



PATTLE DELAMORE PARTNERS LTD

Tui Mine Water Quality Monitoring Report 2012 - 2013: Water Quality Monitoring from Tui Mine (Adits 4 and 5)

Waikato Regional Council



Tui Mine Water Quality Monitoring Report 2012 – 2013: Water Quality Monitoring from Tui Mine (Adits 4 and 5)

∴ Prepared for
Waikato Regional Council

∴ February 2013



PATTLE DELAMORE PARTNERS LTD

Level 4, PDP House
235 Broadway, Newmarket, Auckland 1023
PO Box 9528, Auckland 1149, New Zealand

Tel +9 523 6900 Fax +9 523 6901
Web Site <http://www.pdp.co.nz>
Auckland Wellington Christchurch



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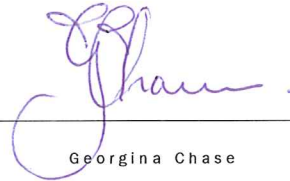
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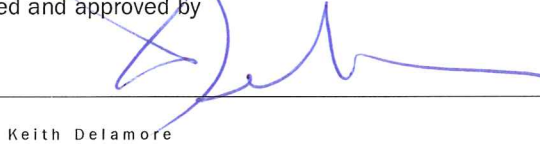
Andrew Rumsby



Georgina Chase

Directed, reviewed and approved by

SIGNATURE



Keith Delamore

Limitations:

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Executive Summary

Waikato Regional Council (WRC) has commissioned Pattle Delamore Partners Ltd (PDP) to undertake additional water quality monitoring from Adits 4 and 5 of the disused Tui Mine, Mt Te Aroha.

During 2012-2013 three rounds of monitoring were undertaken on the water quality being discharged from Adit 4 (sample location SW3) and Adit 5 (sample location SW5). The monitoring was undertaken to assist Waikato Regional Council in assessing the effectiveness of remedial work aimed to reduce the mass load of trace elements being discharged in water seeping from the underground workings at the Tui Mine Site. Remedial works in level 4 and level 5 of the Tui Mine were underway during the monitoring period.

Three rounds of water quality sampling were undertaken by PDP in August 2012, December 2012 and January 2013.

The results of the water quality sampling are presented in this report.

Table of Contents

SECTION	PAGE
Executive Summary	ii
1.0 Introduction	1
2.0 Sampling Methodology	2
2.1 Field Sampling Locations	2
2.2 Sampling Techniques	2
2.3 Field Measurements	2
2.4 Flow Monitoring Procedures	3
3.0 Monitoring Results	3
3.1 Quality Assurance/Quality Control	3
4.0 References	4

Table of Tables

Table 1: Tui Baseline Water Quality Monitoring Sites and Parameters for 2012	2
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Appendices

Appendix A: Figure

Appendix B: Tables

Appendix C: Laboratory Reports

1.0 Introduction

Waikato Regional Council (WRC) has commissioned Pattle Delamore Partners Ltd (PDP) to undertake additional water quality monitoring from Adits 4 and 5 of the disused Tui Mine, Mt Te Aroha. Three rounds of water quality sampling were undertaken by PDP in August 2012, December 2012 and January 2013.

During the monitoring rounds, work was underway at the mine site on Phase 1 and Phase 2 of the remedial works, which are aimed at reducing the mass load of trace elements being discharged from the underground workings at the Tui Mine Site, and at stabilising the tailing dam site. Remedial works in level 4 and level 5 of the Tui Mine were still underway during the monitoring period.

According to information received from Tonkin and Taylor (Tonkin and Taylor, 2012) , remedial works during this monitoring period included dewatering of Adit 4, which occurred from 13 September to 28 September 2012 and injection of 20 tonnes of lime just behind coffer dam 2 on the 25 to 25 September 2012. Work was also undertaken to divert the flows with the poorest water quality from behind coffer dam 2 into race 3.

The work undertaken by PDP included:

- ∴ The collection, analysis and interpretation of water quality samples over three monitoring rounds; and
- ∴ The measurements of stream flow at each of the water quality sample locations during each of the three monitoring rounds.

A similar methodology was used by PDP during this monitoring period as was used by PDP in the October 2009 baseline monitoring of the site, when a series of monitoring rounds were undertaken at the mine site prior to remedial works (see PDP 2010).

2.0 Sampling Methodology

2.1 Field Sampling Locations

Water quality samples were collected from the baseline monitoring locations on the discharges of the Tui Mine as outlined in Table 1 below.

