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PATTLE DELAMORE PARTNERS LTD

Moanataiari Subdivision
Site Investigation Report

Waikato Regional Council

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Prepared for
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Executive Summary

Waikato Regional Council (WRC) engaged Pattle Delamore Partners Limited (PDP) to undertake a limited soil cap depth and sampling investigation of the Moanataiari subdivision in Thames. WRC requested that this site be investigated because a preliminary desktop study undertaken in June 2010 has identified that the subdivision is located on land reclaimed from the Firth of Thames using mine waste, municipal landfill and unidentified wastes. Therefore, WRC has commissioned this site investigation to delineate and characterise the chemicals in the ground so as to assess the risks to the community and therefore determine the need for any future investigations required for the site.

Between the 26 to 28 October 2011 hand augering was undertaken at 28 locations across the site. The sampling was undertaken based on a distorted 100 m grid sampling pattern, with the grid being distorted to ensure all sampling locations were located on public areas (such as road verges). Every borehole was carefully logged by a qualified geologist and soil samples were collected from the surface (0-10 cm), 0.5 m, 1.0 m and, where possible, 1.5m depth below ground level.

All samples collected from the surface (0-10 cm) and at 0.5 m were submitted to Hills Laboratory for chemical analysis (except M0A026 where only the surface sample was submitted). In addition to these samples the 1 m deep samples, which were believed to be collected within the fill material, were submitted from 15 of the 28 sampling sites. At one position (MOA022) the 1.5 m sample was also analysed.

The soil samples were analyzed to determine total recoverable (US EPA method 200.2) antimony (Sb), arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), lead (Pb), mercury (Hg), nickel (Ni), and zinc (Zn). At 20 hand auger locations the soil samples were also analysed for Total Petroleum hydrocarbons (TPH). Samples from these 20 hand auger locations were selected for TPH analysis on the basis that either historical information indicated that landfill waste may be present at these locations or hand augering confirmed the presence of organic wastes at these sampling locations.

The laboratory testing found that the concentration of arsenic exceeded the National Environmental Soil Contaminant Standard (SCS) for arsenic of 20 mg/kg for residential soils at all of the surface sampling sites. (Residential use is not applicable to the road reserve where the samples were collected but the comparison allows for the possibility that the sample results are indicative of the soils in the residential properties).

The highest concentrations of arsenic were found east of Kuranui Street. The two highest surface soil samples collected in this area contain arsenic concentrations at 320 and 350 mg/kg, which are 16 and 17.5 times higher than the national standard for arsenic in residential soils. Arsenic concentrations in soil samples collected from sampling sites located west of Kuranui Street were much lower than those obtained from the east of Kuranui Street. The analytical results obtained from the laboratory also indicate that the

concentration of arsenic is generally higher in samples collected from greater than 0.5 m depth than those obtained from the surface (0-10 cm).

In addition to elevated concentration of arsenic found in the soils, elevated concentrations of antimony and lead, which exceed the default soil guideline value (antimony) or soil contaminant standard (lead) for protecting human health on residential properties, were present in some surface samples. Testing of the samples for total petroleum hydrocarbons (TPH) found that the concentrations of TPH in the samples were below the analytical detection limit in most samples. However, at sampling location MOA021 hydrocarbon residues were detected and therefore the soil samples from this location were also analysed for polycyclic aromatic hydrocarbons (PAHs). The PAH testing found that the benzo(a) pyrene equivalent (BAP eq) was lower than the National Environment Standards (NES) soil contaminant standard (SCS) for human health in all of the samples.

After receiving the initial laboratory report, the 10 samples with high concentrations of arsenic were re-analysed using an extended element suite of 32 elements to determine if there were any other elements which were elevated enough to potentially exceed human health protection guidelines or standards. This analysis revealed that thallium concentrations in all of the soils tested was higher than the US EPA guideline value for human health protection (0.8 mg/kg) (There is no New Zealand guideline or soil contaminant standard (SCS) for thallium in residential soils). The laboratory was then asked to identify which samples potentially contained concentration of thallium above 1 mg/kg and these samples were analysed for thallium. In cases where thallium exceeded 1 mg/kg thallium (28% of samples), concentrations of up to three times the USEPA guideline were detected. Relative to guideline values, thallium, antimony and lead remain secondary contaminants compared with arsenic, and dealing with arsenic issues would also deal with those of the other three elements.

Soil gas measurements were undertaken at 8 sampling locations where historical information suggested that municipal waste may be present. However no evidence of landfill gas was found in any of these monitoring locations.

On the 15 November 2011 an XRF survey was undertaken at 70 locations alongside the road verges within the Moanataiari subdivision. The XRF survey confirmed the findings of the laboratory testing undertaken on the surface soil samples. The XRF measurements found elevated concentrations of lead at several locations between Ensor, Kuranui Street and Tararu Road. Readings of up to 1100 parts per million (ppm) were detected in a surface soil sample measured at one location, but in general XRF results for lead were in keeping with results of laboratory testing.

All the soil samples were collected from the road verge away from underground services and no soil samples or XRF readings have been undertaken on residential properties. It is possible that the roadside verges may contain more arsenic on average than the adjacent residential properties. This is because the verges may have been subjected to more mixing of material excavated from beneath the ground surface than some of the

residential properties, when the roadways were established. Therefore it is not possible to infer soil concentrations on residential properties using the data obtained by laboratory analysis of soil samples or XRF measurements from the adjacent soil sampling locations.

On the basis that widespread exceedances of the SCS for residential soils were detected across that Moanataiari subdivision, PDP recommends that:

- Soil testing of all residential sites within the subdivision should be undertaken.
- For laboratory testing of the soil samples and XRF measurements the analytical suite should include antimony, arsenic, cadmium, lead and thallium.
- Residents and workers (including maintenance workers and contractors) at the subdivision should receive advice on how to minimise health risks that may be associated with coming into contact with chemically impacted soils within the Moanataiari subdivision.
- Further testing of petroleum hydrocarbons and landfill gas is not required at the site.

Note on Terms

Heavy metals / trace elements

The focus of this report is on concentrations and sources of ten chemical elements (some of which are major elements, and some are trace): antimony (Sb), arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), mercury (Hg), lead (Pb), thallium (Th) and zinc (Zn). Sometimes arsenic, cadmium, chromium, copper, mercury, lead 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' exist in the scientific literature and the group of elements covered by that term changes depending on the definition used. In addition, arsenic is not regarded as a true metal, but a metalloid. The term 'elements' is used in this report because it is not ambiguous, and accurately describes the group of elements that are the focus of this work.

The term 'trace element' refers to a chemical element that is not one of the ten major elements that occur in the earth's crust. Ninety-nine percent of the earth's crust is composed of these ten major elements: silicon, oxygen, aluminium, iron, calcium, potassium, sodium, magnesium, titanium and phosphorus. All other elements are 'trace elements', and most are present at natural concentrations of well under 100 mg/kg (parts per million) in the earth's crust.

Glossary of Terms	
Acid Digestion	A laboratory sample preparation technique to prepare samples for analysis using a strong acid to release the chemical elements from the soil.
Antimony (Sb)	A naturally occurring chemical element concentrated in some gold bearing mineral deposits and typically found as a trace impurity in pyrite and occasionally in the sulfide mineral stibnite (Sb_2S_3).
Arsenic (As)	A naturally occurring chemical element concentrated in some mineralised rocks in the Coromandel area and typically found with pyrite and occasionally in the sulphide minerals orpiment (As_2S_3), realgar (As_4S_4), arsenopyrite ($FeAsS_2$) and Enargite (Cu_3AsS_4).
Benzo(a) pyrene equivalent (BAP eq.).	Benzo(a) pyrene equivalent is a technique used to calculate the overall carcinogenic (cancer causing) potential of a group of PAHs compounds. This is done by assessing the overall cancer potency relative of the group of PAHs by multiplying the concentration of the cancer causing PAHs by their relative potency as compared benzo(a) pyrene (one type of polycyclic aromatic hydrocarbon).
Cadmium (Cd)	A naturally occurring chemical metal element found in low levels in soils and rocks and also present in superphosphate fertilisers.
Chromium(Cr)	A naturally occurring chemical metallic element found in low levels in soils and rocks.
Copper (Cu)	A naturally occurring chemical metallic element found in low levels in soils and rocks which is enriched in some mineralised rocks present in the Coromandel area.
Elevated	Concentrations are considered elevated if they are above background concentrations.
Hand Auger	A hand-held, manually turned drilling device with a rotating blade for boring into the earth and removing the drilled out material.
Landfill Gas	A complex mix of different gases created by the action of microorganisms within a landfill. Landfill gas is comprised of methane and carbon dioxide.

Lead (Pb)	A naturally occurring chemical metallic element found in low levels in soils and rocks which is enriched in some mineralised rocks present in the Coromandel area.
Mercury (Hg)	A naturally occurring chemical metallic element found in low levels in soils and rocks which are enriched in some mineralised rocks present in the Coromandel area.
Metals	The main metallic elements consider in this report include aluminium, cadmium, chromium, copper, lead, mercury, nickel, thallium and zinc.
Metalloids	A group of elements which have properties similar to metals and non-metals elements. The group of elements which are generally consider being metalloids are boron, silicon, germanium, arsenic, antimony and tellurium.
Mullock	Waste rock from which valuable material has been extracted. Mullock can be generated in the search for minerals or during the mining process.
NES Soil Contaminant Standard (SCS)	Numerical value for a soil contaminant that has regulatory status under the National Environmental Standard (NES)
Nickel (Ni)	A naturally occurring chemical metallic element found in low levels in soils and rocks.
Petroleum Hydrocarbons	Naturally occurring, organic compounds that are found in fossil fuels such as petrol or coal.
Polycyclic aromatic hydrocarbons (PAHs)	PAHs are chemical compounds which are found in the environment that are formed mainly by the incomplete combustion of organic materials, such as wood or fossil fuels. PAH molecules are made up of 3 or more benzene (aromatic) rings which are joined together.
Semi-quantitative	Yielding an approximation of the concentration or amount of a substance; falling short of a quantitative result.
SGV	Soil Guideline Value. Soil contaminant concentrations derived on a site-specific basis or derived in accordance with appropriate hierarchy.
Tailings	The materials left over after the process of separating the valuable fraction from the uneconomic fraction of an ore.
Thallium (Th)	A naturally occurring chemical element concentrated in some mineralised rocks in the Coromandel area and may be found as a trace impurity in pyrite containing rocks.

Trace Element	A naturally occurring element that is not one of ten major elements that occur in the Earth's crust.
Zinc (Zn)	A naturally occurring metallic chemical element found in low levels in soils and rocks which is enriched in some mineralised rocks present in the Coromandel area.

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1.0 Introduction

Waikato Regional Council (WRC) has engaged Pattle Delamore Partners Limited (PDP) to undertake an assessment of the soil capping depth and to undertake soil chemistry tests of the Moanataiari subdivision in Thames (Figure 1). The subdivision is located on land reclaimed from the Firth of Thames using mine waste, municipal landfill and unidentified wastes.

A Phase 1 historical desktop review of the site (CSI, 2010) revealed that the Moanataiari community of residential housing is situated on wastes that potentially contain a range of chemicals. Therefore WRC engaged PDP to conduct a limited site investigation to further delineate and characterise the chemicals in the ground so as to assess the risks to the community and therefore determine the need for any future site investigations. In addition, the investigation is to provide limited information on the nature and presence of the capping and fill material at the site.

1.1 Background to the Investigation

In 2005, WRC engaged an environmental consultant to undertake sediment sampling of the lower Firth of Thames to determine trace element concentrations at a range of sites. The sediment sampling identified a localised hotspot of arsenic (average concentration of 36.9 mg/kg) and mercury (average concentration of 0.7 mg/kg) near the Moanataiari subdivision (N. Kim, 2007). At this time it was brought to the attention of WRC staff that a Ministry for the Environment (MfE, 2001) publication stated that the Moanataiari subdivision had been reclaimed from the sea using mullock and mine tailings. This suggested an explanation for elevated mercury and arsenic in sediments outside the Moanataiari sea-wall: that this was due to presence of mine tailings material in the area.

As part of a separate study for urban soils (11 towns throughout the Waikato Region) surface soil samples were collected from the Moanataiari School on the 19th January 2007. The sampling involved the collection of 16 sub-samples from the upper 10 cm of the soils of the Moanataiari School recreational field to form a single composite sample. These sub-samples were composited together and one sample was analysed by Hill Laboratories which showed that the concentration of these elements were within the typical background concentration range for soils found in the Waikato region (N. Kim, WRC, pers. coms.). It was later discovered from council records that around the time of subdivision development the school was built up an additional meter using imported fill materials, therefore these soil sampling results may not be representative of the rest of the subdivision

In 2010, WRC commissioned a Phase 1 desktop scoping report to investigate the composition of the fill material used to construct the Moanataiari subdivision and to identify potential risks to human health and the environment. The report identified a high potential risk to residents east of Tararu Road and a medium potential risk to residents west of Tararu Road (CSI, 2010). This risk assessment was based only on qualitative data (interviews with various people and review of District and Regional Council records);

no quantitative information (i.e. concentration of elements within the soils) was used to undertake this assessment. WRC forwarded the report to the Ministry for the Environment (MfE) in 2011 as required by the contaminated site remediation fund (CSRF) priority list review exercise. A subsequent independent review of the report identified a number of uncertainties relating to the site such as depth and distribution of capping material, as a result the site was provisionally placed on the Ministry's draft priority list (Bruce Croucher, MfE, pers. coms.).

In order to further assess uncertainties relating to the site WRC commissioned this study, particularly to address potential human health risks associated with contaminated soils in the Moanataiari subdivision. Following the receipt of interim results for this investigation indicating elevated arsenic levels WRC also commissioned PDP to develop preliminary screening criteria for acute arsenic toxicity in soils.

1.2 Scope of Works

The scope of works, as set out in WRC's e-mail dated 21 September 2011, is:

- Carry out shallow hand augered boreholes, to a target depth of 1-1.5m below ground level (bgl), at approximately 23 locations (chosen by WRC on a distorted 100 m grid spacing). The depth of the boreholes would be dependent on the subsurface conditions encountered (i.e. if waste material is encountered);
- Ensure that all borehole locations are placed on public land (e.g. road side verges);
- Select approximately 1-2 soil samples from each borehole location to be analysed by an IANZ accredited laboratory. (The number of samples selected for analysis per borehole would be dependent on the total depth achieved);
- Undertake measurement of surface soil samples using a portable X-ray florescence spectrometer (XRF) to improve investigation coverage across the site;
- Uptake landfill gas measurements at up to 10 selected locations;
- Undertake macro-digestion and laboratory testing of selected samples containing waste material for heavy metals; and
- Report on the findings, including comparison of results against residential and other applicable land use guidelines.

2.0 Site Description and History

2.1 Site Description

The Moanataiari subdivision is located on the foreshore at the northern end of Thames, adjacent to State Highway 25 (Figure 1). The subdivision is bounded to the North and West by the Firth of Thames, to the south by Burke Street and to the east by Queen Street (State Highway 25). The subdivision is generally flat. The western end of the site

is slightly below high tide level. The seawall adjacent to Fergusson Drive is raised above the surrounding land to prevent storm surges inundating the subdivision.

There are approximately 200 households within the subdivision and the average section size is approximately 0.07 ha (700 m^2). Based on Census data from the 1996, 2001 and 2006 there are approximately 435 to 460 residents living in the sub-division and there appears to be about 27 children under 6 years old living in the subdivision.

Moanataiari primary school is located between Moanataiari Street to the east, Kuranui Road to the West, Burke Street to the South and Ensor Street to the north (see Figure 1). The school has a roll of 101. Most of the site around the school buildings is grass-covered. A small vegetable garden is located on the western site of the school. The topography of the school is predominately flat however the perimeter on the southern end of the school (where the recreational field is located) is elevated approximately 1 m above the adjacent footpath.

A Montessori play centre is located on the western side of Moanataiari School between the recreational field of the primary school and Moanataiari Road. The school operates out of an existing class room block and has its' own fenced off area. The site is predominately covered in grass with a large bark covered playground located in the southeastern portion of the school area and a shallow (approximately 10 cm deep) sandpit located between the bark playground and the classroom.

The Thames Early Childhood Education Centre is located adjacent to the A & G Price foundry on the corner of Tarau Road and Haven Street. Approximately 63 children under 5 are enrolled here. Visual observations by PDP staff indicate the playing areas within the Child Education Centre are all covered with artificial surfaces and there is a sand pit located on the site. PDP staff saw no vegetable gardens, fruit trees or grassed play areas on the site.

2.2 Site History

Based on the information summarised in the scoping report prepared by Contaminated Site Investigation (CSI) (CSI, 2010), the reclamation of the foreshore at Moanataiari is believed to have begun soon after gold was discovered in the foothills at the mouths of the Kuranui, Moanataiari and Waiotahi streams in the 1860s. Mullock (waste rock) and mine tailings were discharged into the coastal area from seven stamper batteries located on the foreshore. As a mercury amalgam process was used to extract the gold from the crushed ore it is possible that the tailings may be enriched with mercury. Mine wastes were pushed into the Firth of Thames behind the seawalls which were created by the Thames Harbour Board for the Thames Goods Wharf. Records from the Thames Coromandel District Council (TCDC) state that prior to 1920 infilling of the Moanataiari reclamation comprised of mine mullock or tailings. The Thames Borough Council inherited the reclamation from the Thames Harbour Board in 1936 and commenced developing the sub-division around 1948. The council also used the reclamation as a local tip for at least five years, with deposal of municipal waste occurring west of Moanataiari Street and south of Ensor Street.

TCDC council records show that a clay cap has been placed over the majority of the subdivision, however it is not certain if the properties east of Tararu have been capped as this area predates the Thames Borough Council subdivision works. Most of the clay used for the cap was sourced from the quarry located east of the Moanataiari reclamation. It is possible that this material may contain elevated concentration of metals due to mining activity occurring in the area where the capping material was sourced.

The extent of the clay cap between Tararu Road and Kuranui Street is not known as aerial photographs in 1940s indicate that the pre-existing fill of mullock and tailings was extensive.

The CSI 2010 report states that clay comprised the majority of the fill from Kuranui Road west but as municipal waste was also deposited in this area the depth and lateral extent of the clay cap in this area is unknown.

Oblique aerial photography and interviews indicate that the surface of the reclamation was very hummocky prior to any capping occurring and this could mean that the capping depth could be highly variable between locations.

The subdivision is believed to have been developed in three main stages, with houses being established:

- Pre 1914 – East of Tararu Road,
- Between 1950 to late 1960s – Tararu Road to Kuranui Street,
- 1970s – Kuranui Street to Fergusson Drive

Figure A summarises the extent of knowledge regarding the type of fill used in the Moanataiari subdivision as determined in the CSI 2010 report.

Figure A Moanataiari Subdivision – Potential Fill Areas

3.0 Site Investigation Methodology

3.1 Soil and Landfill Gas Sampling

3.1.1 Hand Auger Investigations

On 26, 27 and 28 October 2011, a series of hand augered boreholes was completed on a grid pattern throughout the road reserves across the suburb of Moanataiari by PDP staff. The boreholes were undertaken to a target depth of 1.5 m bgl to investigate fill depth and to provide soil samples for testing. The grid spacing was based on the WRC distorted grid, with sampling locations set out at approximately 100 m intervals across the suburb.

A total of 28 hand auger boreholes (MOA001-MOA028), were located on the approximate nodes of the grid, to obtain thorough coverage across the Moanataiari area. Four of the boreholes (MOA009, MOA012, MOA027-028) were undertaken within the boundary of Moanataiari School, with all other bores located in public areas (i.e. road side verges). Two of the boreholes were targeted to specific areas within the school, the first (MOA027) in the Moanataiari School Garden, and the second (MOA028) in the area indicated to PDP by the Moanataiari School Principal where it is proposed to extend the school garden on to an adjacent grassed area. MOA009 and MOA012 boreholes locations where moved onto the boundary of the school from there initial sampling based on the 100 m grid to avoid underground services.

Prior to the commencement of any site work a review of all utility services in the vicinity of the location of proposed boreholes was carried out.

Each proposed borehole location was then checked for buried services by Underground Service Locators. In any instance that the borehole location was deemed to be too close to an existing underground service, the borehole was moved to a more safe location free from buried services. For proposed borehole locations MOA001-003 and MOA005 a low voltage power cable was inferred to be too close to the proposed borehole locations. Due to the presence of the existing seawall running parallel to Fergusson Drive in the west of the subdivision it was deemed that no other suitable sampling locations were feasible. A stand over and service location was provided by a technician from TENIX (local electricity line contractor) for the proposed borehole locations MOA001-003 and MOA005 to ensure the safety of the PDP field staff.

3.1.1.1 Capping Depth

To accurately assess the depth of fill and/or natural ground at the location of each borehole, every borehole was carefully logged by a qualified engineering geologist in accordance with the New Zealand Geotechnical Society ‘Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes’ dated December 2005.

3.1.1.2 Soil Sampling

At each borehole location a surface soil sample was initially collected from the top 10 cm of soil material, after first removing the grass. The surface samples represent soil that a person could be exposed to during normal activities around the site. Deeper soil samples were also collected where possible, at each borehole location at approximately 0.5 m, 1.0 m and 1.5 m depth below ground level.

The boreholes completed on both the grid and at targeted locations were advanced using a hand auger with a 50 mm diameter dutch head. The hand auger was cleaned between each location by scrubbing the head and extension rods with a mixture of decontamination detergent (Decon90) and fresh water. The equipment was then rinsed with fresh water, in order to minimise the chance of cross contamination occurring between investigation locations in accordance with the MfE's Contaminated Land Management Guidelines - No. 5; Site Investigation and Analysis of Soils 2004 (MfE, 2004). On completion of each borehole location, the disturbed soils that were not collected for sampling were placed back into the borehole.

A new pair of disposable nitrile gloves was worn for each sample collection to prevent cross contamination between samples. Soil samples were placed into individual glass and plastic jars supplied by the analysing laboratory (Hill Laboratories Ltd in Hamilton) and immediately placed into chilled storage.

Prior to shipment to the laboratory, the soil samples remained in chilled storage before being packed in a chilly bin with ice packs and delivered by PDP under standard chain-of-custody procedures to the laboratory for analysis. The chain-of-custody documentation for the soil samples is appended to this report.

3.1.2 Landfill Gas Sampling

In areas where municipal solid waste was suspected to be present, PDP undertook a gas spiking measurement. An AMS Soil gas probe was driven into the ground to just above the groundwater level or 1 m (which ever was the shallowest) and then the AMS probe was connected to a GA2000+ landfill gas meter (serial number GA13464). The GA2000+ is capable of continuously and simultaneously recording the concentrations of methane, carbon dioxide, carbon monoxide, hydrogen, hydrogen sulphide and oxygen. Peak soil gas measurements were recorded by the field staff.

