</i>				Y				
<i>Dianella caerulea</i>			Y	Y				
<i>Dianella prunina</i>			Y	Y		1		1
<i>Dianella revoluta</i> var. <i>revoluta</i>				Y				
<i>Dillwynia acicularis</i>				Y				
<i>Dillwynia parvifolia</i>				Y				
<i>Dillwynia retorta</i>				Y			1	
<i>Dodonaea pinnata</i>				Y				
<i>Dodonaea triquetra</i>				Y				
<i>Drosera auriculata</i>				Y				
<i>Echinopogon caespitosus</i> var. <i>caespitosus</i>				Y				

Scientific name	Common name	Exotic	Recorded within trig reserve	Species of Sydney Hinterland transition woodland	Quadrat			
					1	2	3	4
<i>Einadia hastata</i>	Berry Saltbush		Y					
<i>Entolasia stricta</i>	Wiry Panic		Y	Y	4		3	
<i>Entolasia whiteana</i>				Y				
<i>Epacris pulchella</i>	NSW Coral Heath			Y				
<i>Epacris purpurascens</i> var. <i>purpurascens</i>				Y				
<i>Eragrostis benthamii</i>				Y				
<i>Eragrostis brownii</i>	Brown's Lovegrass			Y	2		3	
<i>Eriostemon australasius</i>				Y				
<i>Eucalyptus beyeriana</i>				Y				
<i>Eucalyptus crebra</i>				Y				
<i>Eucalyptus eugenioides</i>	Thin-leaved Stringybark		Y	Y			3	
<i>Eucalyptus notabilis</i>				Y				
<i>Eucalyptus oblonga</i>	Stringybark			Y	1			
<i>Eucalyptus pilularis</i>				Y				
<i>Eucalyptus punctata</i>	Grey Gum		Y	Y	1			
<i>Eucalyptus resinifera</i> subsp. <i>resinifera</i>				Y				
<i>Eucalyptus ?saligna</i>					2			
<i>Eucalyptus scias</i> subsp. <i>scias</i>				Y				
<i>Eucalyptus sclerophylla</i>			Y	Y				
<i>Eucalyptus sparsifolia</i>	Narrow-leaved Stringybark		Y	Y				
<i>Eucalyptus squamosa</i>				Y				

Scientific name	Common name	Exotic	Recorded within trig reserve	Species of Sydney Hinterland transition woodland	Quadrat			
					1	2	3	4
<i>Exocarpos cupressiformis</i>	Native Cherry				1			
<i>Exocarpos strictus</i>	Dwarf Cherry		Y	Y				
<i>Glycine clandestina</i>			Y	Y	2			
<i>Glycine tabacina</i>			Y	Y	1			
<i>Gnaphalium</i> sp.						1		1
<i>Gompholobium glabratum</i>	Dainty Wedge Pea		Y	Y				
<i>Gompholobium grandiflorum</i>				Y				
<i>Gompholobium inconspicuum</i>				Y				
<i>Gompholobium minus</i>				Y				
<i>Gompholobium pinnatum</i>				Y				
<i>Gompholobium uncinatum</i>				Y				
<i>Gonocarpus tetragynus</i>				Y				
<i>Gonocarpus teucrioides</i>							1	
<i>Goodenia bellidifolia</i> subsp. <i>bellidifolia</i>			Y	Y				
<i>Goodenia hederacea</i> subsp. <i>hederacea</i>				Y				
<i>Goodenia heterophylla</i>			Y	Y				
<i>Grevillea buxifolia</i> subsp. <i>buxifolia</i>	Grey Spider Flower		Y	Y				
<i>Grevillea diffusa</i>				Y				
<i>Grevillea longifolia</i>				Y				
<i>Grevillea mucronulata</i>				Y				

