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Baseline Environmental Monitoring, Program 8: Physical Environment Survey – Exploration Permit #51985 at Puhipuhi, Northland

Evolution Mining NZ Pty Limited

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Baseline Environmental Monitoring, Program 8: Physical Environment Survey - Exploration Permit #51985 at Puhipuhi, Northland

Prepared for

Evolution Mining NZ Pty Limited

June 2017

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Executive Summary

At the Puhipuhi gold exploration tenement, Northland, twenty-six soil samples were collected from ten locations representative of the major lithologies identified within the tenement (greywacke, lake sediments of the Purua beds, sinter-rich siliceous breccia, basalt and a wetland location, also overlying basalt). At each location, samples were collected from soil horizons A, B and C (if present). Sample locations were selected where high levels of mercury had been obtained from previous sampling of the B or C soil horizon, so that the distribution of mercury within the soil profile could be investigated. Samples were analysed for eleven elemental totals as well as pH. The focus of this report has been on the vertical distribution of total mercury, arsenic and antimony within the soil profile.

In samples collected from soils overlying lake sediments and siliceous breccia, concentrations of mercury, arsenic and antimony increase with depth through the soil profile, from soil horizon A to C. Mercury concentrations were also found to increase with depth in samples collected over greywacke and at one wetland location.

In samples collected over basalt, including samples from wetlands overlying basalt, the opposite was found, with concentrations of mercury, arsenic and antimony either decreasing or remaining constant with depth (this is with the exception of one wetland sample described above in which mercury increased with depth).

Samples collected from soils overlying greywacke show a variable pattern of arsenic and antimony concentrations, with some results showing enrichment with depth and some results showing the opposite. This may be a function of the limited sample size and that at the locations sampled, there was no A horizon preserved.

The pH of soil samples collected for this study ranged from pH 3.3 to pH 5.5 indicating acidic to moderately acidic conditions resulting from weathering of sulphide minerals. The lowest pH was found in soils overlying greywacke and the highest pH was from soils overlying siliceous sinter. If the soils will be disturbed within the tenement it would be advisable to undertake an acid sulphate soil assessment.

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Note on Terms Used in this Report

Elements

The focus of this report is on concentrations of fifteen inorganic elements: antimony (Sb), arsenic (As), boron (B), cadmium (Cd), chromium (Cr), Cobalt (Co), copper (Cu), iron (Fe), manganese (Mn), mercury (Hg), nickel (Ni), lead (Pb), thallium (Th) and zinc (Zn). Sometimes antimony, arsenic, cadmium, chromium, cobalt, copper, nickel, manganese, mercury, lead, thallium and zinc are referred to as 'heavy metals.' However, this term is falling out of favour because it is an ambiguous one. A range of different definitions for 'heavy metal' exists in the scientific literature and the group of elements covered by that term changes depending on the definition used. Therefore the more general term "elements" is used in this report to describe both the metals and metalloids (arsenic, antimony, and boron) listed above.

Elevated Concentrations

Elements occur naturally. When their concentrations are greater relative to other sampling locations, they are usually referred to as being **elevated.** This can be caused by either natural chemical or physical processes or by the addition of substances into the environment by human activities.

Glossary[1]

Acidic Having a pH of less than 7.

Acid sulphate soils naturally occurring soils, sediments or organic substrates. These soils contain iron sulphide minerals (predominantly as the mineral pyrite) or their oxidation products. In an undisturbed state below the water table, acid sulphate soils are benign. However, if the soils are drained, excavated or exposed to air by a lowering of the water table, the sulphides react with air to form acidic leachate which can mobilized trace elements (such as arsenic).

Alkaline (or basic) Having a pH of greater than 7.

Baseline study Data collected to document existing conditions onsite.

Detection limit (DL) The concentration below which a particular analytical method becomes difficult to determine with certainty.

IANZ International Accreditation New Zealand. This organisation undertakes independent assessments of laboratories to verify that they have appropriate quality assurance/quality control method to assure that the analysis is undertaken in accordance with international best practice.

Major elements Geological major elements are defined as those elements that compose 95% of the earth's crust. They are Silicon, Aluminium, Calcium, Magnesium, Sodium, Potassium, Titanium, Iron, Manganese and Phosphorus.

MfE Ministry for Environment

pH A measure of the acidity or alkalinity of a solution. This can include a paste made of a soil sample and distilled water.

Quality Assurance (QA) Evaluation of data collection and analysis techniques to ensure correct procedures was followed.

Sediment Particles of sand, clay, silt, and plant or animal matter carried in water.

Trace element In analytical chemistry, a trace element is one whose average concentration is less than 0.1 to 100,000 ppb.

US EPA United States Environmental Protection Agency.

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[1] Primary sources:
Government of British Columbia, Ministry of Environment, Glossary of Water Quality Terms http://www.env.gov.bc.ca/wat/wq/reference/glossary.html#index accessed 05/02/16, and;
Wai Care Manual Book 6 - Fact Sheets, Wai Care, 2003.

1.0 Introduction

Pattle Delamore Partners Ltd (PDP) has been engaged by Evolution Mining NZ Pty Limited (ENZ) to undertake an assessment of shallow soil samples collected from within their Puhipuhi gold exploration tenement (Figure 1). The primary aim of this programme is to provide defensible and high quality baseline data relating to the distribution of mercury in shallow soils.

In addition, the results aim to address the key question

- How does mercury concentration vary vertically (i.e. with depth) within the soil profile?

This report presents the results of soil sampling undertaken by ENZ between September 2016 and January 2017.

2.0 Project Background

The physical environmental survey is one of several baseline environmental investigations undertaken by PDP on behalf of ENZ. Other environmental investigations that have been undertaken include groundwater, surface water and sediment sampling, ecological and air monitoring and hydrogeological assessments.

Previous geological and geochemical surveys have shown that elevated mercury values, consistent with geothermal influence such as at Ngawha (NZEL, 2003), are widespread in Puhipuhi rocks and soils (e.g. Craw *et al*., 2000; Hampton *et al*., 2004).

A number of studies have been undertaken previously at Puhipuhi, both by regulators such as Northland Regional Council and by academic researchers. Studies have tended to focus on the levels of mercury and other metals in water and sediment, primarily as a response to legacy issues associated with an abandoned small-scale mercury mine and processing plant, which is located in the headwaters of Waikiore Stream and was active between 1907 and 1945 (DOC, 2010). There have been few studies looking at the natural distribution of mercury in soils across the Puhipuhi region.

3.0 Scope and Objectives

The purpose of this study was to provide information on how the mercury concentration varies with depth across the soil profile.

All samples collected were analysed by an independent IANZ accredited laboratory (accredited laboratories require an independent assessment of quality control and accuracy standards).