3.1.3 XRF Investigation

A Nitron XL3t portable X-ray fluorescence (XRF) instrument (serial number 30189) was used to semi-quantitatively determine the in-situ concentration of trace and major elements in the soil. All XRF measurements were undertaken by a PDP staff member who is a licensed XRF operator, who has been trained in the safe use of portable X-ray equipment.

XRF measurements were taken at sites located between the soil sampling locations to better delineate of element distributions in the investigation area. The portable XRF instrument was placed directly in contact with the ground to ensure that the X-ray window was fully in contact with the soil. XRF readings were taken for at least 90 seconds. The X-ray window was cleaned between sampling locations in accordance with the manufacturer's instructions.

The XRF measurements were not undertaken in accordance with US EPA protocol 6200 as the purpose of this exercise was to further delineate areas of high trace element concentrations from areas of low trace element concentrations. In particular, the soil samples were not screened through a minus 2 mm sieve and dried before XRF measurements. The consequence of this testing approach is that the in-situ soils have higher moisture content than the samples that the laboratory analysed and may have included material (i.e. gravels). The higher moisture content of the in-situ soils and the presence of gravels in the sample might result in the XRF reading slightly lower concentrations than the laboratory result.

The soil sampling locations where XRF readings were collected were recorded using a high resolution GPS (x-y positional RMS, error less than 0.5 m). This method was used so that the precise location can be revisited should further sampling be required (for example, because a hotspot was detected).

XRF readings were taken of 20 soil samples that were sent to the lab for analysis, which allowed PDP to determine the bias and relative precision of the XRF measurements against the laboratory results.

Also, the multi-element capability of the portable XRF meter was used to screen the samples to determine if any further elements should be included in the laboratory analytical suite.

3.2 Laboratory Analysis

All soil samples collected from the surface (0-10 cm) and at a depth of 0.5 m were scheduled for laboratory analysis (except M0A026 where only the surface sample was submitted). In addition to these samples the 1 m deep samples believed to be collected within the fill material, from 15 of the 28 sampling locations, were also analysed by the laboratory. At one location (MOA022) the 1.5 m sample was also analysed because PDP staff felt that the material was indicative of mine wastes.

At one sampling location (MOA005) organic waste was encountered at 1.5 m, therefore to reduce problems associated with potential nugget effects[1], a 10 g macro-digestion procedure was used to digest this sample. Using an increased mass of sample helps to

[1] A nugget effect is when the analysis of samples does not adequately represent the composition of the bulk material tested due to the presence of high-concentration nuggets in the material.

minimize the effects of sample inhomogeneity, and thereby obtaining a truer representation of the analytes present in the sample.

Selected samples submitted to Hill Laboratories were analyzed to determine total recoverable (US-EPA method 200.2) antimony (Sb), arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), lead (Pb), mercury (Hg), and zinc (Zn).

An extended element suite of 32 elements was undertaken of the 10 samples which had the highest concentrations of arsenic to identify if there were any other elements of potential concern.

Twenty-one soil samples were also analysed for total petroleum hydrocarbons (TPH). Samples were selected for TPH analysis if PDP staff identified municipal waste or obvious signs of petroleum hydrocarbons being present at the location (either based of field observations or historical information). If petroleum hydrocarbons were detected in the samples then the sample TPH chromatographs were evaluated in consultation with the laboratory to determine if follow-up analysis of individual polycyclic aromatic hydrocarbons (PAHs), volatile organic compounds (VOC) or benzene, toluene, ethylbenzene and xylene (BTEX) compounds was required.

3.2.1 Target Analytes

3.2.1.1 Trace Elements

Metals and metalloids included in the analytical suite were arsenic, antimony, copper, lead, mercury and zinc, as these elements are typically found in mine wastes. Sediment samples collected by University of Auckland (Bosely & Maulk, 2008) and WRC have determined that freshwater and marine sediments around Thames contain elevated concentrations of arsenic and mercury and to a lesser extent antimony, copper, lead and zinc. Work undertaken by the University of Otago (Craw D. and Chappell, (2000), Craw, D. (2003), Haffert, L. and Craw, D. (2008a and 2008b) has also determined that sediment and water around former mine sites within Coromandel contain elevated arsenic, antimony and mercury. Although it is typical to include nickel in many soil sampling investigations, historical sampling results around Thames (N. Kim, 2007; WRC, 2011; PDP, 2011) have indicated that nickel is not normally elevated in mine waste or environmental samples in this area.

3.2.1.2 Petroleum Hydrocarbons

Petroleum hydrocarbons are known to be associated with municipal solid waste, landfills and coal ash (potentially from the furnace of the A&G Price foundry located on the south eastern corner of the investigation area); therefore these compounds were identified as potentially being present during the Phase 1 review of the site (CSI, 2010).

PDP experience drawn from other sites similar to this suggests that a site of this age and size will not have a significant, more volatile (and then degradable) contaminants found in landfills, however, benzene and other mono-aromatic hydrocarbons may be present.

3.2.2 Quality Assurance/Quality Control

To determine the variability in the sample composition and the precision of laboratory analysis, duplicate extraction and analysis of 6 samples from the sampling area was undertaken. The relative percentage difference (RPD) for the replicates samples was then calculated to assess the heterogeneity of the sample. Relative percentage difference of less than 30% indicates that the sample results are representative of the average element concentrations in the samples. Relative percentage difference of greater than 50% indicates that the sample may be highly heterogeneous or there may be a problem with the laboratory extraction and analysis.

4.0 Soil Standards and Guidelines

4.1 Introduction

A risk to human health or the environment can only arise if there is a hazard (e.g. contaminated soil or water), a receptor (people or the environment) and an exposure pathway between the hazard and receptor. An absence of any of these components means no risk can exist. As an initial step, it is appropriate to consider through the development of a conceptual site model what receptors exist, how they might be exposed to the contaminant, and if this exposure is possible, whether the concentrations of contaminant in the soil (as measured by the soil testing) are sufficiently high to conclude an adverse effect is possible from that exposure. In the case of people this is an adverse effect on health.

The normal way of establishing whether there is a possibility of effects is to compare the sampling results with soil guidelines values or standards. Depending on the legal context, guidelines typically are advisory values while standards are often mandatory. For simplicity, in this section the term guideline is used for both values unless the context requires a mandatory sense, in which case the term standard is used.

New Zealand has soil guideline and standards for some contaminants but otherwise draws on overseas guideline values. For this report, only human health is being considered and therefore comparisons have been made to human guideline values, not guidelines intended to protect ecological receptors.

The Ministry for the Environment has established policy for selecting guidelines in its document '*Contaminated Land Management Guidelines No.2 – Hierarchy and Application in New Zealand of Environmental Guideline Values*' (MfE, 2011a). This document establishes the following principles:

- New Zealand guideline values should be used in preference to guidelines from other nations; and,
- Preference should be given to the guidelines using a risk assessment methodology to establish guideline values.

The MfE then ranks reference documents in the following hierarchy (from most to least preferred):

- New Zealand derived risk-based guideline values;
- Internationally derived risk-based guideline values, with preference given to those nations using risk assessment methodologies consistent with those used in New Zealand;
- New Zealand derived threshold values; then
- Rest of the world derived threshold values.

This hierarchy has been followed in choosing values.

4.2 Conceptual site model

The sampling was carried out in road verges with the intent of establishing possible risks to Moanataiari residents; the assumption being that the soil under road verges is similar to soil in nearby residential properties. The receptor to be considered is therefore residents of those properties. That is not to say there are not other potential human receptors, e.g. workers who may carry out excavations under the verges or roads, but these people are not considered in this report (and are at considerably less risk than residents exposed to the same contaminant concentrations). A further group of people who may be exposed to soil on road verges are children from nearby houses who use the verges as play areas.

Residents are exposed to soil through a variety of activities and through a number of exposure routes or pathways. The primary routes of exposure are:

- soil ingestion
- absorption of contaminants through the skin from soil that accumulates on exposed skin surfaces (dermal absorption)
- eating of produce (principally vegetables) grown in contaminated soil at home

For volatile contaminants (e.g. petroleum hydrocarbons like petrol) inhalation of vapours from contaminated soil is also a relevant pathway. Breathing in of contaminated dust is not a significant pathway for a typical residential situation (MfE, 2011b) but may be relevant for an excavation worker or similar occupational setting.

New Zealand residential guidelines are derived assuming exposure by soil ingestion, dermal absorption, home-grown produce ingestion and, where relevant, inhalation of vapours. Most overseas guidelines do not include home-grown produce.

The primary contaminants of concern at Moanataiari are arsenic and lead. For these contaminants the primary concern is soil ingestion and to a lesser extent eating of home-grown vegetables. Absorption of arsenic and lead through the skin is negligible.

For children using road verges as play areas soil ingestion and dermal absorption are relevant pathways but eating of produce grown in that soil is not relevant.

There are also schools and child-care centres in Moanataiari. The receptors in these cases are the children and staff. The same exposure pathways exist as for the residential situation, except it would be an unusual school or childcare centre that had a vegetable

garden that provided a significant part of a person's produce diet. Thus, home-grown produce ingestion would not normally be considered for an educational establishment.

4.3 Derivation of Soil Guideline Values

For simplicity, soil guideline values are derived for standard exposure scenarios following internationally recognised methods. Throughout the world, and New Zealand is no exception, one of the standard scenarios for which guidelines are derived is for residential use. New Zealand has chosen to derived guideline values for three residential scenarios; rural residential, standard urban residential and high density residential. The appropriate scenario for Moanataiari residential properties is standard urban residential (MfE, 2011b).

New Zealand has not adopted schools or childcare centres as standard scenarios and therefore has not derived guidelines for these land uses. As a first "screening" comparison to assess whether further study is warranted, one of the standard guideline scenarios can be used, provided the scenario is conservative relative to the likely actual exposure. For example, a residential value could be used for a childcare centre or primary school. A residential value will be conservative because it assumes more frequent exposure to soil than will occur at a school or childcare centre (seven days per week for most weeks in a year rather than the maximum five days per week at a school or childcare centre) and includes a greater allowance for exposure to home-grown produce than is likely to occur even if a school has a vegetable garden. Similarly, the recreational guideline value could be used for a secondary school playing field (MfE, 2011b). However, if on first screening it is apparent that soil samples exceed the initial conservative screening, it is generally more appropriate to derive what are known as site-specific values, using estimates of the actual soil exposure.

The standard scenarios assume that an average child and an average adult inadvertently consume a certain amount of soil each day, get a certain amount of soil sticking to their skin each day and, in the case of the residential scenario, eat a certain amount of home-grown vegetables each day (MfE, 2011b). The amounts are based on international and New Zealand research.

The relative proportions of contaminant entering the body through each exposure route are different for each contaminant. However, soil ingestion is often the greatest contributor to exposure. Most of us routinely ingest a small amount of fine soil particles and house dust (which contains some soil from outside) through actions such as touching our lips with dirty fingers or sucking our fingers which have soil or house dust on them, from dust sticking to our faces during gardening or playing outside and then licking our lips; from children sucking on dirty toys and from eating food with dirty hands. Small children on average ingest more soil than older children and adults.

This soil ingestion does not necessarily occur every day but occurs sufficiently frequently that average daily rates can be assumed to represent what is know as "chronic" or long-term exposure. Soil guidelines are derived to guard against health effects or assess risks from such chronic exposure. Soil guidelines are not derived to guard against or assess acute (short-term) poisoning risks that arise from one-off events or exposure over a few

days. Very few people will ever be exposed to sufficient contaminants in soil to be at risk from acute poisoning. However, there is a sub-set of children who have a behaviour known as soil-pica in which they deliberately eat soil. These children could be at risk if they consumed sufficient contaminated soil. Soil guidelines are not intended to protect such children; the normal approach being behaviour modification (MfE, 2011b).

WRC requested that PDP develop acute arsenic guideline values and to use these values to assess the analytical results. A copy of PDP report outlining the methodology used to derive these values is attached in Appendix E of this report. Acute soil guidelines values have not been derived for any other analyte measured during this investigation.

Different contaminants can have different effects on our health. Contaminants are put into two major categories based on, in simple terms, whether they cause cancer or not, with a slightly different approach to the guideline derivation for the two categories. The two types of contaminants are known as threshold and non-threshold contaminants.

For threshold contaminants there is a limit (generally an average daily limit known as a Tolerable Daily Intake - TDI) above which there may be a risk of a health effect if exposed to that daily amount for long enough (months and years) and below which there should be no effect on health. The intake threshold above which there might be a toxic effect is typically set by consensus amongst toxicology experts, generally at governmental level and often by international agencies such as the World Health Organization and the United Nations Food and Agriculture Organization. The TDI values are deliberately conservative, having factors of uncertainty and safety built into them. Exceeding a TDI does not mean a person will get sick; rather they are intended to be precautionary values above which the onset of subtle health effects might occur. Tolerable Daily Intakes are also used to set limits for contaminants in drinking water.

Daily intakes are calculated relative to body weight (MfE, 2011b). For a given intake a child is more vulnerable than an older person because a child has a lower body weight. For the purposes of guideline derivation in New Zealand a body weight of 13 kg is used, equivalent to about a two-year old. Research suggests a two-year old is likely to ingest more soil than either younger or older children thus, combined with low body weight and being at a developmentally vulnerable period, the small child is considered to be the critical receptor for threshold substances for the residential situation. Babies are considered at less risk because they are generally kept indoors and are insufficiently mobile to get as dirty as a toddler.

The small child being the critical receptor for a threshold contaminant means that for a given soil concentration a young child might be at risk while and older child or adult would not be at risk. For example, the soil concentration could be nearly 11 times greater for an adult compared with a small child. However, regardless of whether a young child happens to be living at a particular property, the lower guideline still applies on the precautionary principle to guard against the possibility of a child being resident at that property some point in the future. This principle is applied internationally.

For non-threshold contaminants there is no safe intake; instead a probabilistic approach is taken to assessing risk (MfE, 2011b). At a certain daily dose for a particular period of exposure (expressed in years) there is deemed by toxicology experts to be a certain probability of cancer, while at some other dose for the same exposure period there is some other probability. It is government policy in New Zealand to set the acceptable probability of excess cancer from contaminants for both soil and drinking water at 1 in 100,000 over a lifetime. A lifetime is defined as 75 years. Looked at another way, the acceptable dose is assumed to cause one extra cancer in a population of 100,000 people over their lifetime of 75 years. This is very much smaller than the normal incidence of cancer. In a population the size of Moanataiari it is unlikely that cancer could ever be definitively attributed to soil contamination as the theoretical rate would be tiny compared with the background incidence of cancer.

For the residential exposure scenario, guideline values for non-threshold substances are calculated by averaging childhood and adult weight-normalised intake rates[2] over a 24 year period (MfE, 2011b). This period has been selected as a typical maximum time in the same house for most people where the occupancy includes both childhood and adulthood. A lesser period of occupancy will mean a person is at a lower risk of cancer than 1 in 100,000 over a lifetime if the soil concentration is at the soil guideline concentration or, alternatively, a person could tolerate a higher soil concentration for the same risk. However, even if a person lives in the same house for longer than 24 years, the additional period will not necessarily increase the risk. In fact a consequence of the probabilistic approach using weight-normalised intake rates averaged over a lifetime is that somebody living at the same property for 50 years as an adult will have a similar risk to a child living at the property for just a few years.

A further consequence of the probabilistic approach for non-threshold contaminants is that soil concentrations less than the soil guideline value does not eliminate the risk of health effects, it just reduces the chance of effects. If the soil concentration was ten times less than the guideline than everything else being equal, the theoretical risk of cancer would be 1 in 1,000,000 over a lifetime. Alternatively, if the concentration was ten times greater than the guideline the theoretical rate of excess cancers would be 1 in 10,000 over a lifetime, still a small rate.

For the contaminants of greatest importance at Moanataiari, lead is a threshold contaminant and arsenic is a non-threshold contaminant.

4.4 Soil Guideline Application

Guideline values for non-volatile contaminants (the type of contaminants of concern at Moanataiari) apply to surface soil. People mainly contact near surface soil in their day-today lives and grow their vegetables in surface soil. There is no formal definition of surface soil in New Zealand (although the United States Environmental Protection Agency

[2] A weight-normalised intake rate is the intake rate divided by the body weight.

defines the surface as being the top 2 cm). For a nation of gardeners, a practical definition is not less than the typical depth of digging, say 0.25 to 0.3 m. However, to provide a buffer over this depth and to encompass other less frequent activities that might bring contaminated soil to the surface, it is reasonable to consider surface soil to be down to 50 cm. Soil deeper than this will be contacted rarely and a higher guideline value should apply.

The following activities might result in potential exposure to arsenic in soil at Moanataiari, in order of decreasing frequency. The list includes an estimate of the depth of soil that a person might be exposed to and the frequency that the person might undertake that activity. It should be noted that the depths and frequency estimates provided below are a matter of professional judgement and are only approximations:

- playing or digging in the garden, a frequent activity (up to several days per week?) – 25 to 30 cm;
- planting shrubs and small trees, an occasional activity (<10 times per year) – 45 to 60 cm;
- digging fence post holes, a rare activity (every few years?) – 60 to 90 cm;
- digging trenches for services for house extensions (20 – 30 years?) – 60 to 90 cm;
- installing a swimming pool, a one-off activity – 2 m.
- It is common for plant roots to exceed 60 cm in depth but the majority of the root mass will be less than 60 cm deep.

Soil guidelines are also intended to be applied to exposed soil. Grass and other more permanent cover provide a barrier to contact, this reducing the risk. However, for the residential setting grass is not considered permanent and therefore surface soil guidelines apply to lawn areas.

4.5 Selected Guideline Values

4.5.1 Metal and Metalloids

Where available, following the hierarchy in MfE (2011a), results have been compared to the Soil Contaminant Standard (SCS) values from the 'Methodology for Deriving Standards for Contaminants in Soil to Protect Human Health (MfE, 2011b). This document contains SCS for the following contaminants which were included as part of this investigation: arsenic, cadmium, chromium, copper and lead.

The values in MfE (2011b) were derived to support the National Environmental Standard (NES) for Assessing and Managing Contaminants in Soil to Protect Human Health. The NES comes into effect as regulations[3] under the Resource Management Act 1991 on Jan

[3] Resource Management (National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health) Regulations 2011 -

1 2011. From that date, the SCS will be mandatory (i.e. applied as standard) for exposed surface if soil disturbing activities are carried out. Until that date, the SCS have guideline status, but are considered to be the most appropriate values to apply as they have been derived in New Zealand using the most up-to-date methodology.

Where the NES does not contain a SCS for a metal or metalloid contaminant included as part of this assessment (i.e. antimony, thallium and zinc), guideline values have been selected using the hierarchy in MfE (2011a). Using this hierarchy, PDP has determined that the United States Environmental Protection Agency (US EPA) Regional Screening Levels (US EPA, 2011) are the most appropriate guidelines for comparing the analytical results for antimony and thallium, and the Australian NEPC (1999) are the most appropriate for comparing the analytical results for zinc.

The US EPA residential values do not include consideration of home-grown produce consumption but are derived using a childhood soil ingestion rate of 200 mg/kg. This is four times greater than the soil ingestion rate used for the New Zealand derivations and will compensate for not including the produce pathway. The US EPA values are derived as "screening" values to determine whether there is an issue worth looking at further and are not intended to be used as clean-up values.

The residential NEPC (1999) values are intended to apply to sites with home-grown produce but do not explicitly include the produce consumption pathway in their derivation. However, the derivations use a childhood soil ingestion rate of 100 mg/day, twice the rate used for the New Zealand values, and therefore should be conservative. The values are "health Investigation levels" intended for initial screening but are often used as clean-up values in their home jurisdiction.

The selected values are shown in Table 1.0.

4.5.2 Petroleum Hydrocarbons

On the basis of the MfE (2011a) hierarchy, the MfE *Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand* (1999) Tier 1 soil acceptance criteria (hereby refered to as the petroleum hydrocarbon guidelines) have been selected for comparison of the soils results for petroleum hydrocarbons (TPH and PAH compounds). The MfE (1999) Tier 1 criteria have been developed on a risk-based approach for protection of human health for a range of land uses including residential. In addition to site usage, the Tier 1 acceptance criteria take into consideration the environmental settings, including soil type (permeability) and depth to contamination.

The NES SCS value for benzo(a) pyrene equivalent has been used in this assessment instead of the guideline value for proposed in the MfE petroleum hydrocarbons guidelines. The SCS is based on more recent toxicological data and as such is a better indicator of the risks associated with the benzo(a) pyrene like compounds.

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http://www.legislation.govt.nz/regulation/public/2011/0361/latest/DLM4052228.html?search=ts_regulation_contaminants_resel&p=1&sr=1

As such, the Tier 1 soil acceptance criteria via All Pathways are a reflection of the most stringent criteria associated with the protection of human health via several exposure routes. Comparison of analytical results to these criteria reveals whether a more in-depth review of the potential exposure pathways is required at the site. Where a detailed review is required, route specific criteria are determined based on a site-specific assessment of both potential receptors and exposure pathways.

Therefore, the MfE (1999) Tier 1 soil acceptance criteria (All Pathways) for residential (MfE, 1999) have been applied as the most appropriate screening criteria for the comparison of the results of petroleum hydrocarbon analysis and are presented in Table C-3. The 'sandy silt' soil types have been applied for comparison with the relevant criteria for the soil samples. This soil types is considered to be most representative of the underlying soils encountered during the augering investigation.

4.5.3 Summary of Selected values

Table 1.0 below summarises the selected values.

Table 1: Summary of selected soil guideline values (mg/kg)

Analyte	Value	Source
Arsenic	20	Soil Contaminant Standard MfE (2011b)
Antinomy	31	Regional Screening Level US EPA (2011)
Cadmium	3	Soil Contaminant Standard MfE (2011b)
Chromium	460	Soil Contaminant Standard MfE (2011b)
Copper	No Limit	Soil Contaminant Standard MfE (2011b)
Lead	210	Soil Contaminant Standard MfE (2011b)
Mercury	310	Soil Contaminant Standard MfE (2011b)
Thallium	0.8	Regional Screening Level US EPA (2011)
Zinc	7,000	Health Investigation Level NEPC (1999)
TPH	Soil type dependant	Petroleum Hydrocarbons Guidelines (1993)
Total PAHs	Soil type dependant	Petroleum Hydrocarbons Guidelines (1993)
BaP (eq.)	25	Soil Contaminant Standard MfE (2011b)

5.0 Landfill gas assessment criteria

The landfill gas (LFG) assessment criteria used in this assessment are outlined in Table 2.0 below.

The maximum trigger value for methane of 1.25% is based on US EPA recommended values for in-ground methane near buildings (US EPA (2003) 310 CMR 19.132(4) (g & h)).

The maximum concentration for carbon dioxide of 5% has been set based on the recognised industry standard implemented in New Zealand.