Scientific name	Common name	Exotic	Recorded within trig reserve	Species of Sydney Hinterland transition woodland	Quadrat			
					1	2	3	4
<i>Grevillea parviflora</i> subsp. <i>parviflora</i>				Y				
<i>Grevillea phyllicoides</i>				Y				
<i>Grevillea sericea</i>				Y				
<i>Grevillea sphacelata</i>				Y				
<i>Haemodorum planifolium</i>				Y				
<i>Hakea dactyloides</i>	Broad-leaved Hakea			Y		2	2	1
<i>Hakea sericea</i>			Y	Y		2	2	2
<i>Hardenbergia violacea</i>	False Sarsaparilla		Y	Y	1			
<i>Hibbertia aspera</i> subsp. <i>aspera</i>				Y				
<i>Hibbertia circumdans</i>					2	1		
<i>Hibbertia bracteata</i>				Y				
<i>Hibbertia diffusa</i>				Y				
<i>Hibbertia serpyllifolia</i>				Y				
<i>Hibbertia</i> sp.							1	
<i>Hovea linearis</i>			Y	Y				
<i>Hybanthus monopetalus</i>				Y				
<i>Hypochaeris radicata</i>	Catsear	*			2	3	2	2
<i>Imperata cylindrica</i> var. <i>major</i>	Bladey Grass		Y	Y			2	
<i>Isopogon anemonifolius</i>				Y				
<i>Jacksonia scoparia</i>				Y				
<i>Juncus</i> sp.			Y					
<i>Kunzea ambigua</i>	Tick Bush			Y			1	

Scientific name	Common name	Exotic	Recorded within trig reserve	Species of Sydney Hinterland transition woodland	Quadrat			
					1	2	3	4
<i>Lagenifera gracilis</i>				Y				
<i>Lambertia formosa</i>	Mountain Devil			Y				
<i>Lasiopetalum ferrugineum</i>				Y				
<i>Lasiopetalum rufum</i>				Y				
<i>Laxmannia gracilis</i>				Y				
<i>Lepidosperma latens</i>				Y				
<i>Lepidosperma laterale</i>			Y	Y	1			
<i>Leptomeria acida</i>				Y				
<i>Leptospermum parvifolium</i>				Y				
<i>Leptospermum trinervium</i>				Y	3			2
<i>Leucopogon juniperinus</i>			Y				2	
<i>Leucopogon lanceolatus</i>	Lance Beard Heath		Y					
<i>Leucopogon muticus</i>				Y				
<i>Leucopogon virgatus</i>				Y				
<i>Lindsaea microphylla</i>				Y				
<i>Lissanthe sapida</i>				Y				
<i>Lissanthe strigosa</i>				Y				
<i>Lobelia gracilis</i>				Y				
<i>Logania pusilla</i>				Y				
<i>Lomandra confertifolia</i> subsp. <i>rubiginosa</i>				Y				
<i>Lomandra cylindrica</i>				Y				

Scientific name	Common name	Exotic	Recorded within trig reserve	Species of Sydney Hinterland transition woodland	Quadrat			
					1	2	3	4
<i>Lomandra filiformis</i> subsp. <i>coriacea</i>				Y				
<i>Lomandra filiformis</i> subsp. <i>filiformis</i>				Y				
<i>Lomandra glauca</i>				Y				
<i>Lomandra gracilis</i>			Y	Y				
<i>Lomandra longifolia</i>	Spiny-headed Mat-rush		Y		2		2	1
<i>Lomandra multiflora</i> subsp. <i>multiflora</i>			Y	Y				
<i>Lomandra obliqua</i>			Y	Y				
<i>Lomatia silaifolia</i>	Crinkle Bush		Y	Y				
<i>Macrozamia spiralis</i>			Y	Y				
<i>Melaleuca nodosa</i>				Y				
<i>Micrantheum ericoides</i>				Y				
<i>Mirbelia rubiifolia</i>				Y				
<i>Monotoca scoparia</i>				Y				
<i>Myrsiphyllum asparagoides</i>	Florist's Smilax	*	Y					
<i>Olearia microphylla</i>				Y				
<i>Opercularia diphylla</i>				Y				
<i>Opercularia varia</i>				Y				
<i>Oxalis perennans</i>					1			
<i>Oxylobium ilicifolium</i>	Prickly Shaggy Pea		Y		1			
<i>Ozothamnus diosmifolius</i>	White Dogwood		Y	Y	1			
<i>Pandorea pandorana</i>	Wonga Vine		Y					