4.0 Geology

Basement rocks in the Puhipuhi region are Triassic-Jurassic Waipapa Group greywacke and argillite. These are overlain by lacustrine deposits of the Purua beds and basalts of the Kerikeri volcanics which were emplaced between 5 and 2 Ma. Significant hydrothermal alteration subsequently occurred along north-south faults, resulting in layered siliceous sinter deposits and has resulted in the deposition of mercury sulphides (e.g. cinnabar), arsenic and antimony bearing sulphides (e.g. stibnite, livingstonite and pyrite), iron sulphides and minor gold and silver (Craw *et al*., 2000; Hampton *et al*., 2004).

The hydrothermal alteration and mineralisation is thought to be Plio-Pleistocene in age (White, 1986) and is exposed most prominently in sinters and lake deposits (Purua beds) and at the contact with the underlying basement rocks (Craw *et al*., 2000). However, in some areas the Purua beds contain alluvial cinnabar, indicating that at least some hydrothermal mineralisation had occurred prior to their emplacement (Locke *et al*., 1999).

4.1 Lithology

The major lithologic units present within the tenement are:

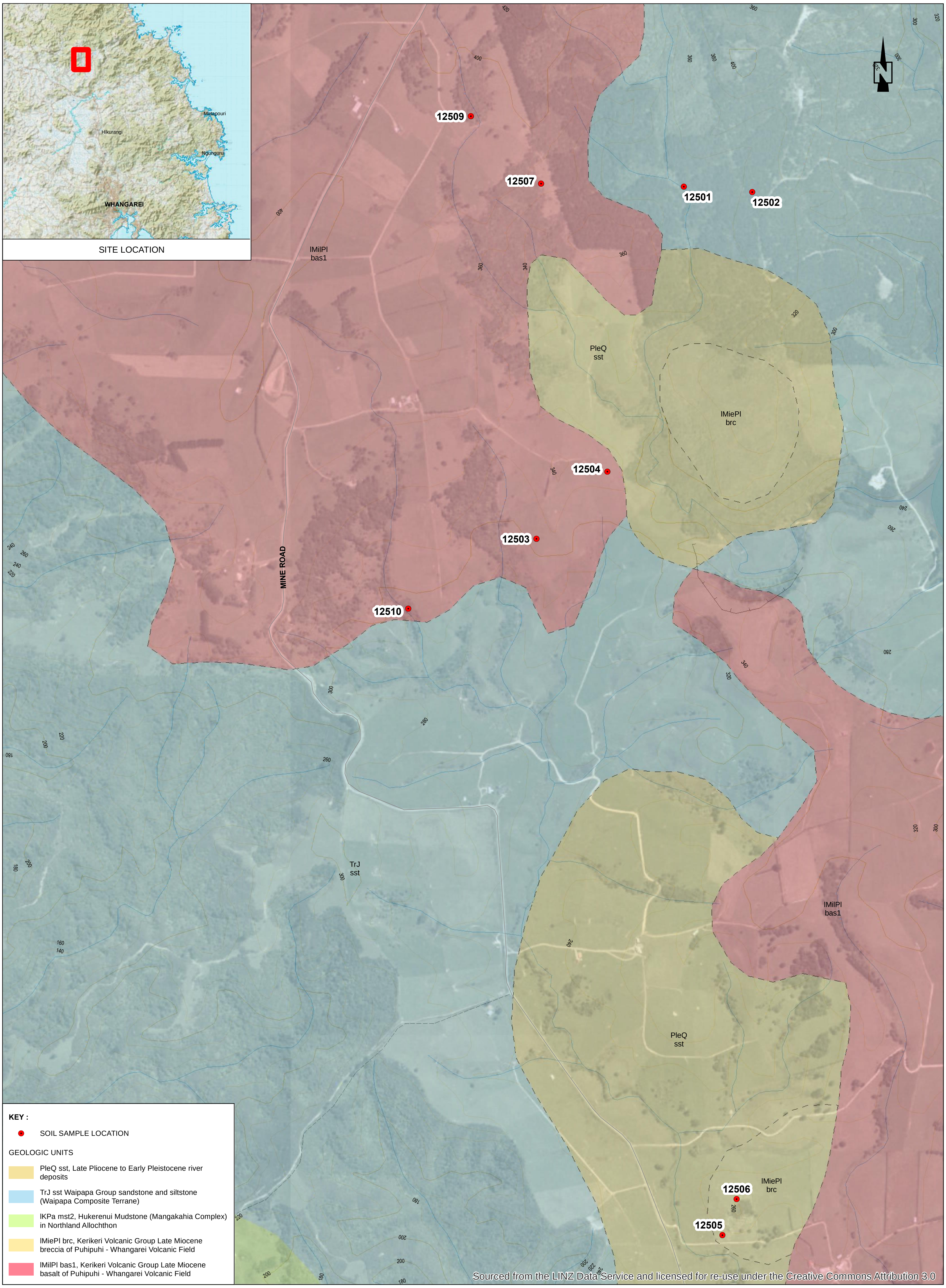
- Basalt
- Siliceous sinter deposits
- Lake sediments of the Purua beds
- Greywacke

5.0 Methodology

Soil samples were collected in accordance with the sampling and analysis plan (PDP, 2016) by ENZ staff between September 2016 and January 2017. Shallow soil samples were collected in to clean plastic containers supplied by the laboratory using a hand trowel; deeper samples were collected using a hand auger.

5.1 Site Locations

Figure 1 shows the sample locations.



SOURCE:
1. INSET AND TOPOGRAPHIC INFORMATION DERIVED FROM LINZ DATA.
2. GEOLOGIC INFORMATION SOURCED FROM EDBROOKE, S.W.; BROOK, F.J. (COMPILERS) 2009: GEOLOGY OF THE WHANGAREI AREA. INSTITUTE OF GEOLOGICAL & NUCLEAR SCIENCES 1:250,000 GEOLOGICAL MAP 2. (C) GNS SCIENCE 2014.

FIGURE 1 : SAMPLE LOCATION PLAN

SCALE : 1:10,000 (A3)

0 125 250 500
Meters

The following lithologies underlying each soil sample are based on the field notes provided by ENZ:

- Sample locations 12501 and 12502 overlie greywacke;
- Sample locations 12503 and 12504 overlie lake sediments of the Purua beds;
- Sample locations 12505 and 12506 overlie sinter rich siliceous breccia;
- Sample locations 12507 and 12510 overlie basalt and were collected from a wetland environment;
- Sample locations 12508 and 12509 also overlie basalt.

At each location, a representative sample was collected from each of the principal soil horizons A, B and C, where possible. At locations 12501 and 12502 there was no A soil horizon and at locations 12505 and 12506 there was no C horizon. A total of 26 soil samples were collected.