Site Label	Site Description	Laboratory Parameters
SW3	Adit 4 outlet (discharges to Tunakohoia Stream, north branch).	pH, EC, Cation Anion Profile, Total Acidity, dissolved and total iron, dissolved cadmium, dissolved manganese and dissolved zinc.
SW5	Adit 5 outlet (discharges to Tunakohoia Stream, north branch).	pH, EC, Cation Anion Profile, Total Acidity, dissolved and total iron, dissolved cadmium, dissolved manganese and dissolved zinc.

2.2 Sampling Techniques

PDP collected water samples during all of the 2012 monitoring events under either low or moderate flow conditions, as this allowed the results to be compared to the baseline monitoring round as well as minimising the risk to health and safety of staff working within the water ways. To ensure stream flow conditions were met, PDP staff monitored the weather forecast from MetService and examined rainfall records from the Te Aroha rain-gauge via the WRC website.

At each monitoring site, water samples were collected before any field measurements and flow monitoring had been undertaken, to prevent disturbance of sediments which could potentially affect the water quality.

Samples were collected and stored in the appropriate sample bottles which had been supplied and certified clean by the analysing laboratory. Each sample bottle was uniquely identified in accordance with PDP chain of custody and sampling labelling procedure.

After collection, the water samples were sent under standard PDP chain of custody documentation to the appropriate laboratories as soon as possible. This was to ensure the laboratories received the samples within the required hold times and to ensure sample integrity was maintained.

2.3 Field Measurements

To measure field parameters, a Horiba multi-parameter water quality U-50 series system (physicochemical parameters: dissolved oxygen, electrical conductivity, pH, redox potential, temperature and turbidity) was used.

Prior to each sampling round, the field instrument was calibrated against NIST traceable standards as per the manufacturer's instructions. This was in accordance with good laboratory practices (GLP) as detailed in USEPA and APHA/ AWWA/ WEF "Standard Methods for the Examination of Water and Waste Water" (21st edition). This was done to minimise any sampling variability between the current monitoring round and the sampling undertaken during the baseline monitoring round. Between monitoring locations, the sensor of the meter was rinsed with Type 1 water (deionised water) and the field meter was checked against a manufacturer's quick-calibration solution (electrical conductivity, pH, redox and turbidity) and/or air saturation readings (dissolved oxygen).

2.4 Flow Monitoring Procedures

An estimate of the volume of water being discharged from the mine adits was undertaken using volumetric techniques using a stopwatch and measuring jug.

3.0 Monitoring Results

The monitoring results are shown in Tables B1 and B2 in Appendix B. It should be noted that during the January 2013 monitoring round that analytical interferences could have potentially resulted in incorrect readings for electrical conductivity and sulphate analysis (see Hills Laboratory report in Appendix C for more details). The nature and extent of the interferences is currently unknown. But it should be noted that field readings for electrical conductivity and historical results for both electrical conductivity and sulphate are similar to the reported laboratory results.

3.1 Quality Assurance/Quality Control

Quality Assurance and quality controls (QA/QC) samples (duplicates) were collected as part of each monitoring round. The results of the QA/QC monitoring undertaken as part of this project are presented in Table B3 in Appendix B. All QA/QC samples meet the QA/QC criteria for the project.

4.0 References

APHA/AWWA/WEF, 2005. Standard methods for the examination of water and wastewater. 21st Edition. American Public Health Association, American Waste and Wastewater Association, Water environment federation.

Australian / New Zealand Standard AS/NZS 5667.1 1998. Water quality - Sampling - Guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples.

Australian / New Zealand Standard AS/NZS 5667.6 1998. Water quality - Guidance on sampling of rivers and streams.

Ministry for the Environment, 2011: Contaminated Land Management Guidelines No. 5: Soil Investigation and Analysis of Soils. Ministry for the Environment, Wellington.

PDP, 2010. Tui Remedial Works: Baseline Monitoring Report. Prepared for Environment Waikato, 2010.

Tonkin & Taylor, 2012 Personal Communications to PDP received 31 October 2012.

Appendix B

Tables

Tables

Tui Mine Water Quality Monitoring Report 2012-2013: Water Quality Monitoring From Tui Mine (Adit 4 and 5)