Table 2: Summary of selected LFG trigger values (v/v):

Gas	Trigger Value
Methane (CH_4)	1.25%
Carbon Dioxide (CO_2)	5%

6.0 Results

6.1 General Geological Observations

The hand auger sampling locations are shown in Figure 2 in Appendix A and the geological logs for the twenty eight boreholes (MOA001-MOA028) are appended in Appendix B.

Topsoil (consisting of brown silt) was encountered at every borehole location with the exception of boreholes MOA021 and MOA027, which encountered gravelly silt and organic material, respectively. The thickness of topsoil generally ranged between approximately 0.1 m and 0.4 m. Fine gravels were encountered in the topsoil material in borehole locations MOA005, MOA007-8, MOA012, MOA014-015, MOA019-020, MOA026 and MOA028, and shell fragments in borehole locations MOA007-008.

The topsoil was generally underlain by soil fill material in borehole locations MOA001-018 and MOA020-MOA028 and shelly marine beach sediments in location MOA019. The fill material was inferred to be associated with the mining and reclamation works undertaken at Moanataiari and generally consisted of an orangey/yellowish brown and white, gravelly silt and sand with minor clay. The gravels encountered were up to cobble sized and were of an andesitic (volcanic) nature, although some quartz and pumice grains were also observed mixed with the fill material.

The thickness of the upper fill layer generally ranged between 0.1 m at sample location MOA007 and 0.9 m at sample location MOA010 and was on average approximately 0.5 m thick. The upper fill material was generally of a medium dense/stiff consistency.

Generally the material underlying the upper layer of fill varied between pumiceous clays, silts and sands, shelly beach marine sediments and more silty fill material.

Organic material was encountered at depth in boreholes MOA005 and MOA010 at 1.25 m and 1.2 m respectively.

Boreholes MOA002, MOA004, MOA006, MOA009-012, MOA016, MOA18-021 and MOA025-028 were unable to reach the target depth of 1.5 m due to difficult hand augering conditions through the gravelly fill material.

Groundwater was generally encountered between 0.4 m and 1.45 m depth. Groundwater was not encountered in all sample locations.

6.2 Laboratory Results

Seventy two soil samples were collected by hand auger across Moanataiari Subdivision from 26 to 28 October 2011. Sampling locations are shown in Figure 2 in Appendix A. The results of the analysis of these samples together with the sampling locations and sample depth are shown in Appendix C, Table C-1. A copy of the laboratory reports and chain of custody forms is attached in Appendix D.

6.2.1 Trace Elements

All of the surface soil samples collected from the site exceed the National Environmental Standard (NES) human health Soil Contaminant Standard (SCS) for arsenic and all of the surface samples collected from Kuranui Street east also exceed the lowest boundary of acceptable acute soil concentration of 39 mg/kg derived by PDP (see Appendix E). Four soil samples collected from MOA019, MOA020 and MOA022 exceed the NES Soil Concentration Standards (SCS) value for lead, however only one of these samples MOA019 was collected at the surface (the rest of the samples were collected at 0.5 m sampling interval). The main significance of the SCS in this context is as an indication of the point above which long-term risks would be above the level that would be tolerated in residential soils of a new subdivision under the national standard for contaminants in soil, after 1 January 2012. The SCS does not directly apply in any regulatory sense, because the national standard provisions are not retrospective. In addition, all but two samples were collected from verges, rather than residential soils. However the SCS indicates a point below which long-term health risks are universally deemed to be tolerably low for a standard residential land use. Two samples collected from MOA015 (at 0.5 m and 1.0 m) marginally exceed the antimony guideline value. Thallium was detected above the US EPA Regional Screening Level guideline value for residential soils of 0.8 mg/kg in 8 of 28 surface soils (29%).

6.2.2 Extended Element Suite

The results of the extended element suite are presented in Table C-2 in Appendix C. The extended element suite was undertaken on ten samples and found that thallium was elevated in a number of samples relative to the most conservative international guideline for thallium in soil for human health (0.8 mg/kg, USEPA). The laboratory was asked to

then identify which samples potentially contained concentration of thallium above 1 mg/kg and these samples were analysed for thallium.

6.2.3 Petroleum Hydrocarbons

Eleven samples were analysed for TPHs, however TPH residues were detected at sampling site MOA021 only (see Table B-3 in Appendix B). PDP field staff detected organic residues in the core samples collected from this location which they tentatively identified as being coal ash. An analysis of the samples for PAHs found that the benzo(a)pyrene equivalent (BAPeq) was lower than the soil SCS for human health.

6.2.4 Quality Assurance/Quality Control

To determine the analytical precision of the sampling technique duplicate sample extraction and analysis was undertaken of 6 samples for various sample depths and sampling locations. The results of the QA/QC samples together with the calculated RPD are shown in Table C-4 in Appendix C. The RPD of the duplicate analysis for all elements in all samples was generally less than 30%, the exception being chromium in MOA020 0.1, arsenic and antimony in MOA019 0.1 and antimony in MOA005 0.5 which had a calculated relative percentage difference of between 30 to 50%. This may indicate a degree of heterogeneity within these samples.

A macro-digestion using 10 grams was undertaken on samples MOA022 1.0 m, MOA005 0.5 m and 1.5 m. On one sample (MOA005 1.5 m) the sample was also analysed using a standard 1g digestion technique. The duplicate analysis of sample MOA055 1.5 using the two digestion techniques indicates found that the relative percentage difference between to the two techniques was less than 20% for all elements except antimony (see Table C6).

6.3 XRF Testing Results

6.3.1 XRF testing results

On the 15 November an XRF survey was undertaken at 70 locations alongside the road verges within the Moanataiari subdivision. The raw XRF data in attached in Appendix D and a summary of the XRF findings for arsenic, lead and antimony are shown on Figure 3 in Appendix A. The measurements obtained by the XRF are in units of part per million (ppm) on a weight by weight basis. For soil, this is equivalent to the results reported in the analytical laboratory which are presented in units of milligram of the analyte per kilogram of soil (mg/kg).

6.3.2 Correlation XRF results with Laboratory Results

Arsenic and lead concentrations measured by XRF spectrometer are generally between 30 to 50% lower than those reported by the laboratory. However, in samples which had a very high lead concentration the arsenic concentration readings were less accurate due to known analytical interferences between these two elements. Therefore the reported

arsenic concentration measured by the XRF should be treated with some caution in samples which contain high concentrations of lead.

There was a very poor correlation between the concentrations of cadmium and antimony measured by the XRF and those reported by the analytical laboratory. Since the XRF is only a screening tool, where there is a difference between the XRF readings and the laboratory results, the laboratory results are likely to be more accurate. Comparisons of XRF results with those of a previous composite sample of Moanataiari school playing field suggest that XRF is unreliable for antimony and cadmium. It is believed that spectral artefacts are interfering with the measurement of these elements; therefore the measurements for these elements should be ignored.

6.4 Landfill Gas Monitoring

Soil gas measurements were undertaken at 8 sampling locations where historical information suggested that municipal waste may be present. Measurements of the concentrations of methane, carbon dioxide, carbon monoxide, oxygen and hydrogen sulphide in soil gas are presented in Table C.7 in Appendix C.

Methane was not detected at any of the monitoring locations, however elevated concentrations of carbon dioxide were noted at MOA007 and MOA009.

7.0 Risk Assessment

7.1 Results Assessment and Discussion

Based on the soil testing undertaken to date it appears that arsenic is elevated relative to the SCS in all surface samples, except for one surface composite sample collected from the school recreational fields by WRC in 2007. All surficial soil samples tested as part of this sampling programme exceed the National Soil Contaminant Standard (SCS) for arsenic of 20 mg/kg for residential soils.

The highest surface concentrations of arsenic are generally found east of Kuranui Street. The two highest surface soils samples collected in this area contain arsenic concentrations at 320 and 350 parts per million, which are 16 and 17.5 times higher than the NES SCS for arsenic in residential soils. However, it should be noted that the QA/QC testing and XRF measurements indicate the distribution of arsenic (and other elements) could be very heterogeneous (high degree of variability in concentration of arsenic over short distances). The XRF readings confirmed that the highest arsenic concentrations are generally found east of Kuranui Street. However, they also found that elevated arsenic concentrations may be present at some sampling locations west of Kuranui Street.

In general, arsenic concentrations increase with depth at most sampling locations. The two highest soil arsenic concentrations measured at the site (1,020 and 4,700 mg/kg) were collected from fill material approximately 1 m below the surface. The concentration of arsenic in these soil samples is 51 and 235 times higher than the NES SCS for residential soils. One sample (MOA020) collected at 0.5 m has soil arsenic

concentration of 1,450 mg/kg (72.5 times the NES), however most soil samples collected from this depth have arsenic concentrations ranging between 100 to 700 mg/kg on the eastern portion of the site. The potential relevance of health screening values (here the SCS) to these deeper samples is that some plant roots and routine gardening activities may extend to these depths, and material from depth may be brought to the surface through excavation activities.

To put this another way the high concentration of arsenic present in soil samples collected below the surface, could potentially poise a risk to people if excavation activities bring this material to the surface. Soil disturbance activities which could potentially up-earth this material include:

- Installing or servicing underground utility lines
- Digging holes for fence posts or housing foundations
- Installing swimming pools
- Installing driveways
- Construction of structures such as decks, sheds or home additions, and
- New home construction

A limited number of soil samples were collected from the school grounds and five XRF measurements were taken across the school playing field. The concentration of arsenic collected from the school garden exceeded the SCS, but historical information from WRC indicates that the average arsenic concentration across the school playing field is lower than NES for residential land use. This finding was confirmed by five XRF readings obtained across the playing field obtained by PDP field staff.

No soil samples were collected within the grounds of the Thames Early Childhood Education Centre. However, one soil sample and several XRF readings were taken near the playcentre, which indicated that there are elevated arsenic concentrations near the playcentre.

The sampling results and the fact that the elevated soil concentration are probably relating to mining rock waste which can naturally be very heterogeneous implies that the concentration of trace elements could potential vary substantially from one sampling location to another, even if these sampling locations are very close together.

All the soil samples were collected from the road verge away from underground services and no soil samples or XRF readings have been undertaken on residential properties. It is possible that the roadside verges may contain more arsenic on average than the adjacent residential properties. This is because the verges may have been subjected to more mixing of material excavated from beneath the ground surface than some of the residential properties, when the roadways were established. Therefore it is not possible to infer soil concentrations on residential properties using the data obtained by laboratory analysis of soil samples or XRF measurements from the adjacent soil sampling locations.

However, based on the widespread occurrence of elevated arsenic concentrations in soils testing from the investigation area it is likely that elevated arsenic concentrations are present at least at depth and possibly at ground surface on some of the residential properties within the Moanataiari subdivision. Testing of all the individual residential properties within the subdivision would be required to determine the extent of the problem.

In addition to the elevated concentration of arsenic found in the soils, elevated concentrations of lead and thallium, which exceed relevant soil guideline values for protecting human health on residential properties, were present in some surface samples.

XRF measurements found elevated concentration of lead at several locations between Ensor, Kuranui Street and Tararu Road. Readings of up to 1100 mg/kg were detected in a surface soil samples measurement from these locations indicating that lead present at an elevation concentration may be on some residential properties. It should be noted however that XRF measurements for lead were found to be generally 20 to 50% lower than those values obtained by the analytical laboratory. Therefore if any further laboratory testing of soil is undertaken, lead should be included in the analytical suite.

XRF measurements also detected high concentrations of antimony and cadmium at some sampling locations but these findings are not supported by the laboratory testing of surface samples Comparison between XRF readings and the laboratory results found the two datasets were different by orders of magnitude, indicating that XRF readings for antimony and cadmium at concentrations of 50 mg/kg or lower should be discounted Nevertheless any further soil testing undertaken at the site should include these elements.

Petroleum hydrocarbons were detected at reasonably low levels at one location adjacent to the Play Centre (MOA021). Due to the presence of coal ash noted during the hand augering investigation of this locality all samples collected from MOA021 were also analysed for polycyclic aromatic hydrocarbons (PAHs). PAHs were present at low concentrations in the two depth samples obtained from this locality, however the concentrations of PAHs were lower than the National Soil Contaminant Standard (SCS) for residential soils for benzo(a) pyrene equivalent.

Landfill gas was not detected at any of the sampling locations, although carbon dioxide concentrations of between 5 to 10% were detected at M0A007 and MOA009. Although these values are higher than carbon dioxide concentrations which are typically encountered in most gas spiking surveys, carbon dioxide concentrations of up to 10% can be detected in natural soils especially if calcareous material is in the soils. Rocks from hydrothermal quartz vein systems can contain high concentrations of calcium carbonate which when reacting with acid (such as carbonic acid in rainwater) releases carbon dioxide. This might be the reason for the elevated carbon dioxide readings obtained from these two sampling sites.

8.0 Conclusions and Recommendations

The National Soil Contaminant Standard (SCS) for arsenic of 20 mg/kg for residential soils was used in this work as an index value to denote the potential for long-term risk on residential soils that is higher than would be tolerated at a new subdivision. This value was exceeded at all sampling sites tested during this investigation. In some western areas this exceedance was marginal, but in other eastern areas it was substantial, indicating the potential for risks to human health and a need for further investigation. Therefore, PDP recommends that:

- Soil testing of all residential sites within the subdivision be carried out.
- Based on the laboratory testing of the soil samples and XRF measurements the analytical suite should include antimony, arsenic, cadmium, lead and thallium.
- Residents and workers (including maintenance workers and contractors) at the subdivision should be provided with advice on how to minimise health risks that may be associated with coming into contact with chemically impacted soils within the Moanataiari subdivision.
- Further testing of petroleum hydrocarbons and landfill gas is not required at the site.

9.0 References

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Appendix A
Figures

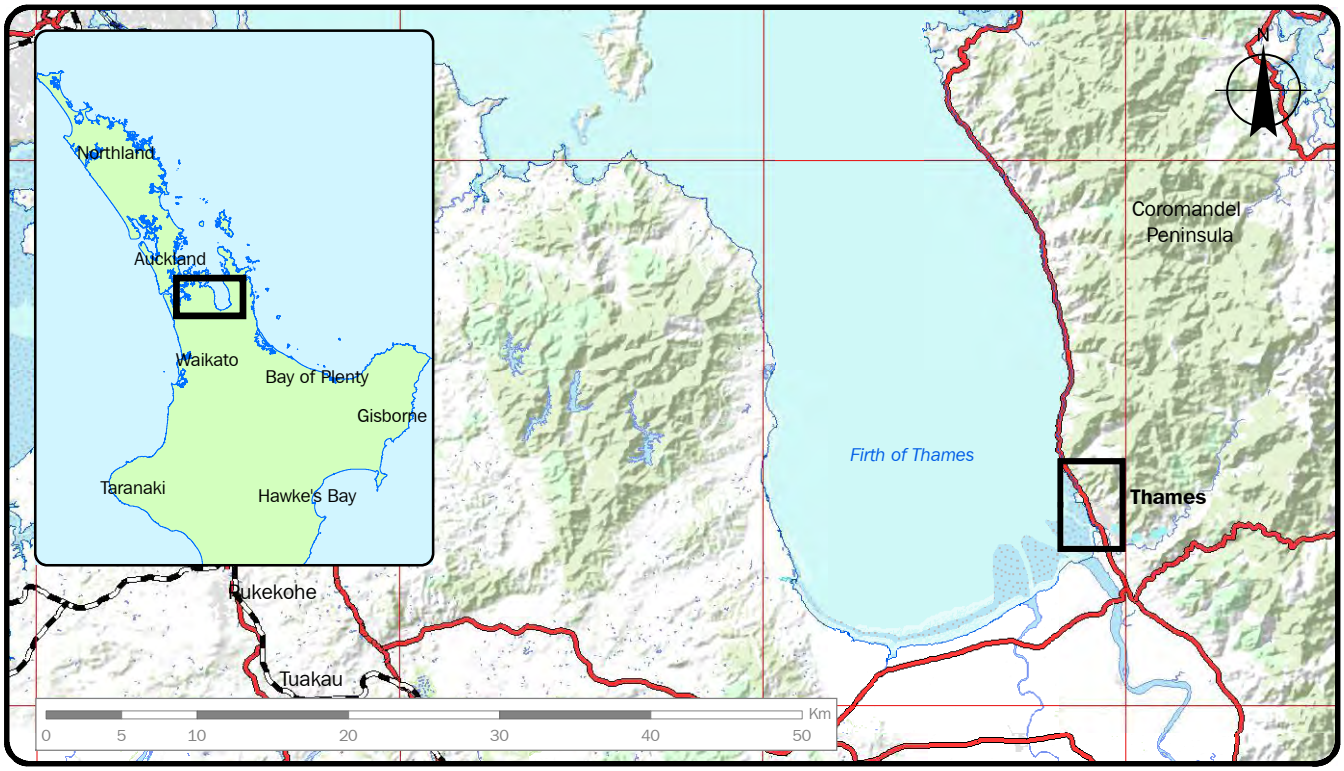
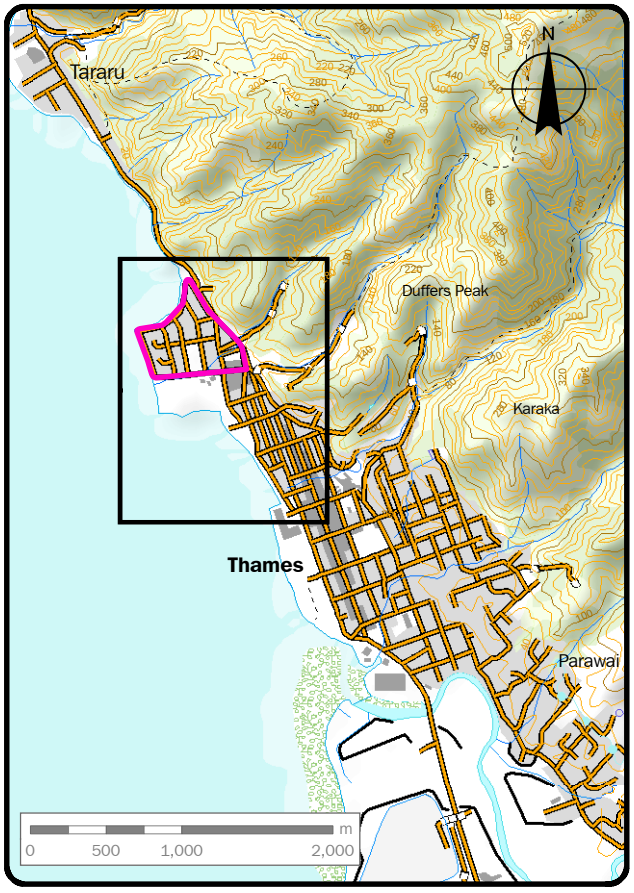
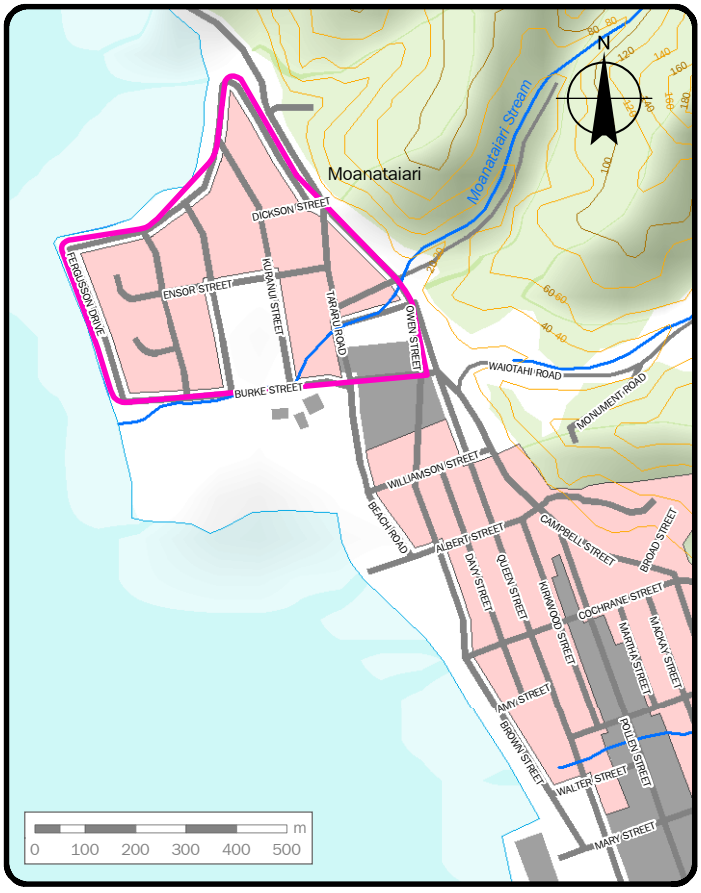


Figure 1A: GENERAL AREA MAP Scale: 1:500,000 (A4)





Scale: 1:50,000 (A4) Figure 1B: LOCAL AREA MAP Scale: 1:15,000 (A4)

Legend

Approx. Investigation Boundary

Residential Area

Source:
Topographical Information sourced from LINZ NZTopo database.

SOURCE: AERIAL IMAGERY DERIVED FROM GOOGLE EARTH PRO (MAY NOT BE SPATIALLY ACCURATE).
CADASTRAL INFORMATION DERIVED FROM LINZ DATA.

FIGURE 2 : SITE PLAN AND SAMPLING LOCATIONS WITH ARSENIC RESULTS

A02469100D002.dwg Nov-11 DRAFT1

KEY

● xrf 1	XRF SOIL TEST LOCATION
———	APPROX. INVESTIGATION BOUNDARY

ELEMENTS	CONCENTRATIONS (ppm)
As (Arsenic)	48
Pb (Lead)	55
Sb (Antimony)	87

< LOD below limit of detection

NOTE: PART PER MILLION (ppm) IS EQUIVALENT TO mg/kg IN SOIL.

0 50 100m

SCALE 1:2,500 (A3)

SOURCE: AERIAL IMAGERY DERIVED FROM GOOGLE EARTH PRO (MAY NOT BE SPATIALLY ACCURATE).
CADASTRAL INFORMATION DERIVED FROM LINZ DATA.

FIGURE 3 : XRF SAMPLING LOCATIONS AND SUMMARY OF RESULTS

Appendix B
Soil Logs

PATTLE DELAMORE PARTNERS LTD

LOG OF HAND AUGER
Moanataiari Subdivision Site Investigation

HOLE NO. **MOA001**
JOB NO: A02469100

CLIENT: Waikato Regional Council
LOCATION: Moanataiari, Thames.