5.2 Sample Analysis

Samples were sent to the PDP Auckland office before being forwarded on to Analytica Laboratories, Hamilton under standard PDP chain of custody. Samples were analysed for total concentrations of eleven elements as well as for pH.

5.3 Quality Assurance/Quality Control

For QA/QC purposes, a duplicate sample from 12506B was analysed by the laboratory. Standard Relative Percentage Difference (RPD) statistical analysis was conducted on the results, whereby an RPD of ± 30% is deemed acceptable (industry accepted guideline – MfE, 2011). Tabulated RPD results for individual elements are presented in Table A-1 (Appendix A).

In general the, RPDs calculated for the duplicate sample was well within the acceptable 30% range, this is with the exception of total antimony which had an RPD value of 71%.

6.0 Results and Discussion

Sample results including soil descriptions, soil horizons and bedrock lithology are provided in Table A-1, Appendix A. The laboratory report is provided in Appendix B. Based on the sample results (which show low concentrations of the base metals copper, lead and zinc) and the expected mineralogy, the investigation has focused on mercury, arsenic and antimony.

Samples were grouped based on their underlying lithology to allow a comparison of concentrations between soil horizons. A statistical analysis has not been undertaken because samples were not randomly selected and the sample size is small.

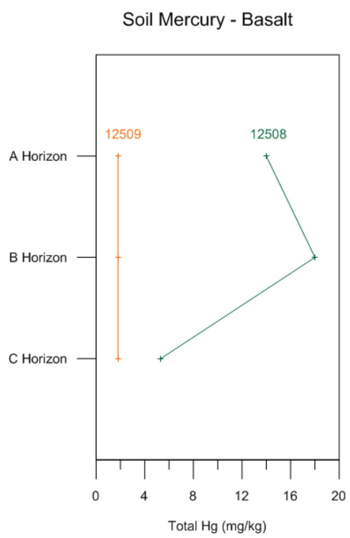
A summary of these results including a graphical display of the variation of elemental concentrations with soil horizon is provided below.

It is important to note that due to the limited sample size the results should be interpreted with caution as the effect of outliers cannot be properly assessed. This is particularly important where there is a large variation in the results for samples from similar areas, such as the samples collected at 12503 and 12504 which overlie lake sediments.

6.1 Mercury

6.1.1 Basalt

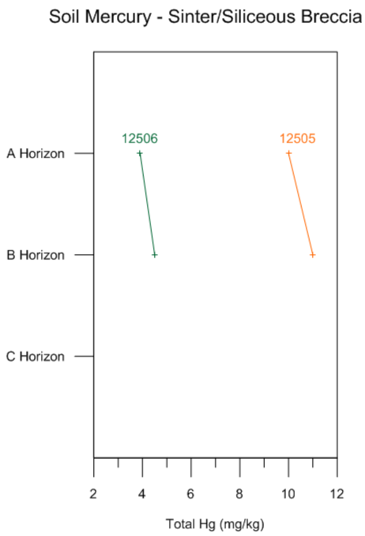
In soils overlying basalt, samples from 12509 do not show any variation in mercury concentrations between soil horizons A, B and C. In samples from 12508, the largest concentration is found in the B horizon. Mercury concentration in the sample collected from the C horizon was significantly lower than the mercury concentration collected from the A or B horizons. The overall trend shows a decrease in mercury concentrations from soil horizon A to C (Plot 1).



Plot 1: Mercury concentration in soils overlying basalt

6.1.2 Siliceous Sinter

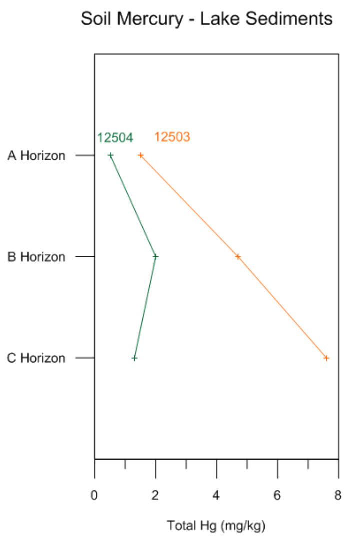
At both locations overlying siliceous sinter, soil samples show an increase in mercury concentrations from soil horizon A to B (Plot 2). There was no C horizon present at these locations.



Plot 2: Mercury concentration in soils overlying sinter

6.1.3 Lake sediments of the Purua beds

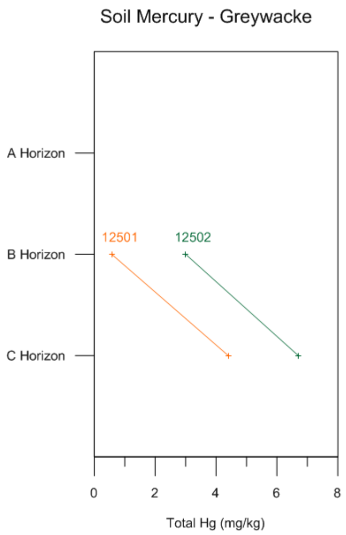
In soils overlying lake sediments, both locations show an overall trend of increasing mercury concentration from soil horizon A to C. Samples from location 12503 show a strong trend of increasing mercury concentration from soil horizon A to C (Plot 3).



Plot 3: Mercury concentration in soils overlying lake sediments

6.1.4 Greywacke

At both locations overlying greywacke, soil samples show an increase in mercury concentrations from soil horizon B to C (Plot 4). There was no A horizon present at these locations.



Plot 4: Mercury concentration in soils overlying greywacke

6.1.5 Basalt Underlying Wetland

In soils collected from wetland areas overlying basalt, samples from 12510 show a very slight decrease in mercury concentrations between soil horizons A to C. It should be noted that the difference in concentration of mercury between the three soil samples is not great and could be due to sample heterogeneity rather than actual decrease in mercury between soil horizons. In samples collected at 12507, the opposite occurs with mercury concentrations increasing from soil horizon A to C (Plot 5).

Plot 5: Mercury concentration in wetland soils overlying basalt

6.1.6 Overview of Mercury Variation with Soil Horizon

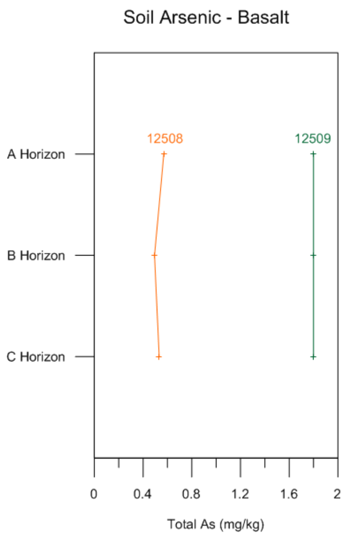
At all sampled locations overlying greywacke, lake sediment and sinter and at one location from a wetland, total mercury concentrations increase with depth through the soil profile, from soil horizon A to C, although not all horizons are represented in this subgroup.