Table B1: Water Quality Results for Tui Mine Baseline Monitoring at SW3				
Sample No.		SW3	SW3	SW3
Sampled By		PDP	PDP	PDP
Sampling date		15/8/12	11/12/12	18/1/13
Laboratory Number		1036699.1	1080595.1	1091666.1
Flow Rate	L/s	4.7	0.6	0.5
Flow Rate	m ³ /sec	0.0047	0.0006	0.0005
Field:				
Temperature	(°C)	10.28	12.16	12.19
pH	pH units	6.38	6.34	6.6
Conductivity	mS/m	18.6	22.8	24.7
ORP	mV	160	376	349
Dissolved Oxygen	mg/L	9.57	11.13	12.17
Turbidity	NTU	39.3	3.4	9.4
Laboratory:				
pH	pH units	6.0	7.0	7.2
Conductivity	mS/m	24.5	19.9	23.4
Anions	meq	2.5	1.98	2.4
Cations	meq	2.3	1.9	2.1
Alkalinity	g/m ³ as CaCO ₃	10.0	44	49
Acidity	g/m ³ as CaCO ₃	54	9.8	12.2
Bicarbonate	g/m ³ at 25°C	12.2	54	60
Total Hardness	g/m ³ as CaCO ₃	47	73	81
Calcium	g/m ³	12.5	22	24
Magnesium	g/m ³	3.9	4.5	5.1
Potassium	g/m ³	<1.0	< 1.0	<1.0
Sodium	g/m ³	6.1	6.5	6.2
Chloride	g/m ³	8.3	9.3	8.3
Nitrite-N	g/m ³	< 0.002	< 0.002	<0.002
Nitrate-N	g/m ³	0.194	0.125	0.075
Nitrate-N+Nitrite-N	g/m ³	0.194	0.125	0.075
Sulphate	g/m ³	96	40	54
Metals:				
Iron Dissolved	g/m ³	<0.4	< 0.4	<0.4
Iron Total Recoverable	g/m ³	1.46	0.59	0.80
Magnesium Dissolved	g/m ³	3.9	4.5	5.1
Manganese Dissolved	g/m ³	0.44	0.194	0.29
Zinc Dissolved	g/m ³	33	4.5	7.7

Tui Mine Water Quality Monitoring Report 2012-2013: Water Quality Monitoring From Tui Mine (Adit 4 and 5)

Table B2: Water Quality Results for Tui Mine Baseline Monitoring at SW5				
Sample No.		SW5	SW5	SW5
Sampled By		PDP 2012	PDP 2012	PDP2012
Sampling date		15/8/2012	12/11/2012	18/1/2013
Laboratory Number		1036699.3	1080595.2	1091666.2
Flow Rate	L/s	1.7	2.1	3.3
Flow rate	m ³ /sec	0.0017	0.0021	0.0033
Field:				
Temperature	(°C)	12.32	12.61	13.9
pH	pH units	6.80	6.62	6.44
Conductivity	mS/m	145	21.1	203
ORP	mV	-9	245	16.2
Dissolved Oxygen	mg/L	8.38	8.15	11.6
Turbidity	NTU	0.0	127.0	78.8
Laboratory:				
pH (pH units)	pH units	6.9	6.8	6.7
Conductivity	mS/m	169.9	217	212
Anions	meq	24	31	36
Cations	meq	24	29	28
Alkalinity	g/m ³ as CaCO ₃	114	118	119
Acidity	g/m ³ as CaCO ₃	37	66	55
Bicarbonate	g/m ³ at 25°C	139	144	145
Total Hardness	g/m ³ as CaCO ₃	1080	1300	1280
Calcium	g/m ³	350	420	410
Magnesium	g/m ³	50	61	61
Potassium	g/m ³	1.7	1.8	2.0
Sodium	g/m ³	25	28	27
Chloride	g/m ³	9.7	10.4	9.9
Nitrite-N	g/m ³	0.008	0.012	<0.02
Nitrate-N	g/m ³	0.006	0.031	0.04
Nitrate-N + Nitrite-N	g/m ³	0.014	0.043	0.04
Sulphate	g/m ³	1010	1360	1580
Metals:				
Cadmium Dissolved	g/m ³	0.0141	0.026	0.020
Iron Dissolved	g/m ³	9.9	14.7	16.200
Iron Total Recoverable	g/m ³	12.5	18.6	19.5
Manganese Dissolved	g/m ³	5.5	7.4	7.5
Zinc Dissolved	g/m ³	12.9	17.7	16.4

Tui Mine Water Quality Monitoring Report 2012-2013: Water Quality Monitoring From Tui Mine (Adit 4 and 5)

Table B3: Results of Duplicate Analysis and Calculated Relative Percentage Difference (RPD) Between Duplicates Samples