START DATE: 27/10/2011
END DATE: 27/10/2011
COORDINATES: E1824590.64 N5887925.42
TOTAL DEPTH: 1.5m
LOGGED BY: CSF
SHEET 1 OF 1

GROUND LEVEL:
TOP OF CASING:

INTERPRETATION	DESCRIPTION OF SOIL / ROCK (based on cuttings etc.)	GRAPHIC LOG	DEPTH (m)	RL (m)	SAMPLES	TESTS	WATER LEVEL GAIN / LOSS	INSTALLATION
FILL	SILT; brown. Firm; moist; low plasticity. [TOPSOIL]		0.0	0	MOA001 0.1			
	Clayey SILT with some sand and minor fine grained gravel; yellow orange mottled white. Stiff; moist; moderate plasticity.							
	...becomes moist.				MOA001 0.5	LFG		
	silty, fine grained SAND with some minor clay and fine grained gravels; light green streaked grey and orange. Firm; moderate plasticity, moist.					LFG		
	...becomes black speckled white and orange. Stiff; low plasticity.		1.0	-1	MOA001 1.0			
	silty fine grained SAND with minor clay, light bluish grey. Firm; slight plasticity; moist.							
	...becomes pinkish orange. Very soft; saturated; pumiceous.				MOA001 1.5		▽	

END OF HAND AUGER AT 1.5 m TARGET DEPTH

Notes:
1. LFG = Land Fill Gas Refer to Table B6 for results.
2. Groundwater was encountered at 1.4 m depth on 27/10/2011
3. Coordinates have been recorded by high precision GPS and are presented in NZTM

KEY
- ▽ Groundwater Level
- ← Water Gain
- → Water Loss
- ● Grab sample
- × PID Reading (ppm)

Drilled By: GJS
Diameter: 50mm
Method: Hand Auger
Datum:

Filename: A02469100B001_MOA001

Logs based on New Zealand Geotechnical Society Field Description of Soil and Rock Guidelines (2005)

PATTLE DELAMORE PARTNERS LTD

LOG OF HAND AUGER
Moanataiari Subdivision Site Investigation

HOLE NO. **MOA002**
JOB NO: A02469100

CLIENT: Waikato Regional Council
LOCATION: Moanataiari, Thames.

START DATE: 27/10/2011
END DATE: 27/10/2011
COORDINATES: E1824636.64 N5887798.54
TOTAL DEPTH: 0.9m
LOGGED BY: GJS
SHEET 1 OF 1

GROUND LEVEL:
TOP OF CASING:

INTERPRE-TATION	DESCRIPTION OF SOIL / ROCK (based on cuttings etc.)	GRAPHIC LOG	DEPTH (m)	RL (m)	SAMPLES	TESTS	WATER LEVEL GAIN / LOSS	INSTALLATION
CAPPING FILL	SILT; brown. Firm; moist; low plasticity [TOPSOIL].		0.0	0	MOA002 0.1			
	Clayey SILT some fine to coarse sand; light brown. Stiff; moist; moderate plasticity.							
	medium SAND minor shells; grey. Loosely packed; moist.							
	Clayey SILT with some sand; light orangey brown mottled green. Stiff; moist; moderately plastic.				MOA002 0.5	LFG		
	Clayey SILT with minor fine to medium sand; orangey yellow. Stiff; moist; moderately plastic with inclusions of medium to coarse SAND; white pumiceous							
	Clayey SILT; light orangey yellow. Stiff; moist; moderately plastic.				MOA002 0.9			

END OF HAND AUGER AT 0.9m REFUSAL

Notes:
1. No groundwater was encountered on 27/10/2011.
2. LFG = Land Fill Gas Refer to Table B6 for results.
3. Coordinates have been recorded by high precision GPS and are presented in NZTM

KEY
- Groundwater Level
- Water Gain
- Water Loss
- Grab sample
- PID Reading (ppm)

Drilled By: CSF
Diameter: 50mm
Method: Hand Auger
Datum:

Filename: A02469100B002_MOA002

Logs based on New Zealand Geotechnical Society Field Description of Soil and Rock Guidelines (2005)

PATTLE DELAMORE PARTNERS LTD

LOG OF HAND AUGER
Moanataiari Subdivision Site Investigation

HOLE NO. **MOA003**
JOB NO: A02469100

CLIENT: Waikato Regional Council
LOCATION: Moanataiari, Thames.

START DATE: 27/10/2011
END DATE: 27/10/2011
COORDINATES: E1824663.51 N5887719.36
TOTAL DEPTH: 1.5m
LOGGED BY: GJS
SHEET 1 OF 1

GROUND LEVEL:
TOP OF CASING:

INTERPRETATION	DESCRIPTION OF SOIL / ROCK (based on cuttings etc.)	GRAPHIC LOG	DEPTH (m)	RL (m)	SAMPLES	TESTS	WATER LEVEL GAIN / LOSS	INSTALLATION
FILL	SILT; brown. Firm to stiff; moist; low plasticity [TOPSOIL].		0.0	0	MOA003 0.1			
	Clayey SILT with some fine to coarse sand and fine gravel; light yellowish brown. Stiff; moist; moderate plasticity.							
	Medium SAND minor shells; grey. Loosely packed; moist.							
	Clayey SILT with minor fine to medium sand and trace medium gravel; medium orange mottled light orange. Stiff; moist; moderately plastic.				MOA003 0.5			
	SILT with minor clay and fine to coarse sand; greenish/brownish grey. Stiff; moist; moderately plastic; gravel is pumice.		1.0	-1	MOA003 1.0			
	SILT with some clay and trace fine to coarse sand; dark grey mottled white. Stiff; moist; moderately plastic; gravel is pumice.				MOA003 1.5			

END OF HAND AUGER AT 1.5m TARGET DEPTH

Notes:
1. No groundwater was encountered on 27/10/2011.
2. Coordinates have been recorded by high precision GPS and are presented in NZTM

KEY
- Groundwater Level
- Water Gain
- Water Loss
- Grab sample
- PID Reading (ppm)

Drilled By:
Diameter: 50mm
Method: Hand Auger
Datum:

Filename: A02469100B003_MOA003

Logs based on New Zealand Geotechnical Society Field Description of Soil and Rock Guidelines (2005)

PATTLE DELAMORE PARTNERS LTD

LOG OF HAND AUGER
Moanataiari Subdivision Site Investigation

HOLE NO. **MOA004**
JOB NO: A02469100

CLIENT: Waikato Regional Council
LOCATION: Moanataiari, Thames.

START DATE: 26/10/2011
END DATE: 26/10/2011
COORDINATES: E1824742.83 N5887623.43
TOTAL DEPTH: 0.85m
LOGGED BY: GJS
SHEET 1 OF 1

GROUND LEVEL:
TOP OF CASING:

INTERPRE-TATION	DESCRIPTION OF SOIL / ROCK (based on cuttings etc.)	GRAPHIC LOG	DEPTH (m)	RL (m)	SAMPLES	TESTS	WATER LEVEL GAIN / LOSS	INSTALLATION
FILL	SILT with trace fine to medium sand; brown. Firm; moist; low plasticity [TOPSOIL].		0.0	0	MOA004 0.1			
	Clayey SILT with some fine to coarse gravel; brown. Stiff; moist to dry; low plasticity to non-plastic; gravel is angular andesite.							
	SILT with some coarse sand; white with few orange mottles. Stiff; dry; non-plastic.				MOA004 0.5			
	SILT with minor coarse sand and fine gravel; dark brown with medium brown mottles. Stiff; moist.							
	Medium to coarse SAND with some clayey silt and minor fine to coarse gravel; orange with dark orange and light yellow mottles. Stiff/tightly packed; moist.				MOA004 1.0			

END OF HAND AUGER AT 0.85m REFUSAL

Notes:
1. Groundwater was not encountered on 26/10/2011.
2. Refusal at 0.85m.
3. Coordinates have been recorded by high precision GPS and are presented in NZTM

KEY
- Groundwater Level
- Water Gain
- Water Loss
- Grab sample
- PID Reading (ppm)

Drilled By:
Diameter: 50mm
Method: Hand Auger
Datum:

Filename: A02469100B004_MOA004

Logs based on New Zealand Geotechnical Society Field Description of Soil and Rock Guidelines (2005)

PATTLE DELAMORE PARTNERS LTD

LOG OF HAND AUGER
Moanataiari Subdivision Site Investigation

HOLE NO. **MOA005**
JOB NO: A02469100

CLIENT: Waikato Regional Council
LOCATION: Moanataiari, Thames.

START DATE: 27/10/2011
END DATE: 27/10/2011
COORDINATES: E1824870.42 N5887623.79
TOTAL DEPTH: 1.5m
LOGGED BY: CSF
SHEET 1 OF 1

GROUND LEVEL:
TOP OF CASING:

INTERPRETATION	DESCRIPTION OF SOIL / ROCK (based on cuttings etc.)	GRAPHIC LOG	DEPTH (m)	RL (m)	SAMPLES	TESTS	WATER LEVEL GAIN / LOSS	INSTALLATION
FILL	SILT with minor fine gravels; brown. Dry; friable [TOPSOIL].		0.0	0	MOA005 0.1			
	Silty fine grained SAND some clay minor gravel; yellowish orange mottled white. Stiff; friable.				MOA005 0.5	LFG		
	...becomes clayey; stiff with moderate plasticity.							
	Fine grained Sandy SILT with minor fine grained gravels; brownish dark grey. Soft; wet.		1.0	-1	MOA005 1.0			
	...contains black organic inclusions, some glass shards.				MOA005 1.5			
	END OF HAND AUGER AT 1.5m TARGET DEPTH							

Notes:
1. LFG = Land Fill Gas Refer to Table B6 for results.
2. Groundwater was encountered at 0.9 m depth on 27/10/2011.
3. Diffucult to recover core below 1.4 m depth.
4. Coordinates have been recorded by high precision GPS and are presented in NZTM

KEY
- Groundwater Level
- Water Gain
- Water Loss
- Grab sample
- PID Reading (ppm)

Drilled By:
Diameter: 50mm
Method: Hand Auger
Datum:

Filename: A02469100B005_MOA005

Logs based on New Zealand Geotechnical Society Field Description of Soil and Rock Guidelines (2005)

PATTLE DELAMORE PARTNERS LTD

LOG OF HAND AUGER
Moanataiari Subdivision Site Investigation

HOLE NO. **MOA006**
JOB NO: A02469100

CLIENT: Waikato Regional Council
LOCATION: Moanataiari, Thames.

START DATE: 27/10/2011
END DATE: 27/10/2011
COORDINATES: E1824791.76 N5887723.26
TOTAL DEPTH: 0.9m
LOGGED BY: GJS
SHEET 1 OF 1

GROUND LEVEL:
TOP OF CASING:

INTERPRE-TATION	DESCRIPTION OF SOIL / ROCK (based on cuttings etc.)	GRAPHIC LOG	DEPTH (m)	RL (m)	SAMPLES	TESTS	WATER LEVEL GAIN / LOSS	INSTALLATION
FILL	SILT; brown. Firm to stiff; moist to dry; non-plastic [TOPSOIL].		0.0	0	MOA006 0.1			
	Sandy SILT with some fine to coarse gravel; brown. Stiff; moist; low plasticity; sand is fine to coarse; gravel is angular andesite.							
	Cobbles; grey. Tightly packed; cobbles are slightly weathered angular andesite.							
	Clayey SILT with minor fine to coarse gravel; orange. Stiff; moist; moderately plastic.				MOA006 0.5	LFG		
	Sandy SILT; white with orange mottles. Stiff; moist; moderately plastic; sand is fine to coarse, pumiceous.					LFG		
					MOA006 1.0			

END OF HAND AUGER AT 0.9m REFUSAL

Notes:
1. Groundwater was not encountered on 27/10/2011.
2. Refusal at 0.9m.
3. LFG= Land Fill Gas Refer to Table B6 for results.
4. Coordinates have been recorded by high precision GPS and are presented in NZTM

KEY
- Groundwater Level
- Water Gain
- Water Loss
- Grab sample
- PID Reading (ppm)

Drilled By:
Diameter: 50mm
Method: Hand Auger
Datum:

Filename: A02469100B006_MOA006

Logs based on New Zealand Geotechnical Society Field Description of Soil and Rock Guidelines (2005)

PATTLE DELAMORE PARTNERS LTD

LOG OF HAND AUGER
Moanataiari Subdivision Site Investigation

HOLE NO. **MOA007**
JOB NO: A02469100

CLIENT: Waikato Regional Council
LOCATION: Moanataiari, Thames.

START DATE: 27/10/2011
END DATE: 27/10/2011
COORDINATES: E1824775.24 N5887819.75
TOTAL DEPTH: 1.5m
LOGGED BY: CSF
SHEET 1 OF 1

GROUND LEVEL:
TOP OF CASING:

INTERPRETATION	DESCRIPTION OF SOIL / ROCK (based on cuttings etc.)	GRAPHIC LOG	DEPTH (m)	RL (m)	SAMPLES	TESTS	WATER LEVEL GAIN / LOSS	INSTALLATION
FILL	SILT; brown. Dry; friable; contains shell fragments [TOPSOIL].		0.0	0	MOA007 0.1			
	...becomes shelly silt.							
	Silty CLAY with minor fine grained sand and gravels; white streaked reddish orange. Stiff; moist; slight plasticity.							
	Silty CLAY; reddish orange. Soft; saturated; high plasticity.				MOA007 0.5	LFG		
	...contains shell fragments.							
	Silty, well graded SAND with fine grained gravels; reddish brown spekcled white and purple. Loose; moist; friable; contains occasional shell fragments.		1.0	-1	MOA007 1.0	LFG		
	...contains clay and pumiceous inclusions; reddish brown speckled white. Wet.						▽	
	Silty fine grained GRAVEL with some clay and medium sand; orange red. loose; saturated; low plasticity.				MOA007 1.5			

END OF HAND AUGER AT 1.5m TARGET DEPTH

Notes:
1. LFG = Land Fill Gas Refer to Table B6 for results.
2. Diffucult to recover core below 1.3 m depth.
3. Groundwater was encountered at 1.3 m depth on 27/10/2011.
4. Coordinates have been recorded by high precision GPS and are presented in NZTM

KEY
- ▽ Groundwater Level
- ← Water Gain
- → Water Loss
- ● Grab sample
- × PID Reading (ppm)

Drilled By: GJS
Diameter: 50mm
Method: Hand Auger
Datum:

Filename: A02469100B007_MOA007

Logs based on New Zealand Geotechnical Society Field Description of Soil and Rock Guidelines (2005)

PATTLE DELAMORE PARTNERS LTD

LOG OF HAND AUGER
Moanataiari Subdivision Site Investigation

HOLE NO. **MOA008**
JOB NO: A02469100

CLIENT: Waikato Regional Council
LOCATION: Moanataiari, Thames.

START DATE: 28/10/2011
END DATE: 28/10/2011
COORDINATES: E1824768.20 N5887920.46
TOTAL DEPTH: 1.5m
LOGGED BY: CSF
SHEET 1 OF 1

GROUND LEVEL:
TOP OF CASING:

INTERPRETATION	DESCRIPTION OF SOIL / ROCK (based on cuttings etc.)	GRAPHIC LOG	DEPTH (m)	RL (m)	SAMPLES	TESTS	WATER LEVEL GAIN / LOSS	INSTALLATION
FILL	SILT with minor fine gravels; brown. Dry; friable [TOPSOIL].		0.0	0	MOA008 0.1			
	Sandy SILT with some clay; brownish orange. Stiff; moist; friable. Contains occasional topsoil mottling and well graded andesitic angular gravels. Sand is medium grained.				MOA008 0.5	LFG		
	Silty fine grained SAND with minor clay; orangey brown speckled white. Medium dense; moist; low plasticity; pumiceous.							
	...contains angular quartz and fine grained gravel inclusions, becomes moist to wet.		1.0	-1	MOA008 1.0	LFG		
	...becomes wet, high plasticity.				MOA008 1.5			
	END OF HAND AUGER AT 1.5m TARGET DEPTH							

Notes:
1. LFG = Land Fill Gas Refer to Table B6 for results.
2. Groundwater was not encountered on 28/10/11.
3. Coordinates have been recorded by high precision GPS and are presented in NZTM

KEY
- Groundwater Level
- Water Gain
- Water Loss
- Grab sample
- PID Reading (ppm)

Drilled By: CSF
Diameter: 50mm
Method: Hand Auger
Datum:
Filename: A02469100B008_MOA008

Logs based on New Zealand Geotechnical Society Field Description of Soil and Rock Guidelines (2005)

PATTLE DELAMORE PARTNERS LTD

LOG OF HAND AUGER
Moanataiari Subdivision Site Investigation

HOLE NO. **MOA009**
JOB NO: A02469100

CLIENT: Waikato Regional Council
LOCATION: Moanataiari, Thames.

START DATE: 26/10/2011
END DATE: 26/10/2011
COORDINATES: E1824861.42 N5887959.78
TOTAL DEPTH: 0.97m
LOGGED BY: GJS
SHEET 1 OF 1

GROUND LEVEL:
TOP OF CASING:

INTERPRE-TATION	DESCRIPTION OF SOIL / ROCK (based on cuttings etc.)	GRAPHIC LOG	DEPTH (m)	RL (m)	SAMPLES	TESTS	WATER LEVEL GAIN / LOSS	INSTALLATION
FILL	SILT with minor clay and trace fine to medium sand; brown. Firm to stiff; moist to dry; low plasticity [TOPSOIL].		0.0	0	MOA009 0.1			
	Clayey SILT with some fine to coarse sand minor fine to coarse gravel; orangey brown mottled white. Stiff; moist; moderate plasticity; gravel is angular andesite.				MOA009 0.5	LFG		
					MOA009 1.0			

END OF HAND AUGER AT 0.97m REFUSAL

Notes:
1. Groundwater was not encountered on 26/10/2011.
2. Refusal at 0.97m.
3. LFG=Land Fill Gas Refer to Table B6 for results.
4. Coordinates have been recorded by high precision GPS and are presented in NZTM

KEY
- Groundwater Level
- Water Gain
- Water Loss
- Grab sample
- PID Reading (ppm)

Drilled By:
Diameter: 50mm
Method: Hand Auger
Datum:

Filename: A02469100B009_MOA009

Logs based on New Zealand Geotechnical Society Field Description of Soil and Rock Guidelines (2005)

PATTLE DELAMORE PARTNERS LTD

LOG OF HAND AUGER
Moanataiari Subdivision Site Investigation

HOLE NO. **MOA010**
JOB NO: A02469100

CLIENT: Waikato Regional Council
LOCATION: Moanataiari, Thames.

START DATE: 26/10/2011
END DATE: 26/10/2011
COORDINATES: E1824886.01 N5887840.91
TOTAL DEPTH: 1.25m
LOGGED BY: GJS
SHEET 1 OF 1

GROUND LEVEL:
TOP OF CASING:

INTERPRE-TATION	DESCRIPTION OF SOIL / ROCK (based on cuttings etc.)	GRAPHIC LOG	DEPTH (m)	RL (m)	SAMPLES	TESTS	WATER LEVEL GAIN / LOSS	INSTALLATION
FILL	SILT with minor clay and trace fine to medium sand; brown. Firm to stiff; moist to dry; low plasticity [TOPSOIL].		0.0	0	MOA010 0.1			
	SILT with some clay; minor fine to coarse sand and fine to coarse gravel; light orange mottled white. Stiff; moist; low plasticity; gravel is angular andesite.				MOA010 0.5	LFG		
	0.6m: colour light orange mottled white and pink.							
	SILT with some clay minor fine to coarse sand and fine to coarse gravel; light orange with white and medium grey mottles. Stiff; wet; low plasticity; gravel is angular andesite.		1.0	-1	MOA010 1.0			
	PEAT; black; fibrous; spongey. Soft; wet							

END OF HAND AUGER AT 1.25m REFUSAL

Notes:
1. Refusal at 1.25m.
2. Groundwater was encountered at 0.8 m depth on 26/10/2011.
3. LFG=Land Fill Gas refer to Table B6 for results.
4. Coordinates have been recorded by high precision GPS and are presented in NZTM

KEY
- Groundwater Level
- Water Gain
- Water Loss
- Grab sample
- PID Reading (ppm)

Drilled By:
Diameter: 50mm
Method: Hand Auger
Datum:

Filename: A02469100B010_MOA010

Logs based on New Zealand Geotechnical Society Field Description of Soil and Rock Guidelines (2005)

PATTLE DELAMORE PARTNERS LTD

LOG OF HAND AUGER
Moanataiari Subdivision Site Investigation

HOLE NO. **MOA011**
JOB NO: A02469100

CLIENT: Waikato Regional Council
LOCATION: Moanataiari, Thames.

START DATE: 26/10/2011
END DATE: 26/10/2011
COORDINATES: E1824902.85 N5887750.57
TOTAL DEPTH: 0.28m
LOGGED BY: GJS
SHEET 1 OF 1

GROUND LEVEL:
TOP OF CASING:

INTERPRE-TATION	DESCRIPTION OF SOIL / ROCK (based on cuttings etc.)	GRAPHIC LOG	DEPTH (m)	RL (m)	SAMPLES	TESTS	WATER LEVEL GAIN / LOSS	INSTALLATION
FILL	SILT trace fine to medium sand; brown. Firm; moist; non-plastic [TOPSOIL].		0.0	0				
	SILT some clay and fine to coarse gravel trace cobbles; light yellowish brown mottled orange and white. Stiff; moist; moderate to low plasticity; gravel is angular andesite.				MOA011 0.1			
	Gravelly SILT some clay; orange mottled white and light yellow. Very stiff; moist; non-plastic.				MOA011 0.5			

END OF HAND AUGER AT 0.28m REFUSAL

Notes:
1. No groundwater was encountered on 26/10/2011.
2. Refusal at 1.25m.
3. Coordinates have been recorded by high precision GPS and are presented in NZTM

KEY
- Groundwater Level
- Water Gain
- Water Loss
- Grab sample
- PID Reading (ppm)

Drilled By:
Diameter: 50mm
Method: Hand Auger
Datum:

Filename: A02469100B011_MOA011

Logs based on New Zealand Geotechnical Society Field Description of Soil and Rock Guidelines (2005)

PATTLE DELAMORE PARTNERS LTD

LOG OF HAND AUGER
Moanataiari Subdivision Site Investigation

HOLE NO. **MOA012**
JOB NO: A02469100

CLIENT: Waikato Regional Council
LOCATION: Moanataiari, Thames.

START DATE: 27/10/2011
END DATE: 27/10/2011
COORDINATES: E1824978.92 N5887663.08
TOTAL DEPTH: 0.5m
LOGGED BY: CSF
SHEET 1 OF 1

GROUND LEVEL:
TOP OF CASING:

INTERPRE-TATION	DESCRIPTION OF SOIL / ROCK (based on cuttings etc.)	GRAPHIC LOG	DEPTH (m)	RL (m)	SAMPLES	TESTS	WATER LEVEL GAIN / LOSS	INSTALLATION
FILL	SILT with minor fine gravels; brown. Dry; friable [TOPSOIL].		0.0	0	MOA012 0.1			
	Silty SAND with trace medium sized gravels; brownish orange mottled white. Dense; dry; friable.				MOA012 0.5			

END OF HAND AUGER AT 0.5m REFUSAL

Notes:
1. Groundwater was not encountered on 27/10/11.
2. Refusal at 0.5 m.
3. Coordinates have been recorded by high precision GPS and are presented in NZTM

KEY
- Groundwater Level
- Water Gain
- Water Loss
- Grab sample
- PID Reading (ppm)

Drilled By: GJS
Diameter: 50mm
Method: Hand Auger
Datum:

Filename: A02469100B012_MOA012

Logs based on New Zealand Geotechnical Society Field Description of Soil and Rock Guidelines (2005)

PATTLE DELAMORE PARTNERS LTD

LOG OF HAND AUGER
Moanataiari Subdivision Site Investigation

HOLE NO. **MOA013**
JOB NO: A02469100

CLIENT: Waikato Regional Council
LOCATION: Moanataiari, Thames.