In samples collected from soils overlying basalt and in one sample from a wetland area, total mercury concentrations either decrease or remain constant from soil horizon A to C.

6.2 Arsenic

6.2.1 Basalt

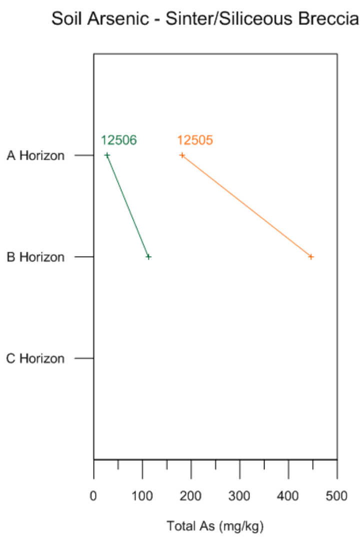
In soils overlying basalt, samples either show no significant variation in mercury concentrations between soil horizons, or a slight decrease from soil horizon A to C (Plot 6).



Plot 6: Arsenic concentration in soils overlying basalt

6.2.2 Siliceous Sinter

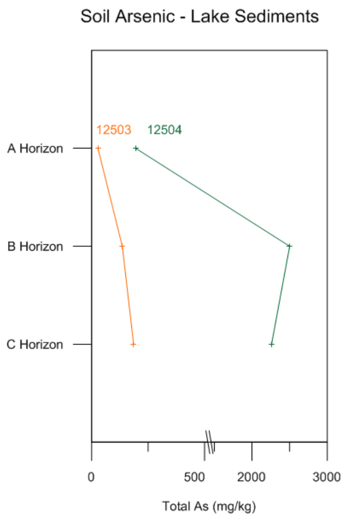
At both locations overlying siliceous sinter, soil samples show an increase in arsenic concentrations from soil horizon A to B (Plot 7). There was no C horizon present at these locations.



Plot 7: Arsenic concentration in soils overlying sinter

6.2.3 Lake sediments of the Purua beds

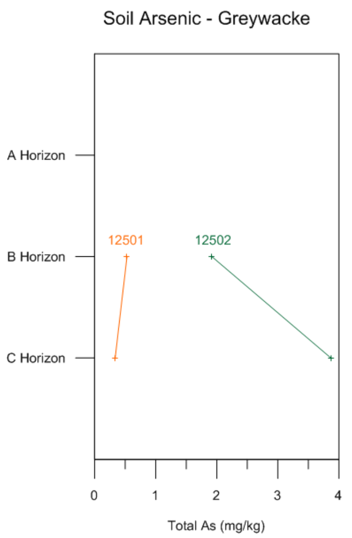
In soils overlying lake sediments, both locations show an overall trend of increasing arsenic concentration from soil horizon A to C. Samples from location 12504 show a strong trend of increasing arsenic concentration from soil horizon A to C with the highest concentration of arsenic found in the sample from the B horizon (Plot 8).



Plot 8: Arsenic concentration in soils overlying lake sediments. Note the change in scale of the x axis.

6.2.4 Greywacke

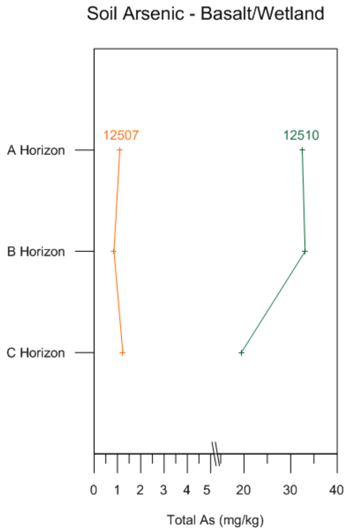
At locations overlying greywacke, soil samples from 12502 show an increase in arsenic concentrations from horizon B to C. Samples collected from sampling location 12501 show a slight decrease in arsenic concentrations from horizon B to C (Plot 9). However, it should be noted that the change in arsenic concentration between the B and C horizon samples is less than what would be expected for analytical variability (± 30%) and therefore the observed decrease may be due to sample heterogeneity.



Plot 9: Arsenic concentration in soils overlying greywacke

6.2.5 Basalt Underlying Wetland

In soils collected from wetland areas overlying basalt, samples from 12510 show a decrease in arsenic concentrations between soil horizons A to C. In samples collected at 12507, the opposite occurs with a very slight increase occurring in arsenic concentrations from soil horizon A to C (Plot 10). However, it should be noted that the change in arsenic concentration between the soil horizon samples is less than what would be expected for analytical variability (± 30%) and therefore the observed increase may be due to sample heterogeneity.



Plot 10: Arsenic concentration in wetland soils overlying basalt. Note the change in scale of the x axis.

6.2.6 Overview of Arsenic Variation with Soil Horizon

At all sample locations overlying lake sediments and sinter, and at one location overlying greywacke, total arsenic concentrations increase from soil horizon A to C, although not all horizons are represented in some of these subgroups.

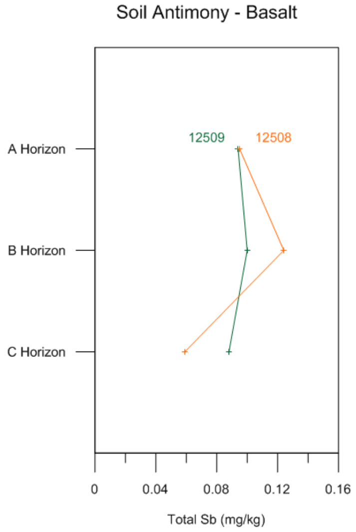
At one sample location from a wetland overlying basalt and at one location overlying greywacke, the opposite occurs, with total arsenic concentrations decreasing from soil horizon A to C, although not all horizons are represented in the greywacke subgroup.

In soil samples collected over basalt and at one wetland location, there is no significant difference in total arsenic between soil horizons.

6.3 Antimony

6.3.1 Basalt

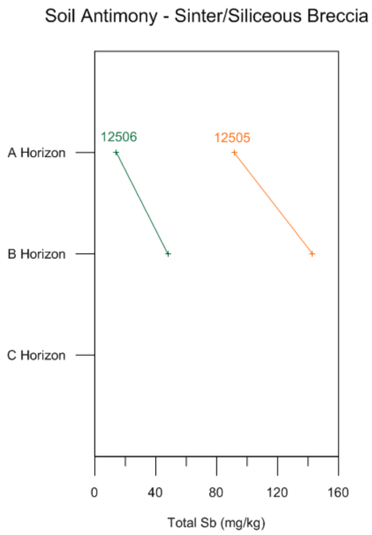
Samples collected from soils overlying basalt show an overall trend of decreasing antimony concentration from soil horizon A to C (Plot 11). In both locations, the largest concentration of antimony was found in the B horizon.