Sampling Round		August 2012 Monitoring Round			Decemeber 2012Monitoring Round			January 2013 Monitoring Round		
Sample No.		SW5	SW2		SW5	BHC		SW3	SWA	
Sampling Date		15-Aug-12	15-Aug-12		11-Dec-12	11-Dec-12		18-Jan-13	18-Jan-13	
Laboratory Number		1036699.2	1036699.3	RPD	1080595.2	1080595.3	RPD	1091666.2	1091666.3	RPD
Sum of Anions	meq/L	24	23	4.3%	31	31	0.0%	2.4	2.4	0.0%
Sum of Cations	meq/L	24	23	4.3%	29	30	-3.4%	2.1	2.2	-4.7%
pH	pH Units	6.9	6.9	0.0%	6.8	6.8	0.0%	7.2	7.2	0.0%
Total Acidity (pH 8.3)	g/m ³ as CaCO ₃	37	39	-5.3%	66	66	0.0%	12.2	11.2	8.5%
Total Alkalinity	g/m ³ as CaCO ₃	114	115	-0.9%	118	119	-0.8%	49	51	-4.0%
Bicarbonate	g/m ³ at 25°C	139	140	-0.7%	144	145	-0.7%	60	62	-3.3%
Total Hardness	g/m ³ as CaCO ₃	1080	1060	1.9%	1300	1370	-5.2%	81	84	-3.6%
Electrical Conductivity (EC)	mS/m	169.9	169.4	0.3%	217	216	0.5%	23.4	23.3	0.4%
Dissolved Cadmium	g/m ³	0.0141	0.0141	0.0%	0.026	0.026	0.0%	0.054	0.054	0.0%
Dissolved Calcium	g/m ³	350	340	2.9%	420	440	-4.7%	24	25	-4.1%
Dissolved Iron	g/m ³	9.9	9.9	0.0%	14.7	15.4	-4.7%	< 0.4	< 0.4	NC ¹
Total Iron	g/m ³	12.5	12.6	-0.8%	18.6	18.4	1.1%	0.80	0.78	2.5%
Dissolved Magnesium	g/m ³	50	50	0.0%	61	65	-6.3%	5.1	5.2	-1.9%
Dissolved Manganese	g/m ³	5.5	5.5	0.0%	7.4	7.7	-4.0%	0.29	0.29	0.0%
Dissolved Potassium	g/m ³	1.7	1.6	6.1%	1.8	1.9	-5.4%	< 1.0	< 1.0	NC ¹
Dissolved Sodium	g/m ³	25	25	0.0%	28	28	0.0%	6.2	6.2	0.0%
Dissolved Zinc	g/m ³	12.9	12.8	0.8%	17.7	18.2	-2.8%	7.7	7.6	1.3%
Chloride	g/m ³	9.7	9.7	0.0%	10.4	10.3	1.0%	8.3	8.3	0.0%
Nitrite-N	g/m ³	0.008	0.007	13.3%	0.012	0.013	-8.0%	< 0.002	< 0.002	NC ¹
Nitrate-N	g/m ³	0.006	0.008	-28.6%	0.031	< 0.002	NC ¹	0.075	0.077	-2.6%
Nitrate-N + Nitrite-N	g/m ³	0.014	0.015	-6.9%	0.043	0.013	107.1%	0.075	0.078	-3.9%
Sulphate	g/m ³	1010	1000	1.0%	1360	1360	0.0%	54	54	0.0%

Notes

NC ¹	Not calculated. Relative percentage difference not calculated if one or more of the results are below the analytical detection limit.
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ANALYSIS REPORT

Client:	Pattle Delamore Partners Ltd	Lab No:	1036699	SPv2
Contact:	A Rumsby C/- Pattle Delamore Partners Ltd PO Box 9528 Newmarket AUCKLAND 1149	Date Registered:	17-Aug-2012	
		Date Reported:	23-Aug-2012	
		Quote No:	50788	
		Order No:		
		Client Reference:	AO2277609	
		Submitted By:	G Sheridan	

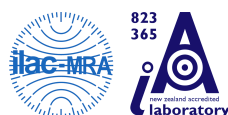
Sample Type: Aqueous

Sample Name:		SW3	SW5	SW2		
Lab Number:		15-Aug-2012	15-Aug-2012	15-Aug-2012		
		1036699.1	1036699.2	1036699.3		
Sum of Anions	meq/L	2.5	24	23	-	-
Sum of Cations	meq/L	2.3	24	23	-	-
pH	pH Units	6.0	6.9	6.9	-	-
Total Acidity (pH 8.3)	g/m ³ as CaCO ₃	54	37	39	-	-
Total Alkalinity	g/m ³ as CaCO ₃	10.0	114	115	-	-
Bicarbonate	g/m ³ at 25°C	12.2	139	140	-	-
Total Hardness	g/m ³ as CaCO ₃	47	1,080	1,060	-	-
Electrical Conductivity (EC)	mS/m	24.5	169.9	169.4	-	-
Dissolved Cadmium	g/m ³	0.25	0.0141	0.0141	-	-
Dissolved Calcium	g/m ³	12.5	350	340	-	-
Dissolved Iron	g/m ³	< 0.4	9.9	9.9	-	-
Total Iron	g/m ³	1.46	12.5	12.6	-	-
Dissolved Magnesium	g/m ³	3.9	50	50	-	-
Dissolved Manganese	g/m ³	0.44	5.5	5.5	-	-
Dissolved Potassium	g/m ³	< 1.0	1.7	1.6	-	-
Dissolved Sodium	g/m ³	6.1	25	25	-	-
Dissolved Zinc	g/m ³	33	12.9	12.8	-	-
Chloride	g/m ³	8.3	9.7	9.7	-	-
Nitrite-N	g/m ³	< 0.002	0.008	0.007	-	-
Nitrate-N	g/m ³	0.194	0.006	0.008	-	-
Nitrate-N + Nitrite-N	g/m ³	0.194	0.014	0.015	-	-
Sulphate	g/m ³	96	1,010	1,000	-	-