START DATE: 27/10/2011
END DATE: 27/10/2011
COORDINATES: E1825006.35 N5887750.79
TOTAL DEPTH: 1.5m
LOGGED BY: GJS
SHEET 1 OF 1

GROUND LEVEL:
TOP OF CASING:

INTERPRETATION	DESCRIPTION OF SOIL / ROCK (based on cuttings etc.)	GRAPHIC LOG	DEPTH (m)	RL (m)	SAMPLES	TESTS	WATER LEVEL GAIN / LOSS	INSTALLATION
FILL	SILT; brown. Firm to stiff; moist; non-plastic [TOPSOIL].		0.0	0	MOA013 0.1			
	Clayey SILT with minor fine to coarse gravel; orangey brown. Stiff; moist; moderate plasticity; gravel is angular andesite.							
	SILT with some fine to coarse gravel; dark brown. Stiff; moist; low plasticity; friable.				MOA013 0.5			
	SILT with minor fine to coarse sand and trace fine to medium gravel; brown. Stiff; moist; moderate plasticity; gravel is pumice.							
	SILT with some fine sand; white with some grey streaks. Firm; wet; dilatant; pumicious.		1.0	-1	MOA013 1.0		▽	
	Medium SAND; brown. Loosely packed; wet. 1.35m: Colour changes to grey.				MOA013 1.5			
	END OF HAND AUGER AT 1.5m							

Notes:
1. Groundwater was encountered at 1.0 m depth on 27/10/2011.
2. Coordinates have been recorded by high precision GPS and are presented in NZTM.

KEY
- ▽ Groundwater Level
- ← Water Gain
- → Water Loss
- ● Grab sample
- × PID Reading (ppm)

Drilled By: CSF
Diameter: 50mm
Method: Hand Auger
Datum:

Filename: A02469100B013_MOA013

Logs based on New Zealand Geotechnical Society Field Description of Soil and Rock Guidelines (2005)

PATTLE DELAMORE PARTNERS LTD

LOG OF HAND AUGER
Moanataiari Subdivision Site Investigation

HOLE NO. **MOA014**
JOB NO: A02469100

CLIENT: Waikato Regional Council
LOCATION: Moanataiari, Thames.

START DATE: 26/10/2011
END DATE: 26/10/2011
COORDINATES: E1824988.56 N5887850.26
TOTAL DEPTH: 1.5m
LOGGED BY: CSF
SHEET 1 OF 1

GROUND LEVEL:
TOP OF CASING:

INTERPRE-TATION	DESCRIPTION OF SOIL / ROCK (based on cuttings etc.)	GRAPHIC LOG	DEPTH (m)	RL (m)	SAMPLES	TESTS	WATER LEVEL GAIN / LOSS	INSTALLATION
FILL	SILT with minor fine gravels; brown. Dry; friable [TOPSOIL].		0.0	0	MOA014 0.1			
	Gravelly SILT, brownish orange. Dense; moist; friable contains up to cobble sized andesitic gravels				MOA014 0.5			
	Clayey SILT with minor coarse grained sand; orange streaked light grey. Stiff; moist; moderate plasticity. ...becomes gravelly							
	Silty CLAY, orange streaked grey. Stiff, moist, moderate plasticity. ...becomes sandy		1.0	-1	MOA014 1.0			
	...becomes silty fine grained sand SAND; saturated.						▽	
	...becomes brownish grey				MOA014 1.5			

END OF HAND AUGER AT 1.5m TARGET DEPTH

Notes:
1. Groundwater was encountered at 1.2 m depth on 26/10/11
2. Coordinates have been recorded by high precision GPS and are presented in NZTM.

KEY
- ▽ Groundwater Level
- ← Water Gain
- → Water Loss
- ● Grab sample
- × PID Reading (ppm)

Drilled By: CSF
Diameter: 50mm
Method: Hand Auger
Datum:

Filename: A02469100B014_MOA014

Logs based on New Zealand Geotechnical Society Field Description of Soil and Rock Guidelines (2005)

PATTLE DELAMORE PARTNERS LTD

LOG OF HAND AUGER
Moanataiari Subdivision Site Investigation

HOLE NO. **MOA015**
JOB NO: A02469100

CLIENT: Waikato Regional Council
LOCATION: Moanataiari, Thames.

START DATE: 26/10/2011
END DATE: 26/10/2011
COORDINATES: E1824983.81 N5887976.58
TOTAL DEPTH: 1.5m
LOGGED BY: CSF
SHEET 1 OF 1

GROUND LEVEL:
TOP OF CASING:

INTERPRETATION	DESCRIPTION OF SOIL / ROCK (based on cuttings etc.)	GRAPHIC LOG	DEPTH (m)	RL (m)	SAMPLES	TESTS	WATER LEVEL GAIN / LOSS	INSTALLATION
FILL	SILT with minor fine gravels; brown. Dry; friable [TOPSOIL].		0.0	0	MOA015 0.1			
	Silty coarse grained SAND minor clay and fine to coarse grained gravels; brown mottled orange and grey. Loose; moist to wet; friable; gravels are sub rounded and carbonacious.				MOA015 0.5			
	...becomes saturated.							
	Silty CLAY; orange streaked white. Soft; saturated; contains pumiceous sand.						▽	
	...becomes silvery grey, some orange course grained sand.		1.0	-1	MOA015 1.0			
	Silty medium grained SAND; brownish grey. Loose, saturated; friable; some clay inclusions.				MOA015 1.5			

END OF HAND AUGER AT 1.5m TARGET DEPTH

Notes:
1. Groundwater was encountered at 0.8 m depth on 26/10/11.
2. Coordinates have been recorded by high precision GPS and are presented in NZTM.

KEY
- ▽ Groundwater Level
- ← Water Gain
- → Water Loss
- ● Grab sample
- × PID Reading (ppm)

Drilled By: GJS
Diameter: 50mm
Method: Hand Auger
Datum:

Filename: A02469100B015_MOA015

Logs based on New Zealand Geotechnical Society Field Description of Soil and Rock Guidelines (2005)

PATTLE DELAMORE PARTNERS LTD

LOG OF HAND AUGER
Moanataiari Subdivision Site Investigation

HOLE NO. **MOA016**
JOB NO: A02469100

CLIENT: Waikato Regional Council
LOCATION: Moanataiari, Thames.

START DATE: 26/10/2011
END DATE: 26/10/2011
COORDINATES: E1824945.85 N5888062.52
TOTAL DEPTH: 0.4m
LOGGED BY: GJS
SHEET 1 OF 1

GROUND LEVEL:
TOP OF CASING:

INTERPRE-TATION	DESCRIPTION OF SOIL / ROCK (based on cuttings etc.)	GRAPHIC LOG	DEPTH (m)	RL (m)	SAMPLES	TESTS	WATER LEVEL GAIN / LOSS	INSTALLATION
FILL	SILT trace fine to medium sand; brown. Firm to stiff; moist; non-plastic [TOPSOIL].		0.0	0	MOA016 0.1			
	Clayey SILT minor fine to coarse gravel; brown. very stiff; moist; non-plastic; gravel is angular andesite. 0.2m: Colour changes to orange.				MOA016 0.5			
	END OF HAND AUGER AT 0.4m REFUSAL							

Notes:
1. Groundwater was not encountered on 26/10/2011.
2. Refusal at 0.4 m.
3. Coordinates have been recorded by high precision GPS and are presented in NZTM.

KEY
- Groundwater Level
- Water Gain
- Water Loss
- Grab sample
- PID Reading (ppm)

Drilled By:
Diameter: 50mm
Method: Hand Auger
Datum:

Filename: A02469100B016_MOA016

Logs based on New Zealand Geotechnical Society Field Description of Soil and Rock Guidelines (2005)

PATTLE DELAMORE PARTNERS LTD

LOG OF HAND AUGER
Moanataiari Subdivision Site Investigation

HOLE NO. **MOA017**
JOB NO: A02469100

CLIENT: Waikato Regional Council
LOCATION: Moanataiari, Thames.

START DATE: 26/10/2011
END DATE: 26/10/2011
COORDINATES: E1824905.66 N5888217.70
TOTAL DEPTH: 1.5m
LOGGED BY: GJS
SHEET 1 OF 1

GROUND LEVEL:
TOP OF CASING:

INTERPRETATION	DESCRIPTION OF SOIL / ROCK (based on cuttings etc.)	GRAPHIC LOG	DEPTH (m)	RL (m)	SAMPLES	TESTS	WATER LEVEL GAIN / LOSS	INSTALLATION
FILL	SILT trace fine to medium sand; brown. Firm; moist to dry; low plasticity to non-plastic [TOPSOIL].		0.0	0	MOA017 0.1			
FILL	Fine to coarse SAND with trace gravel and shell; brown. Loosely packed; moist; gravel is fine to medium and subrounded.							
Marine Beach Sediments	Fine to coarse SAND with trace shell; brown. Loosely packed; moist.				MOA017 0.5			
Marine Beach Sediments	Coarse SAND with some shells; brown. Loosely packed; moist.							
Marine Beach Sediments	Fine to medium SAND with trace shell; brown. Loosely packed; moist.		1.0	-1	MOA017 1.0			
					MOA017 1.5			

END OF HAND AUGER AT 1.5m TARGET DEPTH

Notes:
1. Groundwater was encountered at 1.45 m depth on 26/10/2011.
2. Coordinates have been recorded by high precision GPS and are presented in NZTM.

KEY
- Groundwater Level
- Water Gain
- Water Loss
- Grab sample
- PID Reading (ppm)

Drilled By:
Diameter: 50mm
Method: Hand Auger
Datum:

Filename: A02469100B017_MOA017

Logs based on New Zealand Geotechnical Society Field Description of Soil and Rock Guidelines (2005)

PATTLE DELAMORE PARTNERS LTD

LOG OF HAND AUGER
Moanataiari Subdivision Site Investigation

HOLE NO. **MOA018**
JOB NO: A02469100

CLIENT: Waikato Regional Council
LOCATION: Moanataiari, Thames.

START DATE: 27/10/2011
END DATE: 27/10/2011
COORDINATES: E1825013.92 N5888105.34
TOTAL DEPTH: 0.7m
LOGGED BY: GJS
SHEET 1 OF 1

GROUND LEVEL:
TOP OF CASING:

INTERPRE-TATION	DESCRIPTION OF SOIL / ROCK (based on cuttings etc.)	GRAPHIC LOG	DEPTH (m)	RL (m)	SAMPLES	TESTS	WATER LEVEL GAIN / LOSS	INSTALLATION
FILL	SILT; brown. Firm to stiff; dry; non-plastic [TOPSOIL].		0.0	0	MOA018 0.1			
	Clayey SILT trace fine to coarse sand and fine to coarse gravel; orangey brown. Stiff; moist; moderate plasticity; gravel is angular andesite.				MOA018 0.5			
	SILT some fine sand trace fine gravel; brownish orange. Stiff; moist; low plasticity to non-plastic.				MOA018 1.0			

END OF HAND AUGER AT 0.7m REFUSAL

Notes:
1. No groundwater was encountered on 27/10/2011.
2. Refusal at 0.7m.
3. Coordinates have been recorded by high precision GPS and are presented in NZTM.

KEY
- Groundwater Level
- Water Gain
- Water Loss
- Grab sample
- PID Reading (ppm)

Drilled By:
Diameter: 50mm
Method: Hand Auger
Datum:

Filename: A02469100B018_MOA018

Logs based on New Zealand Geotechnical Society Field Description of Soil and Rock Guidelines (2005)

PATTLE DELAMORE PARTNERS LTD

LOG OF HAND AUGER
Moanataiari Subdivision Site Investigation

HOLE NO. **MOA019**
JOB NO: A02469100

CLIENT: Waikato Regional Council
LOCATION: Moanataiari, Thames.

START DATE: 27/10/2011
END DATE: 27/10/2011
COORDINATES: E1825059.37 N5888027.46
TOTAL DEPTH: 1.45m
LOGGED BY: CSF
SHEET 1 OF 1

GROUND LEVEL:
TOP OF CASING:

INTERPRETATION	DESCRIPTION OF SOIL / ROCK (based on cuttings etc.)	GRAPHIC LOG	DEPTH (m)	RL (m)	SAMPLES	TESTS	WATER LEVEL GAIN / LOSS	INSTALLATION
FILL	SILT with minor fine gravels; brown. Dry; friable [TOPSOIL].		0.0	0	MOA019 0.1			
	Sandy SILT with trace clay; yellowish white streaked orange. Stiff; low pasticity, minor fine grained andesite gravels.				MOA019 0.5			
	Silty, well graded SAND with minor fine gravels; orange yellow speckled white. Loose; moist; friable.		1.0	-1	MOA019 1.0			
	...becomes yellowish brown speckled black. Soft; wet.							
	Clayey fine grained SAND with minor silt; brownish red. Soft; wet; low pasticity.							
	...becomes wet/saturated.				MOA019 1.5			

END OF HAND AUGER AT 1.45m REFUSAL

Notes:
1. Groundwater was not encountered on 27/10/11.
2. Refusal at 1.45 m.
3. Coordinates have been recorded by high precision GPS and are presented in NZTM.

KEY
- Groundwater Level
- Water Gain
- Water Loss
- Grab sample
- PID Reading (ppm)

Drilled By: GJS
Diameter: 50mm
Method: Hand Auger
Datum:

Filename: A02469100B019_MOA019

Logs based on New Zealand Geotechnical Society Field Description of Soil and Rock Guidelines (2005)

PATTLE DELAMORE PARTNERS LTD

LOG OF HAND AUGER
Moanataiari Subdivision Site Investigation

HOLE NO. **MOA020**
JOB NO: A02469100

CLIENT: Waikato Regional Council
LOCATION: Moanataiari, Thames.

START DATE: 27/10/2011
END DATE: 27/10/2011
COORDINATES: E1825099.80 N5887983.52
TOTAL DEPTH: 1.1m
LOGGED BY: CSF
SHEET 1 OF 1

GROUND LEVEL:
TOP OF CASING:

INTERPRETATION	DESCRIPTION OF SOIL / ROCK (based on cuttings etc.)	GRAPHIC LOG	DEPTH (m)	RL (m)	SAMPLES	TESTS	WATER LEVEL GAIN / LOSS	INSTALLATION
FILL	SILT with minor fine gravels; brown. Dry; friable [TOPSOIL].		0.0	0	MOA020 0.1			
	Silty fine grained SAND with minor clay, yellowish orange. Medium dense; moist; low plasticity.							
	...becomes brown speckled black with minor gravels.				MOA020 0.5			
	...becomes orange red streaked yellow; moist; friable.							
	Silty well graded SAND; bluish grey mixed light greenish grey. Dense; wet; friable; contains fine to medium grained gravels.							
	...becomes gravelly, light brownish orange speckled white; contains minor angular quartz inclusions.							
	Gravelly well graded SAND; brownish orange. Dense; wet to saturated; friable.		1.0	-1	MOA020 1.0		▽	

END OF HAND AUGER AT 1.1m REFUSAL

Notes:
1. Groundwater was encountered at 1.0 m depth on 27/10/11.
2. Refusal at 1.1 m.
3. Coordinates have been recorded by high precision GPS and are presented in NZTM.

KEY
- ▽ Groundwater Level
- ← Water Gain
- → Water Loss
- ● Grab sample
- × PID Reading (ppm)

Drilled By:
Diameter: 50mm
Method: Hand Auger
Datum:

Filename: A02469100B020_MOA020

Logs based on New Zealand Geotechnical Society Field Description of Soil and Rock Guidelines (2005)

PATTLE DELAMORE PARTNERS LTD

LOG OF HAND AUGER
Moanataiari Subdivision Site Investigation

HOLE NO. **MOA021**
JOB NO: A02469100

CLIENT: Waikato Regional Council
LOCATION: Moanataiari, Thames.

START DATE: 27/10/2011
END DATE: 27/10/2011
COORDINATES: E1825153.03 N5887930.59
TOTAL DEPTH: 1.0m
LOGGED BY: GJS
SHEET 1 OF 1

GROUND LEVEL:
TOP OF CASING:

INTERPRE-TATION	DESCRIPTION OF SOIL / ROCK (based on cuttings etc.)	GRAPHIC LOG	DEPTH (m)	RL (m)	SAMPLES	TESTS	WATER LEVEL GAIN / LOSS	INSTALLATION
FILL	Gravelly SILT; brown. Hard; dry; non-plastic; gravel is fine to coarse.		0.0	0	MOA021 0.1			
	Silty fine to coarse GRAVEL with trace cobbles; orange. Tightly packed; dry.							
	Fine GRAVEL; black. Tightly packed; dry; coal ash.							
	Gravelly SILT; orange mottled white. Stiff; moist; non-plastic; gravel is fine to coarse pumice.				MOA021 0.5			
	Silty CLAY; brown. Stiff; moist; moderately plastic.							
	Gravelly SILT; orange mottled white. Stiff; moist; non-plastic; gravel is fine to coarse pumice.		1.0	-1	MOA021 1.0			

END OF HAND AUGER AT 1.0m REFUSAL

Notes:
1. No groundwater was encountered on 27/10/2011.
2. Refusal at 1.0 m.
3. Coordinates have been recorded by high precision GPS and are presented in NZTM.

KEY
- Groundwater Level
- Water Gain
- Water Loss
- Grab sample
- PID Reading (ppm)

Drilled By:
Diameter: 50mm
Method: Hand Auger
Datum:

Filename: A02469100B021_MOA021

Logs based on New Zealand Geotechnical Society Field Description of Soil and Rock Guidelines (2005)

PATTLE DELAMORE PARTNERS LTD

LOG OF HAND AUGER
Moanataiari Subdivision Site Investigation

HOLE NO. **MOA022**
JOB NO: A02469100

CLIENT: Waikato Regional Council
LOCATION: Moanataiari, Thames.

START DATE: 27/10/2011
END DATE: 27/10/2011
COORDINATES: E1825087.65 N5887886.12
TOTAL DEPTH: 1.5m
LOGGED BY: GJS
SHEET 1 OF 1

GROUND LEVEL:
TOP OF CASING:

INTERPRE-TATION	DESCRIPTION OF SOIL / ROCK (based on cuttings etc.)	GRAPHIC LOG	DEPTH (m)	RL (m)	SAMPLES	TESTS	WATER LEVEL GAIN / LOSS	INSTALLATION
FILL	SILT; brown. Stiff; dry; non-plastic [TOPSOIL].		0.0	0	MOA022 0.1			
	SILT with some clay and fine to coarse gravel; orangey brown. Stiff; moist; moderate plasticity.							
	SILT with some clay, sand and fine to coarse gravel; orangey brown mottled white. Stiff; moist; moderate plasticity; white mottles are pumiceous sandy silt..				MOA022 0.5			
	Sandy SILT; white. Firm; moist; non-plastic; sand is fine; pumiceous.		1.0	-1	MOA022 1.0			
	1.2m: colour dark grey.							
	Medium to coarse SAND; orange. Loosely packed; moist.							
	Sandy SILT; dark grey. Firm to stiff; wet; non-plastic; sand is fine; pumiceous.				MOA022 1.5			

END OF HAND AUGER AT 1.5m TARGET DEPTH

Notes: 1. No groundwater was encountered on 27/10/2011.
2. Coordinates have been recorded by high precision GPS and are presented in NZTM.

KEY
- Groundwater Level
- Water Gain
- Water Loss
- Grab sample
- PID Reading (ppm)

Drilled By: CSF
Diameter: 50mm
Method: Hand Auger
Datum:

Filename: A02469100B022_MOA022

Logs based on New Zealand Geotechnical Society Field Description of Soil and Rock Guidelines (2005)

PATTLE DELAMORE PARTNERS LTD

LOG OF HAND AUGER
Moanataiari Subdivision Site Investigation

HOLE NO. **MOA023**
JOB NO: A02469100

CLIENT: Waikato Regional Council
LOCATION: Moanataiari, Thames.

START DATE: 27/10/2011
END DATE: 27/10/2011
COORDINATES: E1825176.16 N5887827.55
TOTAL DEPTH: 1.5m
LOGGED BY: GJS
SHEET 1 OF 1

GROUND LEVEL:
TOP OF CASING:

INTERPRETATION	DESCRIPTION OF SOIL / ROCK (based on cuttings etc.)	GRAPHIC LOG	DEPTH (m)	RL (m)	SAMPLES	TESTS	WATER LEVEL GAIN / LOSS	INSTALLATION
FILL	SILT; brown. Stiff; dry; non-plastic [TOPSOIL].		0.0	0	MOA023 0.1			
	SILT with minor clay and fine to coarse gravel; greyish brown. Stiff; moist; low plasticity; pieces of rusted metal encountered.							
	SILT with minor clay and fine to coarse gravel; orangey brown with orange and green mottles. Stiff; moist; low plasticity.				MOA023 0.5			
	SILT some fine to medium gravel and minor clay; reddish brown. Stiff; moist; low plasticity.		1.0	-1	MOA023 1.0			
	SILT with minor fine to medium sand; brownish orange. Stiff; moist; low plasticity.							
	SILT with minor clay and fine to medium sand and shells; dark brown. Stiff; moist; moderate to low plasticity. 1.4m: Colour dark orange. Low plasticity.				MOA023 1.5			

END OF HAND AUGER AT 1.5m TARGET DEPTH

Notes:
1. Groundwater was not encountered on 27/10/2011.
2. Coordinates have been recorded by high precision GPS and are presented in NZTM.

KEY
- Groundwater Level
- Water Gain
- Water Loss
- Grab sample
- PID Reading (ppm)

Drilled By:
Diameter: 50mm
Method: Hand Auger
Datum:
Filename: A02469100B023_MOA023

Logs based on New Zealand Geotechnical Society Field Description of Soil and Rock Guidelines (2005)

PATTLE DELAMORE PARTNERS LTD

LOG OF HAND AUGER
Moanataiari Subdivision Site Investigation

HOLE NO. **MOA024**
JOB NO: A02469100

CLIENT: Waikato Regional Council
LOCATION: Moanataiari, Thames.