Scientific name	Common name	Exotic	Recorded within trig reserve	Species of Sydney Hinterland transition woodland	Quadrat			
					1	2	3	4
<i>Panicum simile</i>	Two-colour Panic		Y	Y	2			
<i>Paspalum dilatatum</i>	Paspalum	*			2	2		2
<i>Passiflora sp.</i>	Passionfruit		Y					
<i>Patersonia glabrata</i>				Y				
<i>Patersonia longifolia</i>				Y				
<i>Patersonia sericea</i>				Y				
<i>Pennisetum clandestinum</i>	Kikuyu	*			2		2	
<i>Persoonia hirsuta</i>	Hairy Geebung			Y				
<i>Persoonia lanceolata</i>				Y				
<i>Persoonia laurina</i>				Y				
<i>Persoonia levis</i>	Broad-leaved Geebung			Y	1			
<i>Persoonia linearis</i>	Narrow-leaved Geebung		Y	Y				
<i>Persoonia oblongata</i>				Y				
<i>Persoonia pinifolia</i>				Y				
<i>Petrophile pulchella</i>				Y				
<i>Petrophile sessilis</i>				Y				
<i>Philothea hispidula</i>				Y				
<i>Phyllanthus hirtellus</i>				Y				
<i>Pimelea curviflora</i> var. <i>curviflora</i>				Y				
<i>Pimelea linifolia</i> subsp. <i>linifolia</i>				Y				
<i>Pittosporum undulatum</i>	Sweet Pittosporum		Y					
<i>Plantago lanceolata</i>	Lamb's Tongues	*				1	1	

Scientific name	Common name	Exotic	Recorded within trig reserve	Species of Sydney Hinterland transition woodland	Quadrat			
					1	2	3	4
<i>Platysace ericoides</i>				Y				
<i>Platysace lanceolata</i>			Y					
<i>Platysace linearifolia</i>				Y				
<i>Poa labillardierei</i> var. <i>labillardierei</i>			Y					
<i>Podolobium scandens</i>				Y				
<i>Polyscias sambucifolia</i>	Elderberry Panax		Y					
<i>Pomax umbellata</i>			Y	Y				
<i>Poranthera microphylla</i>			Y					
<i>Pratia purpurascens</i>	Whiteroot		Y	Y				
<i>Prostanthera howelliae</i>				Y				
<i>Pteridium esculentum</i>	Bracken		Y					
<i>Pteridium esculentum</i>	Bracken							
<i>Pterostylis acuminata</i>				Y				
<i>Pterostylis longifolia</i>				Y				
<i>Pultenaea ferruginea</i>				Y				
<i>Pultenaea microphylla</i>			Y					
<i>Pultenaea polifolia</i>				Y				
<i>Pultenaea scabra</i>			Y	Y				
<i>Pultenaea tuberculata</i>				Y				
<i>Pultenaea villosa</i>				Y				
<i>Scaevola ramosissima</i>			Y	Y				
<i>Schizaea bifida</i>				Y				

Scientific name	Common name	Exotic	Recorded within trig reserve	Species of Sydney Hinterland transition woodland	Quadrat			
					1	2	3	4
<i>Schoenus imberbis</i>				Y				
<i>Senecio madagascariensis</i>	Fireweed	*				2		2
<i>Setaria gracilis</i>	Slender Pigeon Grass	*						
<i>Sida rhombifolia</i>	Paddy's Lucerne	*	Y		1	1		1
<i>Solanum mauritianum</i>	Wild Tobacco Bush	*	Y					
<i>Solanum nigrum</i>	Black-berry Nightshade	*	Y					
<i>Sonchus oleraceus</i>	Common Sowthistle	*	Y					
<i>Stylidium</i> sp.							1	
<i>Styphelia laeta</i> subsp. <i>laeta</i>				Y				
<i>Syncarpia glomulifera</i> subsp. <i>glomulifera</i>	Turpentine		Y	Y		2	2	1
<i>Thelymitra pauciflora</i>				Y				
<i>Themeda australis</i>	Kangaroo Grass		Y	Y		3	3	3
<i>Thysanotus tuberosus</i> subsp. <i>tuberosus</i>				Y				
<i>Trachymene incisa</i> subsp. <i>incisa</i>				Y				
<i>Tricoryne simplex</i>				Y				
<i>Trifolium</i> sp.		*				2		
<i>Verbena bonariensis</i>	Purpletop	*				1		
<i>Veronica plebeia</i>	Trailing Speedwell		Y					
<i>Vicia sativa</i>		*				2		1
<i>Wahlenbergia stricta</i>	Tall Bluebell							
<i>Xanthorrhoea concava</i>				Y				