SUMMARY OF METHODS

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.

Sample Type: Aqueous			
Test	Method Description	Default Detection Limit	Samples
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-3
Total Digestion	Boiling nitric acid digestion. APHA 3030 E 21 st ed. 2005.	-	1-3
Total anions for anion/cation balance check	Calculation: sum of anions as mEq/L.	0.07 meq/L	1-3
Total cations for anion/cation balance check	Calculation: sum of cations as mEq/L.	0.05 meq/L	1-3
pH	pH meter. APHA 4500-H+ B 21 st ed. 2005.	0.1 pH Units	1-3
Total Acidity (pH 8.3)	Titration to pH 8.3 with standard sodium hydroxide solution, phenolphthalein indicator. APHA 2310 B (modified) 21 st ed. 2005.	1.0 g/m ³ as CaCO ₃	1-3
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. APHA 2320 B (Modified for alk <20) 21 st ed. 2005.	1.0 g/m ³ as CaCO ₃	1-3



This Laboratory is accredited by International Accreditation New Zealand (IANZ), which represents New Zealand in the International Laboratory Accreditation Cooperation (ILAC). Through the ILAC Mutual Recognition Arrangement (ILAC-MRA) this accreditation is internationally recognised.

The tests reported herein have been performed in accordance with the terms of accreditation, with the exception of tests marked *, which are not accredited.

Sample Type: Aqueous			
Test	Method Description	Default Detection Limit	Samples
Bicarbonate	Calculation: from alkalinity and pH, valid where TDS is not >500 mg/L and alkalinity is almost entirely due to hydroxides, carbonates or bicarbonates. APHA 4500-CO ₂ D 21 st ed. 2005.	1.0 g/m ³ at 25°C	1-3
Total Hardness	Calculation from Calcium and Magnesium. APHA 2340 B 21 st ed. 2005.	1.0 g/m ³ as CaCO ₃	1-3
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 21 st ed. 2005.	0.1 mS/m	1-3
Dissolved Cadmium	Filtered sample, ICP-MS, screen level. APHA 3125 B 21 st ed. 2005.	0.0010 g/m ³	1-3
Dissolved Calcium	Filtered sample, ICP-MS, screen level. APHA 3125 B 21 st ed. 2005.	1.0 g/m ³	1-3
Dissolved Iron	Filtered sample, ICP-MS, screen level. APHA 3125 B 21 st ed. 2005.	0.4 g/m ³	1-3
Total Iron	Nitric acid digestion, ICP-MS, screen level. APHA 3125 B 21 st ed. 2005.	0.42 g/m ³	1-3
Dissolved Magnesium	Filtered sample, ICP-MS, screen level. APHA 3125 B 21 st ed. 2005.	0.4 g/m ³	1-3
Dissolved Manganese	Filtered sample, ICP-MS, screen level. APHA 3125 B 21 st ed. 2005.	0.010 g/m ³	1-3
Dissolved Potassium	Filtered sample, ICP-MS, screen level. APHA 3125 B 21 st ed. 2005.	1.0 g/m ³	1-3
Dissolved Sodium	Filtered sample, ICP-MS, screen level. APHA 3125 B 21 st ed. 2005.	0.4 g/m ³	1-3
Dissolved Zinc	Filtered sample, ICP-MS, screen level. APHA 3125 B 21 st ed. 2005.	0.02 g/m ³	1-3
Chloride	Filtered sample. Ferric thiocyanate colorimetry. Discrete Analyser. APHA 4500 Cl ⁻ E (modified from continuous flow analysis) 21 st ed. 2005.	0.5 g/m ³	1-3
Nitrite-N	Automated Azo dye colorimetry, Flow injection analyser. APHA 4500-NO ₂ ⁻ I (Modified) 21 st ed. 2005.	0.002 g/m ³	1-3
Nitrate-N	Calculation: (Nitrate-N + Nitrite-N) - NO ₂ N.	0.002 g/m ³	1-3
Nitrate-N + Nitrite-N	Total oxidised nitrogen. Automated cadmium reduction, flow injection analyser. APHA 4500-NO ₃ ⁻ I (Modified) 21 st ed. 2005.	0.002 g/m ³	1-3
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B 21 st ed. 2005.	0.5 g/m ³	1-3

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.