Plot 11: Antimony concentration in soils overlying basalt

6.3.2 Siliceous Sinter

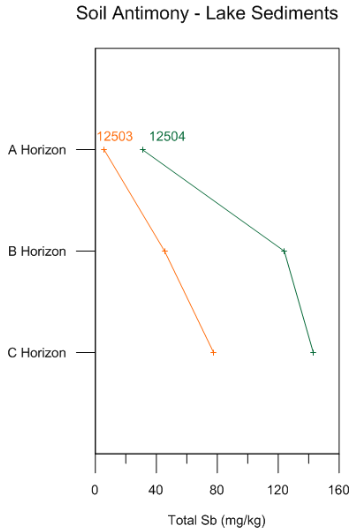
At both locations overlying siliceous sinter, soil samples show an increase in concentrations of antimony from soil horizon A to B (Plot 12).



Plot 12: Antimony concentration in soils overlying sinter

6.3.3 Lake sediments of the Purua beds

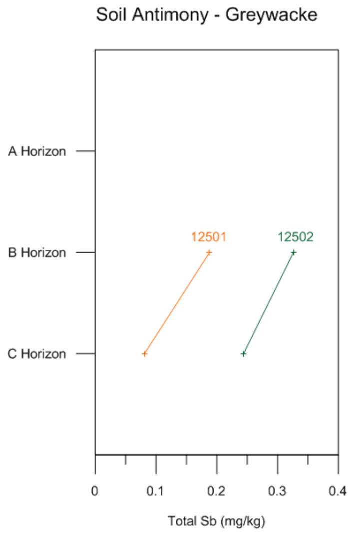
In soils overlying lake sediments, both locations show a strong trend of increasing antimony concentration from soil horizon A to C (Plot 13).



Plot 13: Antimony concentration in soils overlying lake sediments.

6.3.4 Greywacke

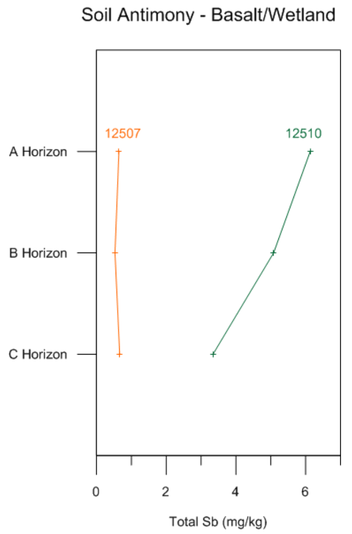
At both locations overlying greywacke, soil samples show a decrease in antimony concentrations from horizon B to C (Plot 14).



Plot 14: Antimony concentration in soils overlying greywacke

6.3.5 Basalt Underlying Wetland

In soils collected from wetland areas overlying basalt, samples from 12510 show a decrease in antimony concentrations between soil horizons A to C. At 12507, there is no significant change in antimony concentration between soil horizons A, B and C (Plot 15).



Plot 15: Antimony concentration in wetland soils overlying basalt.

6.3.6 Overview of Antimony Variation with Soil Horizon

At all sample locations overlying sinter and lake sediments, total antimony concentrations increase from soil horizon A to C, although not all horizons are represented in the sinter subgroup.

At all sample locations overlying basalt and greywacke, and at one wetland location, total antimony concentrations decrease from soil horizon A to C, although not all horizons are represented in the greywacke subgroup.

At the other wetland location, there is no significant difference in total antimony between soil horizons.

6.4 Comparison of Mercury, Arsenic and Antimony

A comparison of mercury, arsenic and antimony results shows that for soils developed over lake sediments and sinter, elemental concentrations increase with depth through the soil profile, from soil horizon A to C (or from A to B in the case of sinter). Mercury concentrations also increase from the B to the C horizon at sample locations overlying greywacke and at one location within a wetland. At one location overlying basalt arsenic was also found to increase from the B to the C horizon.

For samples located over basalt and wetland areas, arsenic and antimony show either a decrease or no significant difference in concentration from the A to the C horizon. Antimony also shows a decrease in concentration from the B to the C horizon at both sample locations overlying greywacke.

6.5 Soil pH

The pH of soil samples collected for this study ranged from pH 3.3 to pH 5.5 indicating acidic to moderately acidic conditions resulting from weathering of sulphides. The lowest pH was found in soils overlying greywacke and the highest pH was from soils overlying siliceous sinter.

Note that the low pH found in these soils may indicate that these soils contain iron sulphide minerals (predominantly as the mineral pyrite) or their oxidation products. Therefore if there are plans to drain, excavate or expose these soils to air then an acid sulphate soil assessment should be undertaken.

Craw (2004) found similar pH values for Puhipuhi soils and reported that soil pH in the range of 3.0 to 4.0 is the most effective for the fixation of mercury and arsenic in iron oxy-hydroxides.

This finding may have some implication for the mobilisation of mercury from soils during any future exploration works that may occur, particularly if the natural weakly acid pH conditions are altered due to such work.

7.0 Conclusions

At the Puhipuhi gold exploration tenement, Northland, twenty-six soil samples were collected by ENZ from ten locations representative of the major lithologies identified within the tenement (greywacke, lake sediments of the Purua beds, sinter-rich siliceous breccia, basalt and a wetland location, also overlying basalt) and known to contain elevated concentrations of mercury. At each location, where possible, samples were collected from soil horizons A, B and C. Samples were analysed for eleven elemental totals as well as pH. The focus of this report has been total mercury, arsenic and antimony.

Because of the small sample size and the non-random nature of the sampling, no statistical analysis was undertaken. Furthermore, due to the small sample size and the fact that in some locations not all the soil horizons were present, the results should be interpreted with caution. The findings are summarised below:

- In samples collected over greywacke, lake sediments, sinter and at one wetland location, mercury concentrations increase with depth from soil horizon A to C;
- In samples collected over lake sediments and sinter, arsenic and antimony concentrations also increase with depth from soil horizon A to C;

- In samples collected over basalt, including samples from wetlands overlying basalt, the opposite occurs, with concentrations of mercury, arsenic and antimony either decreasing or remaining constant with depth from soil horizon A to C (this is with the exception of one wetland sample described above in which mercury increase with depth);
- In samples collected from soils overlying greywacke, arsenic and antimony concentrations show a variable pattern, with some results showing enrichment with depth and some results showing the opposite.
- The pH of soil samples ranged from pH 3.3 to pH 5.5 which is similar to other values reported for Puhipuhi soils. This may indicate that acid sulphate soils are present within the tenement and that an assessment of acid sulphate soils should be undertaken before any soils are drained, excavated or exposed these soils to air.