Scientific name	Common name	Exotic	Recorded within trig reserve	Species of Sydney Hinterland transition woodland	Quadrat			
					1	2	3	4
<i>Xanthorrhoea media</i>				Y				
<i>Xanthorrhoea minor subsp. minor</i>				Y				
<i>Xanthorrhoea resinifera</i>				Y				
<i>Xanthorrhoea sp.</i>	Grass tree		Y					
<i>Xanthosia pilosa</i>				Y				
<i>Xanthosia tridentata</i>				Y				
<i>Xylomelum pyriforme</i>	Woody Pear		Y	Y				
?Unknown native (rosette)						1		

Notes:

Cover abundance scores:

1. 5%- rare or few individuals
2. <5% common
3. 5-25%
4. 25-50%
5. 50-75%
6. 75-100%

Chapter Eight

SOCIAL IMPACT MANAGEMENT

Community representatives participate in the Community Consultative Committee which has met twice during the year. Minutes of these meetings are included as **Attachment 8A**.

**Community Consultative Committee
Hitchcock Road and Lot 198 Maroota
Sand Extraction and Rehabilitation Projects**

**Minutes
11 November 2010**

Attendance

Kristine McKenzie – Baulkham Hills Shire Council (BHSC) - Chairperson
Robert Buckham – Baulkham Hills Shire Council (BHSC)
Daniel Giffney – Baulkham Hills Shire Council (BHSC)
David Gathercole – Department of Environment, Climate Change & Water
Marianne Sheumack – Resident
Shaunagh Hitchcock – Resident
John Graham – PF Formation
Peter Cummins – PF Formation
Joshua Graham – PF Formation

Apology: Kane Winwood – NSW Department of Planning

Minutes of Previous Meeting

- Accepted

Report on Current Status of Operations by John Graham

- Operations have continued in a routine manner
- A major focus has been on rehabilitation in the last 6 months. After receiving advice from Greening Australia an area of 1.5 hectares is being prepared to be seeded. The seeds have been acquired from what Greening Australia had previously collected on site and also from a local nursery. Soil is being translocated to the site and when fully prepared the seeds will be planted.
- Parsons Brinkerhoff ('PB') visited the site in July 2010 to inspect the 3 hectares previously planted. They selected 7 (20x20 metre) quadrants and analysed the results against the criteria for monitoring the success of rehabilitation. In general the rehabilitation areas appeared to be regenerating well. Shrub cover was less than hoped and recommendations were made to supplement planting, erosion and weed control. They also recommended that monitoring not occur for another 2 years. Most recommendations have already been implemented. Supplemental planting occurred in October and further planting will occur in Autumn.
- One complaint was made in the period by someone who didn't leave any details. They rang to comment on the pipe blowing near the intersection of Wisemans Ferry Road which had resulted in sand across the intersection on Wisemans Ferry Road. The area was cleaned with the water truck and nothing left the site. We have had problems with our pipeline and we believe one of the automatic flowmeters has been faulty. A new flowmeter has been ordered but is coming from overseas. (*now received and installed*)

Reporting

- The Landscape Management Plan was approved by the Department of Planning (DOP) on 26 August 2010. All management plans have now been approved by the DOP.
- The PF Formation Planner, David Fingland, has retired and PF Formation is still looking for a replacement
- The Annual Environmental Management Report for the year to 30 June 2010 has been completed and sent to DOP and Department of Environment, Climate Change and Water. A copy is on the website www.pfformation.com.au for anyone else to read or PF Formation can provide a CD copy. In summary the management plans seem to be operating well and no major environmental issues were highlighted in the report.
- An audit environmental audit is required under the Approval. After considerable difficulty identifying anyone acceptable to undertake this audit the DOP approved Bruce Adcock from Environmental Planning.