This report must not be reproduced, except in full, without the written consent of the signatory.



Carole Rodgers-Carroll BA, NZCS
Client Services Manager - Environmental Division



ANALYSIS REPORT

Client:	Pattle Delamore Partners Ltd	Lab No:	1091666	SPv2
Contact:	A Rumsby C/- Pattle Delamore Partners Ltd PO Box 9528 Newmarket AUCKLAND 1149	Date Registered:	22-Jan-2013	
		Date Reported:	31-Jan-2013	
		Quote No:	50788	
		Order No:		
		Client Reference:	AO2277609	
		Submitted By:	A Rumsby	

Sample Type: Aqueous

	Sample Name:	SW5 18-Jan-2013	SW3 18-Jan-2013	SWA 18-Jan-2013		
	Lab Number:	1091666.1	1091666.2	1091666.3		
Sum of Anions	meq/L	36 #1	2.4	2.4	-	-
Sum of Cations	meq/L	28 #1	2.1	2.2	-	-
pH	pH Units	6.7	7.2	7.2	-	-
Total Acidity (pH 8.3)	g/m ³ as CaCO ₃	55	12.2	11.2	-	-
Total Alkalinity	g/m ³ as CaCO ₃	119	49	51	-	-
Bicarbonate	g/m ³ at 25°C	145	60	62	-	-
Total Hardness	g/m ³ as CaCO ₃	1,280	81	84	-	-
Electrical Conductivity (EC)	mS/m	212 #1	23.4	23.3	-	-
Dissolved Cadmium	g/m ³	0.020	0.054	0.054	-	-
Dissolved Calcium	g/m ³	410	24	25	-	-
Dissolved Iron	g/m ³	16.2	< 0.4	< 0.4	-	-
Total Iron	g/m ³	19.5	0.80	0.78	-	-
Dissolved Magnesium	g/m ³	61	5.1	5.2	-	-
Dissolved Manganese	g/m ³	7.5	0.29	0.29	-	-
Dissolved Potassium	g/m ³	2.0	< 1.0	< 1.0	-	-
Dissolved Sodium	g/m ³	27	6.2	6.2	-	-
Dissolved Zinc	g/m ³	16.4	7.7	7.6	-	-
Chloride	g/m ³	9.9	8.3	8.3	-	-
Nitrite-N	g/m ³	< 0.02	< 0.002	< 0.002	-	-
Nitrate-N	g/m ³	0.04	0.075	0.077	-	-
Nitrate-N + Nitrite-N	g/m ³	0.04	0.075	0.078	-	-
Sulphate	g/m ³	1,580 #1	54	54	-	-

Analyst's Comments

Supplement to test report 1091666.1 v1 issued on 30-Jan-2013.

#1 It was observed that the results for 'Sum of Anions', 'Sum of Cations' and Electrical Conductivity were not in good agreement. It is thought that the conductivity has been suppressed due to the high levels of calcium sulphate, and the 'Sum of Anions' may have been overestimated due to a positive interference on sulphate analysis.

SUMMARY OF METHODS

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Samples
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-3
Total Digestion	Boiling nitric acid digestion. APHA 3030 E 21 st ed. 2005.	-	1-3
Total anions for anion/cation balance check	Calculation: sum of anions as mEq/L.	0.07 meq/L	1-3