START DATE: 27/10/2011
END DATE: 27/10/2011
COORDINATES: E1825141.18 N5887769.68
TOTAL DEPTH: 1.5m
LOGGED BY: GJS
SHEET 1 OF 1

GROUND LEVEL:
TOP OF CASING:

INTERPRETATION	DESCRIPTION OF SOIL / ROCK (based on cuttings etc.)	GRAPHIC LOG	DEPTH (m)	RL (m)	SAMPLES	TESTS	WATER LEVEL GAIN / LOSS	INSTALLATION
FILL	SILT; brown. Stiff; dry; non-plastic [TOPSOIL].		0.0	0	MOA024 0.1			
	SILT minor clay and trace fine to medium sand; orange. Firm to stiff; moist; low plasticity.				MOA024 0.5			
	Fine to medium SAND minor silt; greyish brown with black mottles. Loosely packed; moist.		1.0	-1	MOA024 1.0			
	SILT; light orange with light brownish yellow mottles. Stiff; moist; non-plastic. 1.3m: Low plasticity to non-plastic.							
	Silty medium to coarse GRAVEL; orange mottled grey. Loose; moist.							
	SILT; light orange with light brownish yellow mottles. Stiff; moist; non-plastic.				MOA024 1.5			
	END OF HAND AUGER AT 1.5m TARGET DEPTH							

Notes:
1. No groundwater was encountered on 27/10/2011.
2. Coordinates have been recorded by high precision GPS and are presented in NZTM.

KEY
- Groundwater Level
- Water Gain
- Water Loss
- Grab sample
- PID Reading (ppm)

Drilled By:
Diameter: 50mm
Method: Hand Auger
Datum:
Filename: A02469100B024_MOA024

Logs based on New Zealand Geotechnical Society Field Description of Soil and Rock Guidelines (2005)

PATTLE DELAMORE PARTNERS LTD

LOG OF HAND AUGER
Moanataiari Subdivision Site Investigation

HOLE NO. **MOA025**
JOB NO: A02469100

CLIENT: Waikato Regional Council
LOCATION: Moanataiari, Thames.

START DATE: 27/10/2011
END DATE: 27/10/2011
COORDINATES: E1825128.35 N5887672.89
TOTAL DEPTH: 1.3m
LOGGED BY: CSF
SHEET 1 OF 1

GROUND LEVEL:
TOP OF CASING:

INTERPRE-TATION	DESCRIPTION OF SOIL / ROCK (based on cuttings etc.)	GRAPHIC LOG	DEPTH (m)	RL (m)	SAMPLES	TESTS	WATER LEVEL GAIN / LOSS	INSTALLATION
FILL	SILT with minor fine gravels; brown. Dry; friable [TOPSOIL].		0.0	0	MOA025 0.1			
	Fine to coarse grained Sandy SILT; brownish orange. Stiff; moist; friable.				MOA025 0.5			
	...becomes clayey, dark brown specked orange. Low plasticity.		1.0	-1	MOA025 1.0			
	Silty CLAY minor SAND dark brown streaked orange and light grey. Stiff; moist; moderate plasticity.							
	...contains course sand fragments, reddish orange.				MOA025 1.3			

END OF HAND AUGER AT 1.3m REFUSAL

Notes:
1. Groundwater was not encountered on 27/10/11
2. Coordinates have been recorded by high precision GPS and are presented in NZTM.

KEY
- Groundwater Level
- Water Gain
- Water Loss
- Grab sample
- PID Reading (ppm)

Drilled By: GJS
Diameter: 50mm
Method: Hand Auger
Datum:

Filename: A02469100B025_MOA025

Logs based on New Zealand Geotechnical Society Field Description of Soil and Rock Guidelines (2005)

PATTLE DELAMORE PARTNERS LTD

LOG OF HAND AUGER
Moanataiari Subdivision Site Investigation

HOLE NO. **MOA026**
JOB NO: A02469100

CLIENT: Waikato Regional Council
LOCATION: Moanataiari, Thames.

START DATE: 28/10/2011
END DATE: 28/10/2011
COORDINATES: E1825043.29 N5887665.44
TOTAL DEPTH: 0.1m
LOGGED BY: GJS
SHEET 1 OF 1

GROUND LEVEL:
TOP OF CASING:

INTERPRE-TATION	DESCRIPTION OF SOIL / ROCK (based on cuttings etc.)	GRAPHIC LOG	DEPTH (m)	RL (m)	SAMPLES	TESTS	WATER LEVEL GAIN / LOSS	INSTALLATION
FILL	Gravelly SILT; brown. Tightly packed; dry; non-plastic.		0.0	0	MOA026 0.1			

END OF HAND AUGER AT 0.1m REFUSAL

Notes:
1. Groundwater was not encountered on 28/10/2011.
2. Refusal at 0.1m.
3. Located nearby foundry and railway tracks.
4. Coordinates have been recorded by high precision GPS and are presented in NZTM.

KEY
- Groundwater Level
- Water Gain
- Water Loss
- Grab sample
- PID Reading (ppm)

Drilled By:
Diameter: 50mm
Method: Hand Auger
Datum:

Filename: A02469100B026_MOA026

Logs based on New Zealand Geotechnical Society Field Description of Soil and Rock Guidelines (2005)

PATTLE DELAMORE PARTNERS LTD

LOG OF HAND AUGER
Moanataiari Subdivision Site Investigation

HOLE NO. **MOA027**
JOB NO: A02469100

CLIENT: Waikato Regional Council
LOCATION: Moanataiari, Thames.

START DATE: 28/10/2011
END DATE: 28/10/2011
COORDINATES: E1824899.13 N5887784.27
TOTAL DEPTH: 1.0m
LOGGED BY: GJS
SHEET 1 OF 1

GROUND LEVEL:
TOP OF CASING:

INTERPRE-TATION	DESCRIPTION OF SOIL / ROCK (based on cuttings etc.)	GRAPHIC LOG	DEPTH (m)	RL (m)	SAMPLES	TESTS	WATER LEVEL GAIN / LOSS	INSTALLATION
GARDEN FILL	Organic SILT; black. Soft; dry; non-plastic; organic material fibrous.		0.0	0				
	SILT; brown. Firm; moist; non-plastic.				MOA027 0.1			
FILL	Clayey SILT minor fine to coarse sand and fine to coarse gravel; brownish orange. Stiff; moist; low plasticity.				MOA027 0.5			
	Sandy SILT with minor fine to medium gravel; orange mottled white. Stiff; moist; low to moderate plasticity; gravel is pumice.							
	Sandy SILT minor clay; greyish brown. Stiff; moist; moderately plastic.		1.0	-1	MOA027 1.0			

END OF HAND AUGER AT 1.0m REFUSAL

Notes:
1. Groundwater was not encountered on 28/10/2011.
2. Refusal at 1.0m.
3. Hand Auger drilled through Moanataiari School Garden.
4. Coordinates have been recorded by high precision GPS and are presented in NZTM.

KEY
- Groundwater Level
- Water Gain
- Water Loss
- Grab sample
- PID Reading (ppm)

Drilled By:
Diameter: 50mm
Method: Hand Auger
Datum:

Filename: A02469100B027_MOA027

Logs based on New Zealand Geotechnical Society Field Description of Soil and Rock Guidelines (2005)

PATTLE DELAMORE PARTNERS LTD

LOG OF HAND AUGER
Moanataiari Subdivision Site Investigation

HOLE NO. **MOA028**
JOB NO: A02469100

CLIENT: Waikato Regional Council
LOCATION: Moanataiari, Thames.

START DATE: 28/10/2011
END DATE: 28/10/2011
COORDINATES: E1824902.89 N5887771.97
TOTAL DEPTH: 0.7m
LOGGED BY: CSF
SHEET 1 OF 1

GROUND LEVEL:
TOP OF CASING:

INTERPRE-TATION	DESCRIPTION OF SOIL / ROCK (based on cuttings etc.)	GRAPHIC LOG	DEPTH (m)	RL (m)	SAMPLES	TESTS	WATER LEVEL GAIN / LOSS	INSTALLATION
FILL	SILT with minor fine gravels; brown. Dry; friable [TOPSOIL].		0.0	0	MOA028 0.1			
	well graded sandy SILT minor clay; brownish orange speckled white. Stiff; moist; low plasticity; contains minor gravels. ...contains black coloured fine gravels. ...becomes brown, moist. ...becomes brownish orange speckled white.				MOA028 0.5			
	Clayey SILT with minor sand, reddish orange speckled white. Firm; mosit; low pasticity; contains fine gravels.				MOA028 1.0			

END OF HAND AUGER AT 0.7m REFUSAL

Notes:
1. Groundwater was not encountered on 28/10/11.
2. Borehole located in the proposed school garden as indicated by the Moanataiari School Principal (David Brock).
3. Coordinates have been recorded by high precision GPS and are presented in NZTM.

KEY
- Groundwater Level
- Water Gain
- Water Loss
- Grab sample
- PID Reading (ppm)

Drilled By:
Diameter: 50mm
Method: Hand Auger
Datum:

Filename: A02469100B028_MOA028

Logs based on New Zealand Geotechnical Society Field Description of Soil and Rock Guidelines (2005)

Appendix C
Tables

Table C1 Laboratory Analysis of Soil Samples Taken at Selected Locations and Depths at Moanataiari, Thames (mg/kg dry weight) for metal concentrations

Sample Location	MOA001 0.1	MOA001 0.5	MOA001 1.0	MOA002 0.1	MOA002 0.5	MOA003 0.1	MOA003 0.5	MOA003 1.0	MOA004 0.1	MOA004 0.5	MOA004 1.0	MOA005 0.1	MOA005 0.5	MOA005 1.5	MOA006 0.1	MOA006 0.5	Human Health		
Lab Number	947724.1	947724.2	947724.3	947724.5	947724.6	947721.11	947721.12	947721.13	947142.1	947142.2	947142.3	947721.7	647721.8	947721.10	947724.8	947724.9	Risk-based Values		
Sample Depth (m)	0.1	0.5	1.0	0.1	0.5	0.1	0.5	1.0	0.1	0.5	1.0	0.1	0.5	1.5	0.1	0.5	Residential[1]	Recreational[2]	Background [6]
Antimony	0.7	1.7	6.7	7.5	1.7	1.6	1.1	3.1	2.7	15.6	20	3.1	6.8	18.0	3.3	2.1	31[3]	NGV[8]	0.02-0.17 (0.076)
Arsenic	24	**96**	**185**	**65**	**54**	**30**	**41**	**66**	**45**	17	**40**	**75**	**128**	**290**	**39**	**58**	20	80	1.0-25 (5.1)
Cadmium	0.18	<0.10	<0.10	0.12	<0.10	0.26	<0.10	<0.10	0.26	< 0.10	0.38	0.17	<0.10	0.40	0.36	<0.10	3	400	0.03-0.3 (0.11)
Chromium	48	7	9	8	8	17	5	9	21	6	11	18	11	25	12	9	460[4]	2700	1-150 (18)
Copper	32	35	48	22	26	34	22	53	40	9	52	35	38	83	30	24	NL	NL	4-55 (16)
Lead	33	9.9	6.9	32	13.8	91	10.9	9.1	99	23	64	65	28	189	35	7.0	210	880	3-32 (11)
Mercury	0.33	0.49	2.2	0.39	0.36	0.28	0.41	0.17	1.23	0.87	0.49	1.28	1.02	3.7	0.63	0.51	310	1800	0.019-0.5 (0.19)
Zinc	84	25	27	53	46	153	12	12	180	21	185	153	105	210	99	15	7000[5]	NGV[8]	11-58 (28)

Table C1 Laboratory Analysis of Soil Samples Taken at Selected Locations and Depths at Moanataiari, Thames (mg/kg dry weight) for metal concentrations

Sample Location	MOA006 1.0	MOA007 0.1	MOA007 0.5	MOA007 1.0	MOA008 0.1	MOA008 0.5	MOA009 0.1	MOA009 0.5	MOA010 0.1	MOA 010 0.5	MOA010 1.0	MOA011 0.1	MOA011 0.5	MOA012 0.1	MOA012 0.5	MOA013 0.1	Human Health		
Lab Number	947724.10	947721.1	947721.2	947721.3	947915.13	947915.14	947142.4	947142.5	947142.7	947142.8	947142.9	947724.11	947724.12	947724.17	947724.16	947915.1	Risk-based Values		
Sample Depth (m)	1.0	0.1	0.5	1.0	0.1	0.5	0.1	0.5	0.1	0.5	1.0	0.1	0.5	0.1	0.5	0.1	Residential[1]	Recreational[2]	Background [6]
Antimony	1.7	0.6	3.0	4.0	5.2	8.5	1.4	2.5	1.7	1.8	2.4	1.2	1.2	1.6	2.7	5.2	31[3]	NGV[8]	0.02-0.17 (0.076)
Arsenic	**37**	24	**166**	**139**	**51**	**156**	21	**37**	**62**	**42**	**93**	25	**31**	**35**	**86**	**57**	20	80	1.0-25 (5.1)
Cadmium	<0.10	0.21	<0.10	0.18	0.14	< 0.10	0.18	0.15	0.40	< 0.10	< 0.10	0.34	0.31	< 0.10	0.25	< 0.10	3	400	0.03-0.3 (0.11)
Chromium	6	15	28	15	11	7	13	20	14	6	15	15	15	14	12	10	460[4]	2700	1-150 (18)
Copper	16	25	37	34	21	34	26	25	55	59	32	36	132	38	92	26	NL	NL	4-55 (16)
Lead	5.2	51	18.0	36	32	24	41	21	66	7.6	8.8	42	30	35	119	37	210	880	3-32 (11)
Mercury	0.82	0.40	1.14	0.57	0.48	1.37	0.68	1.68	0.70	0.90	0.99	0.64	0.26	0.57	3.8	1.11	310	1800	0.019-0.5 (0.19)
Thallium	nt	nt	1.4	nt	nt	1.1	nt	nt	nt	1.5	nt	nt	nt	nt	nt	nt	0.78[3]	NGV[8]	0.057-0.6 (0.22)
Zinc	7	115	38	117	79	85	100	71	146	16	19	99	70	90	161	64	7000[5]	NGV[8]	11-58 (28)

Table C1 Laboratory Analysis of Soil Samples Taken at Selected Locations and Depths at Moanataiari, Thames (mg/kg dry weight) for metal concentrations

Sample Location	MOA013 0.5	MOA013 1.0	MOA014 0.1	MOA014 0.5	MOA014 1.0	MOA 015 0.1	MOA 015 0.5	MOA 015 1.0	MOA016 0.1	MOA016 0.5	MOA017 0.1	MOA017 0.5	MOA018 0.1	MOA018 0.5	MOA018 1.0	MOA019 0.1	Human Health		
Lab Number	947915.2	947915.3	947769.1	947769.2	947769.3	947142.11	947142.12	947142.13	947769.5	947769.6	947769.7	947769.8	947769.11	947769.12	947769.13	947769.14	Risk-based Values		
Sample Depth (m)	0.5	1.0	0.1	0.5	1.0	0.1	0.5	1.0	0.1	0.5	0.1	0.5	0.1	0.5	1.0	0.1	Residential[1]	Recreational[2]	Background [6]
Antimony	4.4	9.0	4.0	2.6	2.3	27	37	35	4.6	0.7	2.1	0.9	12.8	14.1	19.0	7.3	31[3]	NGV[8]	0.02-0.17 (0.076)
Arsenic	**118**	**230**	**88**	**101**	**111**	**350**	**680**	**1,020**	**187**	**550**	**50**	**55**	**250**	**560**	**600**	**151**	20	80	1.0-25 (5.1)
Cadmium	0.13	0.25	< 0.10	0.15	< 0.10	0.2	0.25	0.32	0.22	< 0.10	0.30	0.10	0.54	0.39	< 0.10	0.74	3	400	0.03-0.3 (0.11)
Chromium	10	14	8	10	9	8	13	6	13	21	12	12	15	8	7	15	460[4]	2700	1-150 (18)
Copper	40	200	28	42	39	43	147	97	49	36	31	29	73	56	33	54	NL	NL	4-55 (16)
Lead	40	182	35	52	18.9	106	156	123	82	8.8	58	71	140	139	123	220	210	880	3-32 (11)
Mercury	2.3	5.0	1.28	2.9	1.98	27	43	78	3.9	1.18	1.10	0.60	10.4	16.7	29	11.5	310	1800	0.019-0.5 (0.19)
Thallium	nt	1.1	nt	nt	nt	2.7	7.5	5.4	1.2	nt	nt	nt	1.9	3.2	6.2	1.3	0.78[3]	NGV[8]	0.057-0.6 (0.22)
Zinc	68	130	68	74	28	101	220	132	148	44	124	189	162	134	58	250	7000[5]	NGV[8]	11-58 (28)

Table C1 Laboratory Analysis of Soil Samples Taken at Selected Locations and Depths at Moanataiari, Thames (mg/kg dry weight) for metal concentrations

Sample Location	MOA019 0.5	MOA019 1.0	MOA020 0.1	MOA020 0.5	MOA020 1.0	MOA021 0.1	MOA021 0.5	MOA021 1.0	MOA022 0.1	MOA022 0.5	MOA022 1.5	MOA023 0.1	MOA023 0.5	MOA024 0.1	MOA024 0.5	MOA024 1.0	Human Health		
Lab Number	947769.15	947769.16	947769.18	947769.19	947769.20	947724.13	947724.14	947724.15	947721.4	947721.5	947721.16	947915.5	947915.6	947769.21	947769.22	947769.23	Risk-based Values		
Sample Depth (m)	0.5	1.0	0.1	0.5	1.0	0.1	0.5	1.0	0.1	0.5	1.5	0.1	0.5	0.1	0.5	1.0	Residential[1]	Recreational[2]	Background [6]
Antimony	19.5	16.6	18.1	27	7.0	5.4	7.2	9.4	9.1	11.9	45	9.7	10.3	4.8	0.5	23	31[3]	NGV[8]	0.02-0.17 (0.076)
Arsenic	**460**	**4,700**	**320**	**1,450**	**550**	**87**	**210**	**270**	**113**	**200**	**920**	**119**	**410**	**46**	18	**500**	20	80	1.0-25 (5.1)
Cadmium	0.72	0.31	0.16	< 0.10	0.16	0.17	< 0.10	< 0.10	0.39	0.31	2.8	0.40	0.24	0.18	< 0.10	0.16	3	400	0.03-0.3 (0.11)
Chromium	10	7	8	7	12	20	10	7	12	9	< 2	12	10	12	10	7	460[4]	2700	1-150 (18)
Copper	130	42	28	31	51	62	152	59	44	66	360	47	56	37	43	41	NL	NL	4-55 (16)
Lead	850	68	117	250	42	81	68	83	106	350	177	166	113	129	11.6	157	210	880	3-32 (11)
Mercury	24	43	13.2	29	8.4	0.92	1.39	6.3	2.5	5.2	24	1.31	13.9	1.98	0.11	132	310	1800	0.019-0.5 (0.19)
Thallium	3.9	5.0	2.0	5.0	2.0	nt	nt	1.9	nt	1.6	5.7	nt	2.2	nt	nt	2.8	0.78[3]	NGV[8]	0.057-0.6 (0.22)
Zinc	260	83	76	62	155	138	59	37	172	150	450	240	160	102	27	57	7000[5]	NGV[8]	11-58 (28)

Table C1 Laboratory Analysis of Soil Samples Taken at Selected Locations and Depths at Moanataiari, Thames (mg/kg dry weight) for metal concentrations

Sample Location	MOA025 0.1	MOA025 0.5	MOA026 0.1	MOA027 0.1	MOA027 0.5	MOA028 0.1	MOA028 0.5	MOA028 1.0	Human Health		
Lab Number	947915.9	947915.10	947721.17	947878.1	947878.2	947878.4	947878.5	947878.6	Risk-based Values		
Sample Depth (m)	0.1	0.5	0.1	0.1	0.5	0.1	0.5	1.0	Residential[1]	Recreational[2]	Background [6]
Antimony	10.7	2.6	10.1	2.5	2.7	1.2	1.3	1.3	31[3]	NGV[8]	0.02-0.17 (0.076)
Arsenic	**132**	**114**	**135**	**40**	**88**	24	**53**	25	20	80	1.0-25 (5.1)
Cadmium	< 0.10	< 0.10	0.23	0.52	0.3	0.24	0.14	0.27	3	400	0.03-0.3 (0.11)
Chromium	9	8	14	19	16	15	11	17	460[4]	2700	1-150 (18)
Copper	36	34	137	47	55	33	40	32	NL	NL	4-55 (16)
Lead	103	40	121	113	200	46	46	45	210	880	3-32 (11)
Mercury	3.1	1.92	4.8	0.43	1.56	0.46	0.82	0.46	310	1800	0.019-0.5 (0.19)
Thallium	1.2	nt	1.1	nt	nt	nt	1.1	nt	0.78[3]	NGV[8]	0.057-0.6 (0.22)
Zinc	61	25	183	610	154	98	56	108	7000[5]	NGV[8]	11-58 (28)

Notes

1. Soil Contaminants Standard for residential areas assuming 10% produce consumption, unless otherwise stated.
2. Soil Contaminants Standard for recreational areas
3. EPA Regional Screening Level (RSL) Resident Soils Table June 2011
4. Guideline[4] values for Chromium VI
5. Schedule B (7a) Guideline of Health-Based Investigation Levels - National Environmental Protection (Assessment of Site Contamination) Measure 1999
6. MFE Identifying, investigating and managing Risks Associated with Former Sheep-dip sites 2006, Table 4: Soil guideline for Human Health
7. nt Not tested
8. No guideline value (NGV)

NL = No Limit. No concentration of copper encountered in soils is likely to cause adverse human health effects.