8.0 References

Craw, D., Chappel, D. and Reay, A. (2000). Environmental mercury and arsenic sources in fossil hydrothermal systems, Northland, New Zealand. Environmental Geology, 39(8), pg 875 -887.

Craw, D., Chappel. D. and Black, A. (2002). Surface run-off from mineralised road aggregate, Puhipuhi, Northland, New Zealand. New Zealand Journal of Marine and Freshwater Research, 36(1), pg 105-116.

Department of Conservation, (2010). The Puhipuhi Mercury Mine History and Site Description. Department of Conservation Whangarei Area Office, August 2010.

Hampton, W.A., White, G.P., Hoskin, P.W.O., Browne, P.R.L., Rodgers, K.A. (2004). Cinnabar, livingstonite, stibnite and pyrite in Pliocene silica sinter from Northland, New Zealand. Mineralogical Magazine, Vol. 68(1), pg 191-198.

Locke, C.A., Johnson, S.A., Cassidy, J., Mauk, J.L. (1999). Geophysical exploration of the Puhipuhi epithermal area, Northland, New Zealand. Journal of Geochemical Exploration 65, pg 91-109.

MfE. (2011). Contaminated Land Management Guidelines No. 5: Site Investigation and Analysis of Soils (Revised 2011). Wellington: Ministry for Environment.

New Zealand Environmental Limited (2003) Ecological Survey of Proposed Reservoir Site. Unpublished report prepared for Ngawha Geothermal Resource Company Limited. New Zealand Environmental Limited, Kerikeri. November 2003.

PDP (2016). Soil sampling analysis plan – mercury bioavailability. Report prepared for Evolution Mining NZ Pty Limited, April 2016.

White, G. (1986). Puhipuhi mercury deposit, in *Monograph Series on Mineral Deposits,* Henley, R.W., Hedenquist, J.W., Roberts, P.J. (Eds.), vol. 26, pg 193-198.

Appendix A
Results Table

Table A-1: Soil Geochemistry Laboratory Results [1]

Sample ID	12501B	12501C	12502B	12502C	12503A	12503B	12503C	12504A	12504B	12504C	12505A	12505B	12506A	12506B	Duplicate of 12506B	% RPD [2]
Sample Site Location	12501		12502		12503			12504			12505		12506			
Bedrock Lithology	Greywacke		Greywacke		Lake Sediments / Siltstone			Lake Sediments / Siltstone			Sinter-rich Siliceous Breccia		Sinter-rich Siliceous Breccia			
Soil Horizon	B	C	B	C	A	B	C	A	B	C	A	B	A	B	B	
Soil Type	Silty CLAY	Silty CLAY	Clayey SILT	Clayey SILT	Silty CLAY	Silty CLAY	Gravelly CLAY	Silty CLAY	Silty CLAY	Gravelly CLAY	Silty CLAY	Silty CLAY	Silty CLAY	Silty CLAY	Silty CLAY	
Sample Depth (m bgl)	0.2	0.4	0.1	0.3	0.2	0.6	0.9	0.2	0.6	0.8	0.05	0.25	0.05	0.25	0.25	
Laboratory ID	17-01078-1	17-01078-2	17-01078-3	17-01078-4	17-01078-5	17-01078-6	17-01078-7	17-01078-8	17-01078-9	17-01078-10	17-01078-11	17-01078-12	17-01078-13	17-01078-14	17-01078-14	
Sampling Date	9/01/2017	9/01/2017	10/01/2017	10/01/2017	29/09/2016	29/09/2016	29/09/2016	29/09/2016	29/09/2016	29/09/2016	6/01/2017	6/01/2017	6/01/2017	6/01/2017	6/01/2017	
Soil pH (pH units)	3.3	3.4	3.5	3.6	5	4.2	3.8	5.5	3.9	3.7	4.1	4.1	5.1	5.1	-	
Inorganic Elements																
Total Arsenic	0.529	0.335	1.92	3.87	28	136	186	195	2500	2260	181	447	27.1	112	112	0%
Total Beryllium	0.037	0.028	0.12	0.12	0.036	0.054	0.077	0.069	0.15	0.17	0.043	0.047	0.061	0.047	0.051	8%
Total Boron	< 1.25	< 1.25	1.37	< 1.25	< 1.25	< 1.25	< 1.25	1.44	< 1.25	< 1.25	< 1.25	< 1.25	2.24	1.61	1.65	2%
Total Cadmium	0.009	< 0.005	0.021	0.013	0.2	0.012	0.008	0.31	0.03	0.015	0.23	0.18	0.43	0.25	0.25	0%
Total Chromium	0.943	1.1	1.97	2.47	2.83	6.1	10.4	9.15	65	51.4	9.22	11.8	4.92	4.97	5.03	1%
Total Copper	0.983	0.343	6.14	3.74	1.31	2.81	9.67	7.57	7.17	9.24	7.11	7.75	7.03	4.85	3.74	26%
Total Lead	2.81	2.36	5.79	7.57	2.74	9.66	14.9	1.5	3.29	3.71	2.56	2.97	1.17	1.11	1.04	7%
Total Mercury	0.57	4.4	3	6.7	1.5	4.7	7.6	0.51	2	1.3	10	11	3.9	4.5	4.2	7%
Total Nickel	0.29	0.14	0.92	0.51	1.34	0.32	0.38	3.79	0.37	0.24	0.48	0.33	1.75	0.92	0.96	4%
Total Zinc	1.2	0.43	3.07	2.64	3.8	1.79	3.08	11	2.45	2.03	3.2	2.43	15	7.3	7	4%
Total Antimony	0.188	0.081	0.326	0.244	5.7	45.4	77.6	30.9	124	143	91.4	143	14.1	47.9	22.8	71%