Sample Type: Aqueous			
Test	Method Description	Default Detection Limit	Samples
Total cations for anion/cation balance check	Calculation: sum of cations as mEq/L.	0.05 meq/L	1-3
pH	pH meter. APHA 4500-H+ B 21 st ed. 2005.	0.1 pH Units	1-3
Total Acidity (pH 8.3)	Titration to pH 8.3 with standard sodium hydroxide solution, phenolphthalein indicator. APHA 2310 B (modified) 21 st ed. 2005.	1.0 g/m ³ as CaCO ₃	1-3
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. APHA 2320 B (Modified for alk <20) 21 st ed. 2005.	1.0 g/m ³ as CaCO ₃	1-3
Bicarbonate	Calculation: from alkalinity and pH, valid where TDS is not >500 mg/L and alkalinity is almost entirely due to hydroxides, carbonates or bicarbonates. APHA 4500-CO ₂ D 21 st ed. 2005.	1.0 g/m ³ at 25°C	1-3
Total Hardness	Calculation from Calcium and Magnesium. APHA 2340 B 21 st ed. 2005.	1.0 g/m ³ as CaCO ₃	1-3
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 21 st ed. 2005.	0.1 mS/m	1-3
Dissolved Cadmium	Filtered sample, ICP-MS, screen level. APHA 3125 B 21 st ed. 2005.	0.0010 g/m ³	1-3
Dissolved Calcium	Filtered sample, ICP-MS, screen level. APHA 3125 B 21 st ed. 2005.	1.0 g/m ³	1-3
Dissolved Iron	Filtered sample, ICP-MS, screen level. APHA 3125 B 21 st ed. 2005.	0.4 g/m ³	1-3
Total Iron	Nitric acid digestion, ICP-MS, screen level. APHA 3125 B 21 st ed. 2005.	0.42 g/m ³	1-3
Dissolved Magnesium	Filtered sample, ICP-MS, screen level. APHA 3125 B 21 st ed. 2005.	0.4 g/m ³	1-3
Dissolved Manganese	Filtered sample, ICP-MS, screen level. APHA 3125 B 21 st ed. 2005.	0.010 g/m ³	1-3
Dissolved Potassium	Filtered sample, ICP-MS, screen level. APHA 3125 B 21 st ed. 2005.	1.0 g/m ³	1-3
Dissolved Sodium	Filtered sample, ICP-MS, screen level. APHA 3125 B 21 st ed. 2005.	0.4 g/m ³	1-3
Dissolved Zinc	Filtered sample, ICP-MS, screen level. APHA 3125 B 21 st ed. 2005.	0.02 g/m ³	1-3
Chloride	Filtered sample. Ferric thiocyanate colorimetry. Discrete Analyser. APHA 4500 Cl- E (modified from continuous flow analysis) 21 st ed. 2005.	0.5 g/m ³	1-3
Nitrite-N	Automated Azo dye colorimetry, Flow injection analyser. APHA 4500-NO ₂ - I (Modified) 21 st ed. 2005.	0.002 g/m ³	1-3
Nitrate-N	Calculation: (Nitrate-N + Nitrite-N) - NO ₂ N.	0.002 g/m ³	1-3
Nitrate-N + Nitrite-N	Total oxidised nitrogen. Automated cadmium reduction, flow injection analyser. APHA 4500-NO ₃ - I (Modified) 21 st ed. 2005.	0.002 g/m ³	1-3
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B 21 st ed. 2005.	0.5 g/m ³	1-3

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.

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Carole Rodgers-Carroll BA, NZCS
Client Services Manager - Environmental Division



ANALYSIS REPORT

Client:	Pattle Delamore Partners Ltd	Lab No:	1080595	SPv2
Contact:	A Rumsby C/- Pattle Delamore Partners Ltd PO Box 9528 Newmarket AUCKLAND 1149	Date Registered:	12-Dec-2012	
		Date Reported:	21-Dec-2012	
		Quote No:	50788	
		Order No:		
		Client Reference:	AO2277609	
		Submitted By:	G Sheridan	

Sample Type: Aqueous

Sample Name:		SW3	SW5	SWA		
Lab Number:		11-Dec-2012	11-Dec-2012	11-Dec-2012		
		1080595.1	1080595.2	1080595.3		
Sum of Anions	meq/L	1.98	31	31	-	-
Sum of Cations	meq/L	1.90	29	30	-	-
pH	pH Units	7.0	6.8	6.8	-	-
Total Acidity (pH 8.3)	g/m ³ as CaCO ₃	9.8	66	66	-	-
Total Alkalinity	g/m ³ as CaCO ₃	44	118	119	-	-
Bicarbonate	g/m ³ at 25°C	54	144	145	-	-
Total Hardness	g/m ³ as CaCO ₃	73	1,300	1,370	-	-
Electrical Conductivity (EC)	mS/m	19.9	217	216	-	-
Dissolved Cadmium	g/m ³	0.033	0.026	0.026	-	-
Dissolved Calcium	g/m ³	22	420	440	-	-
Dissolved Iron	g/m ³	< 0.4	14.7	15.4	-	-
Total Iron	g/m ³	0.59	18.6	18.4	-	-
Dissolved Magnesium	g/m ³	4.5	61	65	-	-
Dissolved Manganese	g/m ³	0.194	7.4	7.7	-	-
Dissolved Potassium	g/m ³	< 1.0	1.8	1.9	-	-
Dissolved Sodium	g/m ³	6.5	28	28	-	-
Dissolved Zinc	g/m ³	4.5	17.7	18.2	-	-
Chloride	g/m ³	9.3	10.4	10.3	-	-
Nitrite-N	g/m ³	< 0.002	0.012	0.013	-	-
Nitrate-N	g/m ³	0.125	0.031	< 0.002	-	-
Nitrate-N + Nitrite-N	g/m ³	0.125	0.043	0.013	-	-
Sulphate	g/m ³	40	1,360	1,360	-	-