	Sample Exceeds NES 10% Residential guideline value
	Sample Exceeds NES Recreational guideline value
	Sample Exceeds EPA Regional Screening Level (RSL) Resident Soils Table June 2011
1	Sample Exceeds MFE Sheep-dip site guideline value

Table C2 Extensive Metals Suite Laboratory Analysis of Soil Samples Taken at Selected Locations and Depths at Moanataiari, Thames (mg/kg dry weight)

		MOA 015 0.1	MOA 015 0.5	MOA 015 1.0	MOA016 0.1	MOA018 0.1	MOA019 0.1	MOA019 1.0	MOA020 0.1	MOA020 0.5	MOA022 1.5	Human Health Risk-based Values		
		947142.17	947142.12	947142.13	947769.25	947769.26	947769.28	947769.16	947769.27	947769.19	947721.16	Residential[1]	Recreational[2]	Background[6]
Metals extensive suite, screen level (32 metals)														
Total Recoverable Aluminium	mg/kg dry wt	5,600	5,900	2,600	12,300	16,300	13,600	1,800	6,700	3,300	1,480	-	-	4,700-70,000 (25,600)
Total Recoverable Antimony	mg/kg dry wt	29	37	35	5.2	14.4	10.9	16.6	23	27	45	31[3]	NGV[7]	0.02-0.17 (0.076)
Total Recoverable Arsenic	mg/kg dry wt	330	680	1,020	191	220	230	4,700	380	1,450	920	20	80	1.0-25 (5.1)
Total Recoverable Barium	mg/kg dry wt	260	240	183	82	220	191	158	149	260	210	-	-	15-310 (97)
Total Recoverable Bismuth	mg/kg dry wt	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	1	3.2	< 0.4	-	-	0.059-0.40 (0.18)
Total Recoverable Boron	mg/kg dry wt	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	-	-	1.0-8.5 (2.9)
Total Recoverable Cadmium	mg/kg dry wt	0.18	0.25	0.32	0.30	0.49	0.64	0.31	0.2	< 0.10	2.8	3	400	0.03-0.3 (0.11)
Total Recoverable Caesium	mg/kg dry wt	2.0	3.1	7.2	2.3	1.9	1.6	3.8	3	4.4	5.8	-	-	0.3-5.3 (1.6)
Total Recoverable Calcium	mg/kg dry wt	2,800	2,200	970	5,700	4,300	6,000	1,240	2,700	2,100	280	-	-	720-14,700 (4,530)
Total Recoverable Chromium	mg/kg dry wt	10	13	6	14	14	13	7	12	7	< 2	460[4]	2,700	1-150 (18)
Total Recoverable Cobalt	mg/kg dry wt	4.3	5.4	5.0	9.6	10.0	9.8	0.5	5.9	3.3	7.4	-	-	0.9-28 (5.9)
Total Recoverable Copper	mg/kg dry wt	49	147	97	52	78	73	42	32	31	360	NL	NL	4-55 (16)
Total Recoverable Iron	mg/kg dry wt	31,000	52,000	59,000	42,000	35,000	32,000	35,000	31,000	47,000	28,000	-	-	4,700-76,00 (25,600)
Total Recoverable Lanthanum	mg/kg dry wt	4.5	6.9	2.6	9.1	16.3	7.4	6.5	5.1	3.3	2.3	-	-	2-65 (11)
Total Recoverable Lead	mg/kg dry wt	112	156	123	78	156	240	68	131	250	177	210	880	3-32 (11)
Total Recoverable Lithium	mg/kg dry wt	3.5	3.8	0.6	7.3	6.8	5.0	0.4	3.1	1.8	< 0.4	-	-	0.6-9.4 (3.9)
Total Recoverable Magnesium	mg/kg dry wt	1,070	650	158	1,800	1,550	2,300	128	1,230	570	76	-	-	140-2010 (760)
Total Recoverable Manganese	mg/kg dry wt	195	155	44	540	1,160	620	22	310	104	33	-	-	50-2960 (780)
Total Recoverable Mercury	mg/kg dry wt	26	43	78	3.9	10.6	12.3	43	15.0	29	24	310	1,800	0.019-0.50
Total Recoverable Molybdenum	mg/kg dry wt	4.6	5.2	12.6	1.1	2.6	2.3	4.9	6.2	9.4	17	-	-	0.23-1.80 (0.76)
Total Recoverable Nickel	mg/kg dry wt	3	6	4	7	7	6	< 2	5	3	4	-	-	0.56-21 (3.9)
Total Recoverable Phosphorus	mg/kg dry wt	380	350	410	440	1,000	530	153	490	410	56	-	-	15-310 (350)
Total Recoverable Potassium	mg/kg dry wt	570	560	690	1,140	850	820	1,190	1,080	870	790	-	-	170-1300 (490)
Total Recoverable Rubidium	mg/kg dry wt	5.8	5.2	6.5	8.9	7.2	7.6	5.5	6.6	5.9	5.7	-	-	1.1-22 (7.6)
Total Recoverable Selenium	mg/kg dry wt	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	-	-	-
Total Recoverable Sodium	mg/kg dry wt	150	193	42	470	260	360	199	260	210	< 40	-	-	90-280 (160)
Total Recoverable Strontium	mg/kg dry wt	23	41	12.6	38	31	40	13.2	21	31	4.0	-	-	5-57 (19)
Total Recoverable Thallium	mg/kg dry wt	2.5	7.5	5.4	1.1	1.9	1.8	5.0	2.4	5.0	5.7	0.78[3]	NGV[7]	0.057-0.6 (0.22)
Total Recoverable Tin	mg/kg dry wt	4.4	46	3.4	1.2	4.2	6.6	1.5	3.5	9.1	< 1.0	-	-	0.38-2.6 (1.14)
Total Recoverable Uranium	mg/kg dry wt	0.15	0.24	< 0.10	0.29	0.69	0.33	< 0.10	0.14	< 0.10	< 0.10	-	-	0.19-2.5 (0.79)
Total Recoverable Vanadium	mg/kg dry wt	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	-	-	5-300 (68)
Total Recoverable Zinc	mg/kg dry wt	111	220	132	168	173	260	83	94	62	450	7,000[5]	NGV[7]	11-58 (28)

Notes:

1. Soil Contaminants Standard for residential areas assuming 10% produce consumption, unless otherwise stated.
2. Soil Contaminants Standard for recreational areas
3. EPA Regional Screening Level (RSL) Resident Soils Table June 2011
4. Guideline1 values for Chromium VI
5. Schedule B (7a) Guideline of Health-Based Investigation Levels - National Environmental Protection (Assessment of Site Contamination) Measure 1999
6. Taylor, M. D. & Kim, N. D. (2009) Dealumination as a mechanism for increased acid recoverable Al in Waikato mineral soils. Australian Journal of Soil Research, 47, pp 828-838. values given as range and average (in brackets)
7. No Guidline Value (NGV)

NL = No Limit. No concentration of copper encountered in soils is likely to cause adverse human health effects.

	Sample Exceeds NES Soil Contamination Standard (SCS) for Human Health -10% Residential guideline value
	Sample Exceeds NES Soil Contamination Standard (SCS) for Human Health - Recreational guideline value
	Sample Exceeds EPA Regional Screening Level (RSL) Resident Soils Table June 2011

Table C3: Soil Sample Results - TPH, PAH - ALL PATHWAYS

Soil Samples Collected at a Depth of <1 m Below Ground Level [1]

Sample Name	MOA002 0.1	MOA002 0.5	MOA 004 0.5	MOA005 0.5	MOA007 0.1	MOA007 0.5	MOA011 0.5	MOA012 0.5	MOA014 0.1	MOA014 0.5	MOA016 0.1	MOA016 0.5	MOA021 0.1	MOA021 0.5	MOA026 0.1	Tier 1 Soil Acceptance Criteria[2,3]
Laboratory Reference	947724.5	947724.6	947142.2	947721.8	947721.1	947721.2	947724.12	947724.16	947769.1	947769.2	947769.5	947769.6	947724.13	947724.14	947721.17	Residential Land Use
Sample Location	MOA002	MOA002	MOA004	MOA005	MOA007	MOA007	MOA011	MOA012	MOA014	MOA014	MOA016	MOA016	MOA021	MOA021	MOA026	ALL PATHWAYS
Soil Fate	Remaining	Remaining	Remaining	Remaining	Remaining	Remaining	Remaining	Remaining	Remaining	Remaining	Remaining	Remaining	Remaining	Remaining	Remaining	
Soil Type - Field													Sand	Sand		Sand
Soil Type - MfE (1999)													Sand	Sand		
Sample Depth (m bgl)	0.1	0.5	0.5	0.5	0.1	0.5	0.5	0.5	0.1	0.5	0.1	0.5	0.1	0.5	0.1	<1 m
C_7-C_9 hydrocarbons	< 10	< 9	< 8	< 8	< 9	< 10	< 8	< 9	< 11	< 10	< 9	< 8	< 9	-	< 8	120 [m]
C_{10}-C_{14} hydrocarbons	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 30	< 20	< 20	< 20	< 20	-	< 20	(470) [6,x]
C_{15}-C_{36} hydrocarbons	< 40	< 40	< 40	< 40	< 40	< 40	< 40	< 40	< 50	< 40	< 40	< 40	68	-	57	NA [4]
TPH	< 70	< 70	< 70	< 70	< 70	< 70	< 70	< 70	< 80	< 70	< 70	< 70	< 70	-	< 70	-
Naphthalene	-	-	-	-	-	-	-	-	-	-	-	-	< 0.14	< 0.14	-	58 [v]
Non-carc. (Pyrene)	-	-	-	-	-	-	-	-	-	-	-	-	0.69	1	-	(1,600) [6,p]
Benzo(a)pyrene eq.[7]	-	-	-	-	-	-	-	-	-	-	-	-	0.52	0.86	-	10 [p, 8]

Soil Samples Collected at a Depth of 1 - 4 m Below Ground Level [1]

Sample Name	MOA 004 1.0	MOA005 1.5	MOA007 1.0	MOA014 1.0	MOA021 1.0	MOA022 1.0										Tier 1 Soil Acceptance Criteria[2,3]
Laboratory Reference	947142.3	947721.1	947721.3	947769.3	947724.15	947721.6										Residential Land Use
Sample Location	MOA004	MOA005	MOA007	MOA014	MOA021	MOA022										ALL PATHWAYS
Soil Fate	Remaining	Remaining	Remaining	Remaining	Remaining	Remaining										
Soil Type - Field					Sand											Sandy Silt
Soil Type - MfE (1999)					Sandy Silt											
Sample Depth (m bgl)	1.0	1.5	1	1	1	1										1 - 4 m
C_7-C_9 hydrocarbons	< 8	< 9	< 10	< 9	< 9	< 9										(500) [6,m]
C_{10}-C_{14} hydrocarbons	< 20	< 20	< 20	< 20	< 20	< 20										(670) [6,x]
C_{15}-C_{36} hydrocarbons	< 40	< 40	< 40	< 40	115	< 40										NA [4]
TPH	< 70	< 70	< 70	< 70	115	< 70										-
Naphthalene	-	-	-	-	0.14	-										83 [v]
Non-carc. (Pyrene)	-	-	-	-	9.3	-										NA [4]
Benzo(a)pyrene eq.[7]	-	-	-	-	5.29	-										(25) [6,m]

Note:
1. All results in mg/kg.
2. Criteria from Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand. Revised 2011 (MfE, August 1999).
3. Criteria assume residential land use,a 'sand' soil type and contamination depths of <1 m and 1 - 4 m below ground level.
4. NA indicates contaminant is not limiting as health based criterion is significantly higher than may be encountered on site (i.e. 20,000 mg/kg for TPH, 10,000 mg/kg for other contaminants).
5. The following notes indicate the limiting pathway for each criterion: d - dermal, m - maintenance/excavation, p - produce, s - soil ingestion, v - volatilisation, x - PAH surrogate.
6. Brackets denote values exceed threshold likely to correspond to formation of residual separate phase hydrocarbons.
7. Risk associated with mixture of carcinogenic PAHs assessed by comparison with MfE (2011) Methodology for Deriving Standards for Contaminants in Soil to Protect Human Health. Where a laboratory result for an individual PAH compound is below the laboratory detection limit the concentration is taken to be half the
8. National Environmental Standard Residential Contaminant Standard for Human Health Benzo(a)pyrene eq. value adopted.

Concentration above MfE (1999) Tier 1 soil acceptance criteria - ALL PATHWAYS

Table C4: QA/QC

		MOA015 0.1	MOA015 0.1 (duplicate)	%RPD[2]	MOA016 0.1	MOA016 0.1 (duplicate)	%RPD[2]	MOA018 0.1	MOA018 0.1 (duplicate)	%RPD[2]	MOA 020 0.1	MOA 020 0.1 (duplicate)	%RPD[2]	MOA019 0.1	MOA019 0.1 (duplicate)	%RPD[2]	MOA005 0.5	MOA005 0.5 (duplicate)	%RPD[2]
		947142.11	947142.17		947769.5	947769.25		947769.11	947769.26		947769.18	947769.27		947769.14	947769.28		947721.8	947721.18	
Dry Matter		nt	nt	-	76	nt	-	nt	nt	-	nt	nt	-	nt	nt	-	83	nt	-
Total Recoverable Aluminium	g/m3	nt	5,600	-	nt	12,300	-	nt	16,300	-	nt	6,700	-	nt	13,600	-	nt	nt	-
Total Recoverable Antimony	g/m3	27	29	7.1%	4.6	5.2	12.2%	12.8	14.4	11.8%	18.1	23	23.8%	7.3	10.9	39.6%	6.8	4.5	40.7%
Total Recoverable Arsenic	g/m3	350	330	5.9%	187	191	2.1%	250	220	12.8%	320	380	17.1%	151	230	41.5%	128	106	18.8%
Total Recoverable Barium	g/m3	nt	260	-	nt	82	-	nt	220	-	nt	149	-	nt	191	-	nt	nt	-
Total Recoverable Bismuth	g/m3	nt	<0.4	-	nt	<0.4	-	nt	<0.4	-	nt	1.0	-	nt	<0.4	-	nt	nt	-
Total Recoverable Boron	g/m3	nt	<20	-	nt	<20	-	nt	<20	-	nt	<20	-	nt	<20	-	nt	nt	-
Total Recoverable Cadmium	g/m3	0.20	0.18	10.5%	0.22	0.30	30.8%	0.54	0.49	9.7%	0.16	0.2	22.2%	0.74	0.64	14.5%	<0.10	<0.10	-
Total Recoverable Caesium	g/m3	nt	2.0	-	nt	2.3	-	nt	1.9	-	nt	3.0	-	nt	1.6	-	nt	nt	-
Total Recoverable Calcium	g/m3	nt	2,800	-	nt	5,700	-	nt	4,300	-	nt	2,700	-	nt	6,000	-	nt	nt	-
Total Recoverable Chromium	g/m3	8	10	22.2%	13	14	7.4%	15	14	6.9%	8	12	40.0%	15	13	14.3%	11	10	9.5%
Total Recoverable Cobalt	g/m3	nt	4.3	-	nt	9.6	-	nt	10.0	-	nt	5.9	-	nt	9.8	-	nt	nt	-
Total Recoverable Copper	g/m3	43	49	13.0%	49	52	5.9%	73	78	6.6%	28	32	13.3%	54	73	29.9%	38	35	8.2%
Total Recoverable Iron	g/m3	nt	31,000	-	nt	42,000	-	nt	35,000	-	nt	31,000	-	nt	32,000	-	nt	nt	-
Total Recoverable Lanthanum	g/m3	nt	4.5	-	nt	9.1	-	nt	16.3	-	nt	5.1	-	nt	7.4	-	nt	nt	-
Total Recoverable Lead	g/m3	106	112	5.5%	82	78	5.0%	140	156	10.8%	117	131	11.3%	220	240	8.7%	28	28	0.0%
Total Recoverable Lithium	g/m3	nt	3.5	-	nt	7.3	-	nt	6.8	-	nt	3.1	-	nt	5.0	-	nt	nt	-
Total Recoverable Magnesium	g/m3	nt	1,070	-	nt	1,800	-	nt	1,550	-	nt	1,230	-	nt	2,300	-	nt	nt	-
Total Recoverable Manganese	g/m3	nt	195	-	nt	540	-	nt	1,160	-	nt	310	-	nt	620	-	nt	nt	-
Total Recoverable Mercury	g/m3	27	26	3.8%	3.9	3.9	0.0%	10.4	10.6	1.9%	13.2	15.0	12.8%	11.5	12.3	6.7%	1.02	1.07	4.8%
Total Recoverable Molybdenum	g/m3	nt	4.6	-	nt	1.1	-	nt	2.6	-	nt	6.2	-	nt	2.3	-	nt	nt	-
Total Recoverable Nickel	g/m3	nt	3	-	nt	7	-	nt	7	-	nt	5	-	nt	6	-	nt	nt	-
Total Recoverable Phosphorus	g/m3	nt	380	-	nt	440	-	nt	1,000	-	nt	490	-	nt	530	-	nt	nt	-
Total Recoverable Potassium	g/m3	nt	570	-	nt	1,140	-	nt	850	-	nt	1,080	-	nt	820	-	nt	nt	-
Total Recoverable Rubidium	g/m3	nt	5.8	-	nt	8.9	-	nt	7.2	-	nt	6.6	-	nt	7.6	-	nt	nt	-
Total Recoverable Selenium	g/m3	nt	<20	-	nt	<20	-	nt	<20	-	nt	<20	-	nt	<20	-	nt	nt	-
Total Recoverable Sodium	g/m3	nt	150	-	nt	470	-	nt	260	-	nt	260	-	nt	360	-	nt	nt	-
Total Recoverable Strontium	g/m3	nt	23	-	nt	38	-	nt	31	-	nt	21	-	nt	40	-	nt	nt	-
Total Recoverable Thallium	g/m3	2.7	2.5	7.7%	1.2	1.1	8.7%	1.9	1.9	0.0%	2.0	2.4	18.2%	1.3	1.8	32.3%	nt	nt	-
Total Recoverable Tin	g/m3	nt	4.4	-	nt	1.2	-	nt	4.2	-	nt	3.5	-	nt	6.6	-	nt	nt	-
Total Recoverable Uranium	g/m3	nt	0.15	-	nt	0.29	-	nt	0.69	-	nt	0.14	-	nt	0.33	-	nt	nt	-
Total Recoverable Vanadium	g/m3	nt	<100	-	nt	<100	-	nt	<100	-	nt	<100	-	nt	<100	-	nt	nt	-
Total Recoverable Zinc	g/m3	101	111	9.4%	148	168	12.7%	162	173	6.6%	76	94	21.2%	250	260	3.9%	105	96	9.0%
Total Petroleum Hydrocarbons Soil																			
C7 - C9	mg/kg dry wt	nt	nt	-	<9	nt	-	nt	nt	-	nt	nt	-	nt	nt	-	<8	nt	-
C10 - C14	mg/kg dry wt	nt	nt	-	<20	nt	-	nt	nt	-	nt	nt	-	nt	nt	-	<20	nt	-
C15 - C36	mg/kg dry wt	nt	nt	-	<40	nt	-	nt	nt	-	nt	nt	-	nt	nt	-	<40	nt	-
Total hydrocarbons (C7 - C36)	mg/kg dry wt	nt	nt	-	<70	nt	-	nt	nt	-	nt	nt	-	nt	nt	-	<70	nt	-