Sample ID	12507A	12507B	12507C	12508A	12508B	12508C	12509A	12509B	12509C	12510A	12510B	12510C
Sample Site Location	12507			12508			12509			12510		
Bedrock Lithology	Basalt / Wetland			Basalt			Basalt			Basalt / Wetland		
Soil Horizon	A	B	C	A	B	C	A	B	C	A	B	C
Soil Type	CLAY	Silty CLAY	Silty CLAY	CLAY	CLAY	CLAY	CLAY	CLAY	CLAY	Gravelly CLAY	CLAY	CLAY
Sample Depth (m bgl)	0.05	0.25	0.5	0.05	0.25	0.4	0.02	0.3	0.5	0.05	0.35	0.5
Laboratory ID	17-01078-15	17-01078-16	17-01078-17	17-01078-18	17-01078-19	17-01078-20	17-01078-21	17-01078-22	17-01078-23	17-01078-24	17-01078-25	17-01078-26
Sampling Date	10/01/2017	10/01/2017	10/01/2017	6/01/2017	6/01/2017	6/01/2017	9/01/2017	9/01/2017	9/01/2017	9/01/2017	9/01/2017	9/01/2017
Soil pH (pH units)	4.1	4.1	4.1	4.5	4.4	4.1	3.9	3.9	4	4.9	3.9	3.9
Inorganic Elements												
Total Arsenic	1.1	0.85	1.23	0.57	0.494	0.532	1.4	1.59	1.65	32.5	33.1	19.4
Total Beryllium	0.21	0.22	0.32	0.2	0.22	0.35	0.31	0.36	0.47	0.54	0.46	0.63
Total Boron	2.05	1.46	< 1.25	2.25	1.35	< 1.25	2.9	2.72	2.16	2.4	< 1.25	< 1.25
Total Cadmium	0.055	0.043	0.038	0.3	0.12	0.059	0.06	0.048	0.05	0.11	0.043	0.059
Total Chromium	41.2	47.8	97.2	79.4	98.7	128	91.4	102	133	144	106	153
Total Copper	12.2	13.7	26.6	11	11.8	22.7	16.9	17	26.4	23.3	37.8	48.1
Total Lead	4.84	5.03	6.71	4.78	4.44	2.85	3.82	3.82	4.01	6.57	6.14	6.01
Total Mercury	21	22	32	14	18	5.3	1.8	1.8	1.8	4.2	2.5	1.4
Total Nickel	12.7	15	30.3	15.7	16.8	31.1	27.6	30.9	57.1	23.5	28.5	37
Total Zinc	9.61	9.62	13.6	16.7	11.5	18.6	23.3	21.1	28.1	24.8	15.9	23
Total Antimony	0.641	0.529	0.664	0.095	0.124	0.059	0.094	0.1	0.088	6.13	5.08	3.34

Notes:

1. All results in mg/kg unless otherwise stated.
2. RPD = Relative Percent Difference.

Indicates sample results differ by > 30% RPD.

Appendix B

Laboratory Report

ANALYTICA LABORATORIES

Analytica Laboratories Limited
Ruakura Research Centre
10 Bisley Road
Hamilton 3214, New Zealand
Ph +64 (07) 974 4740
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Certificate of Analysis

Pattle Delamore Partners Ltd
Level 4, 235 Broadway, Newmarket
Auckland 1149
Attention: Andrew Rumsby
Phone: 09 523 6900
Email: james.conway@pdp.co.nz

Lab Reference: 17-01078
Submitted by: James Conway
Date Received: 18/01/2017
Date Completed: 1/02/2017
Order Number:
Reference: A02982100

Sampling Site:

Heavy Metals in Soil

		Client Sample ID	12501B	12501C	12502B	12502C	12503A
		Date Sampled	9/01/2017	9/01/2017	10/01/2017	10/01/2017	29/09/2016
Analyte	Unit	*Reporting Limit*	17-01078-1	17-01078-2	17-01078-3	17-01078-4	17-01078-5
Arsenic	mg/kg dry wt	*0.125*	0.529	0.335	1.92	3.87	28.0
Beryllium	mg/kg dry wt	*0.013*	0.037	0.028	0.12	0.12	0.036
Boron	mg/kg dry wt	*1.25*	<1.25	<1.25	1.37	<1.25	<1.25
Cadmium	mg/kg dry wt	*0.005*	0.009	<0.005	0.021	0.013	0.20
Chromium	mg/kg dry wt	*0.125*	0.943	1.10	1.97	2.47	2.83
Copper	mg/kg dry wt	*0.075*	0.983	0.343	6.14	3.74	1.31
Lead	mg/kg dry wt	*0.05*	2.81	2.36	5.79	7.57	2.74
Mercury	mg/kg dry wt	*0.025*	0.57	4.4	3.0	6.7	1.5
Nickel	mg/kg dry wt	*0.05*	0.29	0.14	0.92	0.51	1.34
Zinc	mg/kg dry wt	*0.05*	1.20	0.43	3.07	2.64	3.80
Antimony	mg/kg dry wt	*0.025*	0.188	0.081	0.326	0.244	5.70

Heavy Metals in Soil

		Client Sample ID	12503B	12503C	12504A	12504B	12504C
		Date Sampled	29/09/2016	29/09/2016	29/09/2016	29/09/2016	29/09/2016
Analyte	Unit	*Reporting Limit*	17-01078-6	17-01078-7	17-01078-8	17-01078-9	17-01078-10
Arsenic	mg/kg dry wt	*0.125*	136	186	195	2,500	2,260
Beryllium	mg/kg dry wt	*0.013*	0.054	0.077	0.069	0.15	0.17
Boron	mg/kg dry wt	*1.25*	<1.25	<1.25	1.44	<1.25	<1.25
Cadmium	mg/kg dry wt	*0.005*	0.012	0.008	0.31	0.030	0.015
Chromium	mg/kg dry wt	*0.125*	6.10	10.4	9.15	65.0	51.4
Copper	mg/kg dry wt	*0.075*	2.81	9.67	7.57	7.17	9.24
Lead	mg/kg dry wt	*0.05*	9.66	14.9	1.50	3.29	3.71
Mercury	mg/kg dry wt	*0.025*	4.7	7.6	0.51	2.0	1.3
Nickel	mg/kg dry wt	*0.05*	0.32	0.38	3.79	0.37	0.24
Zinc	mg/kg dry wt	*0.05*	1.79	3.08	11.0	2.45	2.03
Antimony	mg/kg dry wt	*0.025*	45.4	77.6	30.9	124	143

IANZ ACCREDITED LABORATORY

All tests reported herein have been performed in accordance with the laboratory's scope of accreditation, with the exception of tests marked *, which are not accredited.

Heavy Metals in Soil

		Client Sample ID	12505A	12505B	12506A	12506B	12507A
		Date Sampled	6/01/2017	6/01/2017	6/01/2017	6/01/2017	10/01/2017
Analyte	Unit	*Reporting Limit*	17-01078-11	17-01078-12	17-01078-13	17-01078-14	17-01078-15
Arsenic	mg/kg dry wt	*0.125*	181	447	27.1	112	1.10
Beryllium	mg/kg dry wt	*0.013*	0.043	0.047	0.061	0.047	0.21
Boron	mg/kg dry wt	*1.25*	<1.25	<1.25	2.24	1.61	2.05
Cadmium	mg/kg dry wt	*0.005*	0.23	0.18	0.43	0.25	0.055
Chromium	mg/kg dry wt	*0.125*	9.22	11.8	4.92	4.97	41.2
Copper	mg/kg dry wt	*0.075*	7.11	7.75	7.03	4.85	12.2
Lead	mg/kg dry wt	*0.05*	2.56	2.97	1.17	1.11	4.84
Mercury	mg/kg dry wt	*0.025*	10	11	3.9	4.5	21
Nickel	mg/kg dry wt	*0.05*	0.48	0.33	1.75	0.92	12.7
Zinc	mg/kg dry wt	*0.05*	3.20	2.43	15.0	7.30	9.61
Antimony	mg/kg dry wt	*0.025*	91.4	143	14.1	47.9	0.641