Other Matters

- Dangerous truck driving was noted. PF Formation to make a notice to put in the weighbridge to remind drivers to consider residents in particular in the area before Cattai Bridge.
- A new representative for Maroota Primary School has been found to attend the Dixon Sands Community Meetings replacing Marianne Scheumack. Marianne to advise PF Formation of contact details when advised.
- Monthly dust deposit results were reviewed. It was noted that PF Formation had not received any notification from Dixon Sands of the TEOM dust trigger levels being reached.

Site Visit

- A full site inspection including the Lot 1 DP595538 Old Northern Road Maroota site was conducted. Resident members were unable to attend

Next Meeting

- 10.00 am Tuesday 3 May 2011

**Community Consultative Committee
Hitchcock Road and Lot 198 Maroota
Sand Extraction and Rehabilitation Projects**

**Minutes
3 May 2011**

Attendance

Kristine McKenzie – Baulkham Hills Shire Council (BHSC) - Chairperson
Robert Buckham – Baulkham Hills Shire Council (BHSC)
Marianne Sheumack – Resident
Shaunagh Hitchcock – Resident
John Graham – PF Formation
Peter Cummins – PF Formation
Joshua Graham – PF Formation

Absent: Kane Winwood – NSW Department of Planning
Daniel Giffney – Baulkham Hills Shire Council (BHSC)
David Gathercole – Department of Environment, Climate Change & Water

Minutes of Previous Meeting

- Accepted

Report on Current Status of Operations by John Graham

- Operations have continued in a routine manner
- Maintenance of the rehabilitation area has continued to be a main focus on the site. Parsons Brinkerhoff ('PB') quadrant surveys in 2010 recommended some supplemental planting to increase the species variety. Approximately 1,200 plants have been hand planted in the last six months as well as significant weed control measures.
- Seeds have been acquired to rehabilitate an area of 1.5 hectares. The landscape has been prepared but PF Formation needs to relocate some soil and then plant the seeds before summer.
- A fault in our flowmeter caused issues in the past with too much pressure in our pipeline. A new flowmeter has been purchased from overseas and installed. The faulty flowmeter is being reconditioned so that it can be kept in stock to minimize any future disruption with the new flowmeter.

Review of Site Map

- The current extraction areas and rehabilitation areas were reviewed on a map

Reporting

- The independent environmental audit (IEA) has been completed by Environmental Planning Pty Ltd and a copy given to PF Formation in the last week. Within 6 weeks PF Formation is to forward a copy of the IEA Report and its response to

recommendations to the Planning Department. Within 3 months of submitting this copy PF Formation is required to update the environmental management and monitoring strategies/plans/programs and rehabilitation bonds to the satisfaction to the Director-General of the Planning Department.

- Extracts from the IEA Report being the Audit Conclusions and Audit Recommendations were handed out and each item was briefly discussed.
- The full report and PF Formation's response will be put on the website within 6 weeks.

Environmental Matters

- The monthly dust deposit results were handed out and discussed.
- It was noted that the site 'Vuck's House' is actually on Dixon's property next to their monitor at the site closest to the intersection of Hitchcock Road and Wisemans Ferry Road.
- Most monthly results were low but it was noted that February had the highest result at each location for the last 6 months.

Other Matters

- Truck accidents in the region were discussed. John Graham explained how the utmost care and responsibility is taken by PF Formation to the extent it can. Clearly little control exists over legal vehicles once they leave the site.
- As a general comment drivers appear to be getting more mindful of their responsibilities because most are employed by bigger companies who have their own safety and legal responsibilities.
- In a recent case where a dog trailer rolled over at Maroota a letter the transport company discussed with their staff was read out. It also noted that the driver had his employment terminated. The seriousness of the situation and the effort to have drivers act in a responsible matter was made clear.
- A new representative for Maroota Primary School has been found to attend the Dixon Sands Community Meetings replacing Marianne Scheumack. Kristine McKenzie is to see if she has Peter Hawkins contact details and she or Peter Cummins are to investigate whether he would be willing to attend the PF Formation meetings representing the residents.

Site Visit

- A site inspection including the Lot 1 DP595538 Old Northern Road Maroota site was conducted.

Next Meeting

- 10.00 am Wednesday 2 November 2011