SUMMARY OF METHODS

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Samples
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-3
Total Digestion	Boiling nitric acid digestion. APHA 3030 E 21 st ed. 2005.	-	1-3
Total anions for anion/cation balance check	Calculation: sum of anions as mEq/L.	0.07 meq/L	1-3
Total cations for anion/cation balance check	Calculation: sum of cations as mEq/L.	0.05 meq/L	1-3
pH	pH meter. APHA 4500-H+ B 21 st ed. 2005.	0.1 pH Units	1-3
Total Acidity (pH 8.3)	Titration to pH 8.3 with standard sodium hydroxide solution, phenolphthalein indicator. APHA 2310 B (modified) 21 st ed. 2005.	1.0 g/m ³ as CaCO ₃	1-3
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. APHA 2320 B (Modified for alk <20) 21 st ed. 2005.	1.0 g/m ³ as CaCO ₃	1-3



This Laboratory is accredited by International Accreditation New Zealand (IANZ), which represents New Zealand in the International Laboratory Accreditation Cooperation (ILAC). Through the ILAC Mutual Recognition Arrangement (ILAC-MRA) this accreditation is internationally recognised.

The tests reported herein have been performed in accordance with the terms of accreditation, with the exception of tests marked *, which are not accredited.

Sample Type: Aqueous			
Test	Method Description	Default Detection Limit	Samples
Bicarbonate	Calculation: from alkalinity and pH, valid where TDS is not >500 mg/L and alkalinity is almost entirely due to hydroxides, carbonates or bicarbonates. APHA 4500-CO ₂ D 21 st ed. 2005.	1.0 g/m ³ at 25°C	1-3
Total Hardness	Calculation from Calcium and Magnesium. APHA 2340 B 21 st ed. 2005.	1.0 g/m ³ as CaCO ₃	1-3
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 21 st ed. 2005.	0.1 mS/m	1-3
Dissolved Cadmium	Filtered sample, ICP-MS, screen level. APHA 3125 B 21 st ed. 2005.	0.0010 g/m ³	1-3
Dissolved Calcium	Filtered sample, ICP-MS, screen level. APHA 3125 B 21 st ed. 2005.	1.0 g/m ³	1-3
Dissolved Iron	Filtered sample, ICP-MS, screen level. APHA 3125 B 21 st ed. 2005.	0.4 g/m ³	1-3
Total Iron	Nitric acid digestion, ICP-MS, screen level. APHA 3125 B 21 st ed. 2005.	0.42 g/m ³	1-3
Dissolved Magnesium	Filtered sample, ICP-MS, screen level. APHA 3125 B 21 st ed. 2005.	0.4 g/m ³	1-3
Dissolved Manganese	Filtered sample, ICP-MS, screen level. APHA 3125 B 21 st ed. 2005.	0.010 g/m ³	1-3
Dissolved Potassium	Filtered sample, ICP-MS, screen level. APHA 3125 B 21 st ed. 2005.	1.0 g/m ³	1-3
Dissolved Sodium	Filtered sample, ICP-MS, screen level. APHA 3125 B 21 st ed. 2005.	0.4 g/m ³	1-3
Dissolved Zinc	Filtered sample, ICP-MS, screen level. APHA 3125 B 21 st ed. 2005.	0.02 g/m ³	1-3
Chloride	Filtered sample. Ferric thiocyanate colorimetry. Discrete Analyser. APHA 4500 Cl ⁻ E (modified from continuous flow analysis) 21 st ed. 2005.	0.5 g/m ³	1-3
Nitrite-N	Automated Azo dye colorimetry, Flow injection analyser. APHA 4500-NO ₂ ⁻ I (Modified) 21 st ed. 2005.	0.002 g/m ³	1-3
Nitrate-N	Calculation: (Nitrate-N + Nitrite-N) - NO ₂ N.	0.002 g/m ³	1-3
Nitrate-N + Nitrite-N	Total oxidised nitrogen. Automated cadmium reduction, flow injection analyser. APHA 4500-NO ₃ ⁻ I (Modified) 21 st ed. 2005.	0.002 g/m ³	1-3
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B 21 st ed. 2005.	0.5 g/m ³	1-3

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Martin Cowell - BSc (Chem)
Client Services Manager - Environmental Division