Heavy Metals in Soil

		Client Sample ID	12507B	12507C	12508A	12508B	12508C
		Date Sampled	10/01/2017	10/01/2017	6/01/2017	6/01/2017	6/01/2017
Analyte	Unit	*Reporting Limit*	17-01078-16	17-01078-17	17-01078-18	17-01078-19	17-01078-20
Arsenic	mg/kg dry wt	*0.125*	0.850	1.23	0.570	0.494	0.532
Beryllium	mg/kg dry wt	*0.013*	0.22	0.32	0.20	0.22	0.35
Boron	mg/kg dry wt	*1.25*	1.46	<1.25	2.25	1.35	<1.25
Cadmium	mg/kg dry wt	*0.005*	0.043	0.038	0.30	0.12	0.059
Chromium	mg/kg dry wt	*0.125*	47.8	97.2	79.4	98.7	128
Copper	mg/kg dry wt	*0.075*	13.7	26.6	11.0	11.8	22.7
Lead	mg/kg dry wt	*0.05*	5.03	6.71	4.78	4.44	2.85
Mercury	mg/kg dry wt	*0.025*	22	32	14	18	5.3
Nickel	mg/kg dry wt	*0.05*	15.0	30.3	15.7	16.8	31.1
Zinc	mg/kg dry wt	*0.05*	9.62	13.6	16.7	11.5	18.6
Antimony	mg/kg dry wt	*0.025*	0.529	0.664	0.095	0.124	0.059

Heavy Metals in Soil

		Client Sample ID	12509A	12509B	12509C	12510A	12510B
		Date Sampled	9/01/2017	9/01/2017	9/01/2017	9/01/2017	9/01/2017
Analyte	Unit	*Reporting Limit*	17-01078-21	17-01078-22	17-01078-23	17-01078-24	17-01078-25
Arsenic	mg/kg dry wt	*0.125*	1.40	1.59	1.65	32.5	33.1
Beryllium	mg/kg dry wt	*0.013*	0.31	0.36	0.47	0.54	0.46
Boron	mg/kg dry wt	*1.25*	2.90	2.72	2.16	2.40	<1.25
Cadmium	mg/kg dry wt	*0.005*	0.060	0.048	0.050	0.11	0.043
Chromium	mg/kg dry wt	*0.125*	91.4	102	133	144	106
Copper	mg/kg dry wt	*0.075*	16.9	17.0	26.4	23.3	37.8
Lead	mg/kg dry wt	*0.05*	3.82	3.82	4.01	6.57	6.14
Mercury	mg/kg dry wt	*0.025*	1.8	1.8	1.8	4.2	2.5
Nickel	mg/kg dry wt	*0.05*	27.6	30.9	57.1	23.5	28.5
Zinc	mg/kg dry wt	*0.05*	23.3	21.1	28.1	24.8	15.9
Antimony	mg/kg dry wt	*0.025*	0.094	0.100	0.088	6.13	5.08

Heavy Metals in Soil

		Client Sample ID	12510C
		Date Sampled	9/01/2017
Analyte	Unit	*Reporting Limit*	17-01078-26
Arsenic	mg/kg dry wt	*0.125*	19.4
Beryllium	mg/kg dry wt	*0.013*	0.63
Boron	mg/kg dry wt	*1.25*	<1.25
Cadmium	mg/kg dry wt	*0.005*	0.059
Chromium	mg/kg dry wt	*0.125*	153
Copper	mg/kg dry wt	*0.075*	48.1
Lead	mg/kg dry wt	*0.05*	6.01
Mercury	mg/kg dry wt	*0.025*	1.4
Nickel	mg/kg dry wt	*0.05*	37.0
Zinc	mg/kg dry wt	*0.05*	23.0
Antimony	mg/kg dry wt	*0.025*	3.34

Soil Aggregate Properties and Nutrients

		Client Sample ID	12501B	12501C	12502B	12502C	12503A
		Date Sampled	9/01/2017	9/01/2017	10/01/2017	10/01/2017	29/09/2016
Analyte	Unit	*Reporting Limit*	17-01078-1	17-01078-2	17-01078-3	17-01078-4	17-01078-5
pH*		*1*	3.3	3.4	3.5	3.6	5.0

Soil Aggregate Properties and Nutrients

		Client Sample ID	12503B	12503C	12504A	12504B	12504C
		Date Sampled	29/09/2016	29/09/2016	29/09/2016	29/09/2016	29/09/2016
Analyte	Unit	*Reporting Limit*	17-01078-6	17-01078-7	17-01078-8	17-01078-9	17-01078-10
pH*		*1*	4.2	3.8	5.5	3.9	3.7

Soil Aggregate Properties and Nutrients

		Client Sample ID	12505A	12505B	12506A	12506B	12507A
		Date Sampled	6/01/2017	6/01/2017	6/01/2017	6/01/2017	10/01/2017
Analyte	Unit	*Reporting Limit*	17-01078-11	17-01078-12	17-01078-13	17-01078-14	17-01078-15
pH*		*1*	4.1	4.1	5.1	5.1	4.1

Soil Aggregate Properties and Nutrients

		Client Sample ID	12507B	12507C	12508A	12508B	12508C
		Date Sampled	10/01/2017	10/01/2017	6/01/2017	6/01/2017	6/01/2017
Analyte	Unit	*Reporting Limit*	17-01078-16	17-01078-17	17-01078-18	17-01078-19	17-01078-20
pH*		*1*	4.1	4.1	4.5	4.4	4.1

Soil Aggregate Properties and Nutrients

		Client Sample ID	12509A	12509B	12509C	12510A	12510B
		Date Sampled	9/01/2017	9/01/2017	9/01/2017	9/01/2017	9/01/2017
Analyte	Unit	*Reporting Limit*	17-01078-21	17-01078-22	17-01078-23	17-01078-24	17-01078-25
pH*		*1*	3.9	3.9	4.0	4.9	3.9

Soil Aggregate Properties and Nutrients

		Client Sample ID	12510C
		Date Sampled	9/01/2017
Analyte	Unit	*Reporting Limit*	17-01078-26
pH*		*1*	3.9

Method Summary

Elements in Soil Acid digestion followed by ICP-MS analysis. US EPA method 200.8.

pH in Soil 1:2.5 extraction with 0.1M calcium chloride followed by pH probe determination. Department of Sustainable Natural Resources.

Report Comments

Samples were received by Analytica Laboratories in acceptable condition unless otherwise noted on this report.

Terry Cooney, Ph.D.
Signatory