Notes:
1. nt: Not Tested
2. %RPD Relative Percent Difference

Table C5: X-ray Fluoresence (XRF) Raw Data - Page 1 of 3

SAMPLE	INSPECTOR	Mo (± 2Σs.d.)	Mo LOD	Zr (± 2Σs.d.)	Sr (± 2Σs.d.)	U (± 2Σs.d.)	U LOD	Rb (± 2Σs.d.)	Th (± 2Σs.d.)	Th LOD	Pb (± 2Σs.d.)	Se (± 2Σs.d.)	Se LOD	As (± 2Σs.d.)	As LOD	Hg (± 2Σs.d.)	Hg LOD
xrf 1	ajr	< LOD	7.15	141.73 ± 8.85	58.51 ± 5.04	< LOD	11.98	43.78 ± 4.91	< LOD	9.00	54.61 ± 10.13	< LOD	4.81	47.68 ± 9.94	-	< LOD	12.51
xrf 2	ajr	< LOD	5.64	117.65 ± 6.54	51.83 ± 3.79	< LOD	9.46	43.13 ± 3.86	9.92 ± 5.49	-	154.48 ± 12.13	< LOD	3.55	126.53 ± 12.32	-	< LOD	9.23
xrf 3	ajr	< LOD	7.77	137.31 ± 9.56	72.58 ± 5.99	< LOD	12.38	49.18 ± 5.50	< LOD	13.01	333.55 ± 23.64	< LOD	5.11	223.69 ± 23.40	-	< LOD	13.66
xrf 4	ajr	11.38 ± 4.44	-	60.50 ± 6.22	36.13 ± 3.85	< LOD	9.86	34.63 ± 4.08	< LOD	7.45	47.97 ± 8.79	< LOD	3.42	91.16 ± 10.49	-	< LOD	9.20
xrf 5	ajr	< LOD	5.19	117.99 ± 6.34	101.49 ± 4.76	< LOD	8.64	43.09 ± 3.61	9.29 ± 4.75	-	89.38 ± 9.06	< LOD	2.94	89.37 ± 9.46	-	< LOD	8.20
xrf 6	ajr	< LOD	5.17	126.93 ± 6.35	80.66 ± 4.27	< LOD	9.01	51.56 ± 3.87	< LOD	6.04	70.19 ± 8.17	< LOD	3.22	108.16 ± 9.41	-	< LOD	7.80
xrf 7	ajr	< LOD	6.96	105.72 ± 7.71	48.28 ± 4.50	< LOD	10.63	34.57 ± 4.30	< LOD	7.77	74.80 ± 11.00	< LOD	4.75	108.31 ± 12.45	-	< LOD	10.41
xrf 8	ajr	7.38 ± 3.96	-	127.36 ± 7.02	58.55 ± 4.16	< LOD	8.43	23.17 ± 3.18	< LOD	8.69	259.03 ± 15.99	< LOD	3.40	50.64 ± 13.37	-	< LOD	8.29
xrf 9	cf	< LOD	7.70	99.15 ± 8.43	38.60 ± 4.62	< LOD	13.62	60.83 ± 6.06	< LOD	9.98	120.99 ± 14.95	< LOD	5.34	192.45 ± 17.86	-	< LOD	12.12
xrf 10	ajr	< LOD	5.47	123.98 ± 7.18	180.66 ± 6.64	< LOD	9.93	38.30 ± 3.79	< LOD	6.34	42.12 ± 7.34	< LOD	3.54	82.61 ± 8.70	-	< LOD	9.17
xrf 13	cf	< LOD	6.55	115.99 ± 7.74	83.32 ± 5.42	< LOD	11.18	50.36 ± 4.78	< LOD	8.04	116.77 ± 12.58	< LOD	4.10	135.91 ± 13.79	-	< LOD	10.59
xrf 14	ajr	< LOD	6.46	151.59 ± 8.39	90.68 ± 5.56	< LOD	10.95	50.14 ± 4.72	< LOD	7.95	64.00 ± 9.74	< LOD	3.58	97.97 ± 11.14	-	< LOD	9.62
xrf 15	ajr	< LOD	6.40	116.42 ± 7.61	85.77 ± 5.36	< LOD	10.61	44.01 ± 4.45	< LOD	9.64	240.36 ± 16.94	< LOD	3.86	117.37 ± 15.78	-	< LOD	10.19
xrf 16	ajr	< LOD	4.93	122.32 ± 5.96	52.50 ± 3.43	< LOD	7.18	27.08 ± 2.86	< LOD	5.72	28.24 ± 5.74	< LOD	3.01	26.97 ± 5.50	-	< LOD	6.90
xrf 17	ajr	< LOD	6.11	83.15 ± 6.52	22.60 ± 3.17	< LOD	10.09	49.78 ± 4.57	< LOD	6.63	18.64 ± 6.39	< LOD	3.19	50.39 ± 7.59	-	< LOD	8.01
xrf 18	ajr	< LOD	7.11	267.11 ± 11.44	234.88 ± 9.12	< LOD	12.47	45.96 ± 4.94	12.23 ± 6.10	-	34.99 ± 8.52	< LOD	4.32	40.95 ± 8.58	-	< LOD	11.26
xrf 19	ajr	< LOD	8.42	132.36 ± 10.22	81.27 ± 6.77	< LOD	14.88	57.48 ± 6.42	< LOD	10.52	60.99 ± 12.38	< LOD	5.71	121.96 ± 15.10	-	< LOD	12.81
xrf 20	ajr	< LOD	7.43	135.54 ± 9.15	44.48 ± 4.78	< LOD	12.44	49.09 ± 5.40	< LOD	9.60	58.03 ± 10.96	< LOD	4.94	144.24 ± 14.30	-	< LOD	11.67
xrf 21	ajr	< LOD	8.18	176.36 ± 10.78	60.69 ± 5.78	< LOD	13.03	37.87 ± 5.23	< LOD	9.96	33.08 ± 9.64	< LOD	4.80	30.14 ± 9.22	-	< LOD	12.50
xrf 22	ajr	< LOD	6.85	171.05 ± 9.23	73.98 ± 5.42	< LOD	11.72	48.65 ± 4.97	< LOD	8.09	52.86 ± 9.66	< LOD	4.05	135.90 ± 12.74	-	< LOD	11.26
xrf 23	ajr	< LOD	7.94	174.87 ± 10.95	94.44 ± 7.01	< LOD	12.13	31.14 ± 4.83	< LOD	9.61	23.25 ± 8.58	< LOD	4.23	< LOD	10.38	< LOD	12.52
xrf 24	ajr	< LOD	7.49	306.69 ± 12.10	82.44 ± 5.92	< LOD	11.68	35.32 ± 4.60	17.85 ± 6.53	-	10.71 ± 6.73	< LOD	4.38	11.63 ± 5.89	-	< LOD	10.67
xrf 25	ajr	< LOD	6.98	203.12 ± 9.89	63.23 ± 5.11	< LOD	9.80	22.67 ± 3.71	< LOD	7.87	16.24 ± 6.81	< LOD	3.67	< LOD	8.36	< LOD	9.40
xrf 26	ajr	< LOD	7.44	220.61 ± 10.64	58.06 ± 5.15	< LOD	9.43	23.17 ± 3.82	< LOD	8.34	14.40 ± 7.02	< LOD	4.50	9.18 ± 5.97	-	< LOD	10.53
xrf 26	ajr	< LOD	5.08	221.99 ± 7.49	45.24 ± 3.30	< LOD	7.15	19.96 ± 2.62	7.12 ± 3.86	-	12.99 ± 4.85	< LOD	3.00	6.93 ± 4.02	-	< LOD	7.78
xrf 27	ajr	< LOD	6.88	152.03 ± 8.78	48.96 ± 4.57	< LOD	9.88	22.50 ± 3.69	8.92 ± 5.38	-	12.41 ± 6.46	< LOD	3.88	< LOD	7.84	< LOD	9.97
xrf 28	ajr	< LOD	5.99	112.21 ± 7.00	76.71 ± 4.77	< LOD	10.40	53.51 ± 4.48	< LOD	8.55	137.35 ± 12.38	< LOD	4.19	60.42 ± 11.18	-	< LOD	9.76
xrf 29	ajr	< LOD	7.30	100.40 ± 8.36	83.46 ± 6.11	< LOD	12.80	50.37 ± 5.41	< LOD	9.01	64.71 ± 11.19	< LOD	4.58	117.66 ± 13.41	-	< LOD	11.61
xrf 30	ajr	< LOD	5.04	182.83 ± 6.91	84.40 ± 4.17	< LOD	8.22	43.85 ± 3.46	< LOD	5.77	32.39 ± 5.97	< LOD	2.85	22.00 ± 5.44	-	< LOD	6.94
xrf 31	ajr	< LOD	7.92	125.76 ± 9.42	88.88 ± 6.57	< LOD	13.66	46.33 ± 5.53	< LOD	9.57	94.36 ± 13.57	< LOD	4.93	91.36 ± 14.10	-	< LOD	13.08
xrf 32	ajr	< LOD	6.75	131.54 ± 8.25	72.95 ± 5.28	< LOD	11.16	53.58 ± 5.02	< LOD	7.03	28.45 ± 7.71	< LOD	3.94	15.47 ± 6.75	-	< LOD	9.37
xrf 33	cf	< LOD	7.70	637.49 ± 16.24	74.93 ± 5.60	< LOD	11.90	47.96 ± 5.06	16.49 ± 6.52	-	26.38 ± 8.03	< LOD	3.98	< LOD	9.84	< LOD	11.07
xrf 34	cf	< LOD	8.52	198.23 ± 12.57	271.64 ± 11.78	< LOD	14.45	43.98 ± 5.80	< LOD	10.01	41.27 ± 10.68	< LOD	4.82	43.10 ± 10.73	-	< LOD	12.85
xrf 34a	cf	< LOD	6.94	283.67 ± 11.01	62.81 ± 5.00	< LOD	11.52	59.60 ± 5.28	< LOD	8.32	52.18 ± 9.54	< LOD	4.05	69.00 ± 10.29	-	< LOD	10.14
xrf 35	ajr	< LOD	6.45	126.24 ± 8.46	264.16 ± 8.97	< LOD	11.03	38.44 ± 4.26	< LOD	7.76	91.13 ± 11.08	< LOD	4.06	50.46 ± 10.29	-	< LOD	10.18
xrf 36	ajr	< LOD	7.17	116.59 ± 8.73	84.57 ± 6.13	< LOD	11.81	43.72 ± 5.04	< LOD	9.23	71.81 ± 11.64	< LOD	4.49	36.30 ± 10.54	-	< LOD	10.90
xrf 37	ajr	< LOD	7.05	137.51 ± 8.99	122.82 ± 6.93	< LOD	10.81	36.82 ± 4.50	< LOD	8.32	37.79 ± 8.88	< LOD	4.71	28.75 ± 8.30	-	< LOD	10.84
xrf 38	ajr	< LOD	7.19	133.55 ± 8.96	82.33 ± 5.97	< LOD	13.22	63.17 ± 5.85	< LOD	7.83	21.78 ± 7.68	< LOD	4.10	21.82 ± 7.26	-	< LOD	10.45
xrf 39	ajr	< LOD	4.75	91.37 ± 5.13	37.67 ± 2.87	< LOD	6.90	30.36 ± 2.83	< LOD	5.00	23.30 ± 5.13	< LOD	2.55	23.08 ± 4.89	-	< LOD	6.56
xrf 40	ajr	< LOD	7.35	149.61 ± 9.38	82.39 ± 6.01	< LOD	12.27	42.01 ± 5.00	9.18 ± 6.03	-	30.38 ± 8.65	< LOD	4.83	23.40 ± 7.92	-	< LOD	10.08
xrf 41	ajr	< LOD	6.87	278.28 ± 10.82	62.70 ± 4.94	< LOD	10.71	42.02 ± 4.54	< LOD	8.23	38.97 ± 8.57	< LOD	4.03	20.40 ± 7.55	-	< LOD	9.59
xrf 42	ajr	< LOD	7.27	120.58 ± 8.91	72.26 ± 5.82	< LOD	12.33	53.98 ± 5.57	< LOD	8.66	29.03 ± 8.56	< LOD	4.01	28.49 ± 8.29	-	< LOD	10.51
xrf 43	ajr	5.67 ± 3.75	-	88.78 ± 6.13	82.50 ± 4.60	< LOD	9.60	50.44 ± 4.08	< LOD	7.61	127.62 ± 11.16	< LOD	3.72	448.00 ± 17.51	-	14.94 ± 6.59	-
xrf 44	ajr	< LOD	5.33	101.42 ± 6.08	40.94 ± 3.37	< LOD	9.33	53.98 ± 4.11	16.01 ± 9.53	-	1097.06 ± 29.39	< LOD	3.89	217.80 ± 24.75	-	< LOD	8.82
xrf 45	ajr	5.28 ± 3.48	-	134.07 ± 6.37	81.80 ± 4.22	< LOD	8.36	40.85 ± 3.47	< LOD	6.03	42.43 ± 6.67	< LOD	2.91	63.63 ± 7.34	-	< LOD	7.07
xrf 46	ajr	< LOD	7.91	126.15 ± 9.17	30.75 ± 4.32	< LOD	13.75	53.26 ± 5.84	< LOD	9.69	61.99 ± 11.57	< LOD	4.72	122.13 ± 14.16	-	< LOD	12.46
xrf 47	ajr	< LOD	5.29	137.27 ± 6.92	99.20 ± 4.91	< LOD	9.29	50.86 ± 4.02	< LOD	7.10	114.40 ± 10.46	< LOD	3.22	91.54 ± 10.50	-	< LOD	8.86
xrf 48	ajr	< LOD	5.04	155.54 ± 6.54	59.89 ± 3.66	9.05 ± 6.00		48.98 ± 3.71	< LOD	6.10	95.76 ± 9.00	< LOD	3.22	151.87 ± 10.63	-	9.56 ± 5.30	-
xrf 49	ajr	< LOD	7.54	107.46 ± 8.66	51.86 ± 5.17	< LOD	14.88	68.27 ± 6.42	< LOD	8.56	46.35 ± 10.27	< LOD	5.16	74.65 ± 11.54	-	< LOD	12.95
xrf 50	ajr	< LOD	7.56	117.55 ± 8.89	63.55 ± 5.56	< LOD	13.21	62.46 ± 6.02	< LOD	10.18	127.36 ± 15.13	< LOD	5.39	144.62 ± 16.47	-	< LOD	11.72
xrf 51	ajr	8.75 ± 3.74	-	103.24 ± 6.20	66.98 ± 4.12	< LOD	9.32	45.78 ± 3.87	8.10 ± 5.11	-	128.07 ± 10.97	< LOD	3.59	141.29 ± 11.86	-	< LOD	8.66
xrf 52	ajr	< LOD	7.67	140.82 ± 9.96	93.45 ± 6.84	< LOD	12.86	50.16 ± 5.69	< LOD	9.93	67.48 ± 12.07	< LOD	4.39	24.84 ± 10.50	-	< LOD	11.73
xrf 100	ajr	< LOD	5.50	155.85 ± 7.09	60.10 ± 3.96	< LOD	9.50	49.94 ± 4.02	< LOD	6.53	50.17 ± 7.61	< LOD	3.60	77.88 ± 8.53	-	< LOD	8.50
xrf 101	ajr	< LOD	6.00	72.54 ± 6.02	30.98 ± 3.38	< LOD	11.72	80.79 ± 5.44	< LOD	6.61	28.60 ± 6.86	< LOD	2.82	58.46 ± 7.95	-	< LOD	8.27
xrf 102	ajr	< LOD	5.66	94.50 ± 6.48	110.95 ± 5.38	< LOD	8.64	40.83 ± 3.77	< LOD	6.68	47.28 ± 7.73	< LOD	3.30	33.57 ± 7.27	-	< LOD	8.34
xrf 110	ajr	< LOD	5.81	111.75 ± 6.99	70.61 ± 4.62	< LOD	10.65	54.37 ± 4.55	< LOD	7.63	59.39 ± 8.82	< LOD	3.82	152.63 ± 11.71	-	< LOD	9.98
xrf 130	ajr	< LOD	5.16	158.00 ± 6.76	52.02 ± 3.56	< LOD	8.33	35.77 ± 3.36	< LOD	5.59	28.76 ± 5.99	< LOD	3.02	31.17 ± 5.89	-	< LOD	7.07
xrf 140	ajr	< LOD	6.56	236.40 ± 10.11	98.86 ± 5.92	< LOD	11.21	38.61 ± 4.42	< LOD	7.51	27.87 ± 7.61	< LOD	4.21	43.97 ± 8.07	-	< LOD	9.37
xrf 150	ajr	< LOD	6.74	99.48 ± 7.76	79.17 ± 5.58	< LOD	11.25	46.41 ± 4.84	< LOD	8.40	72.59 ± 10.93	< LOD	4.26	86.06 ± 11.74	-	< LOD	10.83
xrf 151	ajr	< LOD	8.34	120.88 ± 10.96	304.07 ± 12.32	< LOD	14.69	44.53 ± 5.79	< LOD	11.81	168.69 ± 18.61	< LOD	5.68	74.25 ± 16.90	-	< LOD	13.96
xrf 152	ajr	< LOD	6.66	140.77 ± 8.37	88.48 ± 5.64	< LOD	11.07	48.13 ± 4.74	< LOD	8.48	80.59 ± 11.01	< LOD	4.44	74.03 ± 11.16	-	< LOD	10.58
xrf 301	ajr	< LOD	5.45	112.95 ± 6.69	84.46 ± 4.7	< LOD	10.34	64.83 ± 4.62	< LOD	12.41	776.73 ± 26.03	< LOD	4.70	348.24 ± 24.12	-	< LOD	9.94
xrf 302	ajr	< LOD	7.03	142.03 ± 8.72	58.31 ± 4.98	< LOD	11.59	61.65 ± 5.47	< LOD	7.92	40.95 ± 8.93	< LOD	3.78	70.95 ± 10.22	-	< LOD	10.36
xrf 303	ajr	< LOD	6.81	164.22 ± 8.95	33.13 ± 3.95	< LOD	10.84	41.46 ± 4.63	< LOD	8.67	102.51 ± 12.54	< LOD	3.95	141 ± 14.31	-	< LOD	10.45
xrf 304	ajr	< LOD	8.59	58.98 ± 8.32	42.17 ± 5.45	< LOD	13.34	35.84 ± 5.49	< LOD	9.89	61.17 ± 12.83	< LOD	5.51	195.2 ± 18.53	-	< LOD	17.04
xrf 305	ajr	< LOD	8.26	120.37 ± 10.39	113.82 ± 8.06	< LOD	15.19	48.22 ± 6.23	< LOD	17.72	695.87 ± 37.14	< LOD	6.08	225.95 ± 32.89	-	< LOD	14.42
xrf 306	ajr	< LOD	8.27	95.69 ± 9.16	48.98 ± 5.54	< LOD	14.07	61.06 ± 6.52	< LOD	16.42	591.3 ± 33.5	< LOD	5.50	448.15 ± 34.26	-	< LOD	15.01
xrf 307	ajr	< LOD	7.08	130.6 ± 8.59	46.95 ± 4.64	< LOD	12.90	60.88 ± 5.66	< LOD	8.64	47.55 ± 9.58	< LOD	3.75	88.14 ± 11.33	-	< LOD	10.67
xrf 500	ajr	< LOD	8.38	328.16 ± 13.69	124.34 ± 7.75	< LOD	13.98	51.34 ± 5.83	13.07 ± 6.99	-	33.64 ± 9.67	< LOD	5.36	14.56 ± 8.20	-	< LOD	12.73

Notes:
1. All values in ppm
2. LOD: Limit of Detection
3. (± 2Σs.d.): Plus or minus two standard deviation

Table C5: X-ray Fluoresence (XRF) Raw Data - Page 2 of 3

SAMPLE	Zn (± 2Σs.d.)	Cu (± 2Σs.d.)	Cu LOD	Ni (± 2Σs.d.)	Ni LOD	Co (± 2Σs.d.)	Co LOD	Fe (± 2Σs.d.)	Mn (± 2Σs.d.)	Cr (± 2Σs.d.)	Cr LOD	V (± 2Σs.d.)	V LOD	Ti (± 2Σs.d.)	Sc(± 2Σs.d.)	Sc LOD	Ca (± 2Σs.d.)
xrf 1	57.59 ± 14.92	< LOD	35.50	< LOD	79.33	< LOD	161.79	20345.52 ± 383.37	415.35 ± 79.34	< LOD	30.90	68.36 ± 39.39	-	1221.66 ± 82.79	21.72 ± 12.94	-	2326.48 ± 144.94
xrf 2	156.53 ± 15.91	54.27 ± 17.41	-	< LOD	51.30	< LOD	127.96	20674.03 ± 305.38	305.16 ± 55.95	< LOD	29.23	63.19 ± 37.58	-	1603.67 ± 79.54	< LOD	17.31	2872.27 ± 137.00
xrf 3	302.85 ± 29.05	71.00 ± 25.16	-	< LOD	74.67	< LOD	216.59	31247.37 ± 514.53	477.42 ± 92.79	< LOD	54.97	< LOD	105.82	2104.05 ± 149.93	< LOD	37.81	5241.74 ± 299.03
xrf 4	74.81 ± 13.61	28.66 ± 17.41	-	< LOD	54.72	< LOD	113.58	11314.30 ± 265.91	142.35 ± 49.64	< LOD	40.67	< LOD	66.46	880.20 ± 91.87	< LOD	21.03	1482.87 ± 161.55
xrf 5	72.75 ± 11.66	49.80 ± 15.59	-	< LOD	46.99	< LOD	142.50	28268.49 ± 337.58	362.70 ± 57.53	< LOD	59.02	< LOD	107.48	1806.84 ± 149.38	< LOD	41.48	6442.03 ± 342.95
xrf 6	154.07 ± 14.82	48.25 ± 14.76	-	< LOD	44.06	< LOD	132.49	24690.93 ± 313.55	329.59 ± 54.37	< LOD	64.43	< LOD	126.10	2678.18 ± 183.32	< LOD	42.44	6079.40 ± 354.32
xrf 7	83.75 ± 15.74	82.93 ± 22.91	-	< LOD	61.35	< LOD	164.62	22151.26 ± 388.34	404.09 ± 75.79	< LOD	45.21	89.00 ± 58.07	-	1510.17 ± 120.19	< LOD	29.95	3987.54 ± 240.27
xrf 8	187.73 ± 17.74	102.20 ± 19.32	-	< LOD	48.51	< LOD	133.50	20043.29 ± 314.84	228.00 ± 53.98	85.69 ± 44.43	-	< LOD	101.88	1610.45 ± 146.80	< LOD	53.34	11327.23 ± 435.59
xrf 9	80.54 ± 17.96	< LOD	35.08	< LOD	72.21	< LOD	216.52	31470.77 ± 515.72	264.30 ± 78.26	< LOD	50.64	< LOD	107.20	2315.01 ± 153.80	< LOD	29.89	3120.71 ± 245.17
xrf 10	82.75 ± 13.46	63.02 ± 18.16	-	< LOD	55.59	< LOD	176.10	39357.52 ± 427.44	716.31 ± 80.54	< LOD	62.54	< LOD	135.40	3318.41 ± 200.49	< LOD	77.08	23002.48 ± 630.52
xrf 13	106.80 ± 16.51	26.67 ± 17.51	-	< LOD	59.61	< LOD	186.14	31634.88 ± 443.44	392.66 ± 74.38	< LOD	70.81	188.86 ± 103.95	-	3694.41 ± 222.58	< LOD	50.34	7762.25 ± 413.62
xrf 14	101.27 ± 15.76	65.43 ± 19.79	-	< LOD	57.85	< LOD	170.85	27233.86 ± 407.34	553.90 ± 81.31	< LOD	65.91	< LOD	143.33	3581.29 ± 209.54	< LOD	47.41	6879.84 ± 379.70
xrf 15	308.35 ± 24.41	61.28 ± 19.65	-	< LOD	56.06	< LOD	181.30	31592.95 ± 433.70	1507.41 ± 121.15	< LOD	60.77	143.34 ± 85.35	-	2465.27 ± 177.99	< LOD	45.37	7777.90 ± 369.76
xrf 16	42.67 ± 9.23	21.44 ± 13.14	-	< LOD	42.86	< LOD	114.26	19656.09 ± 269.99	256.03 ± 47.26	< LOD	52.40	< LOD	107.14	2306.18 ± 154.61	< LOD	35.94	4620.63 ± 279.77
xrf 17	36.44 ± 10.45	< LOD	22.59	< LOD	50.41	< LOD	113.28	11429.74 ± 260.73	103.00 ± 44.19	< LOD	68.02	167.08 ± 98.23	-	3801.43 ± 213.54	< LOD	40.44	4538.56 ± 347.56
xrf 18	95.23 ± 16.81	< LOD	30.28	< LOD	72.23	< LOD	181.61	28028.94 ± 438.42	1032.05 ± 110.80	< LOD	42.98	< LOD	83.68	1676.48 ± 119.10	< LOD	44.87	12183.99 ± 368.44
xrf 19	104.12 ± 20.78	45.43 ± 25.26	-	< LOD	76.53	< LOD	244.77	34288.77 ± 582.94	380.13 ± 93.55	< LOD	66.41	172.85 ± 86.13	-	2182.09 ± 175.26	< LOD	45.37	6554.38 ± 368.72
xrf 20	99.11 ± 17.97	42.90 ± 22.80	-	< LOD	70.23	< LOD	171.64	20553.22 ± 408.89	273.65 ± 72.45	< LOD	41.93	< LOD	80.07	1486.05 ± 113.61	< LOD	23.44	2415.21 ± 186.81
xrf 21	73.15 ± 17.44	< LOD	33.26	< LOD	76.73	< LOD	202.38	24622.92 ± 478.21	606.67 ± 103.29	< LOD	71.57	< LOD	131.20	2015.90 ± 185.76	< LOD	42.75	3687.91 ± 329.47
xrf 22	50.28 ± 13.60	< LOD	27.60	< LOD	63.21	< LOD	189.63	28638.88 ± 443.87	256.40 ± 68.39	< LOD	67.96	< LOD	149.15	3112.83 ± 212.46	< LOD	47.95	7277.80 ± 390.62
xrf 23	38.17 ± 15.74	< LOD	34.98	< LOD	79.77	< LOD	245.72	37252.71 ± 591.23	1755.75 ± 163.59	< LOD	62.85	151.59 ± 95.78	-	3743.27 ± 208.82	< LOD	45.82	6649.53 ± 348.82
xrf 24	42.91 ± 13.66	< LOD	27.50	< LOD	67.52	< LOD	198.17	29343.70 ± 469.45	736.77 ± 101.37	< LOD	80.33	204.17 ± 124.69	-	4864.34 ± 269.27	< LOD	51.38	7237.12 ± 410.09
xrf 25	60.48 ± 14.16	< LOD	25.93	< LOD	59.84	< LOD	177.90	25673.18 ± 425.68	619.76 ± 90.76	< LOD	77.15	< LOD	166.38	4621.40 ± 251.46	< LOD	48.18	5404.58 ± 359.55
xrf 26	47.36 ± 14.33	< LOD	29.14	< LOD	66.28	< LOD	206.24	30300.23 ± 482.63	806.56 ± 106.30	< LOD	66.50	175.74 ± 97.83	-	3683.23 ± 210.40	< LOD	36.95	3840.94 ± 283.88
xrf 26	52.56 ± 10.13	22.36 ± 13.49	-	< LOD	43.84	< LOD	128.25	24568.43 ± 307.01	825.11 ± 74.57	< LOD	58.35	< LOD	125.83	3589.78 ± 186.03	< LOD	31.34	3152.60 ± 239.55
xrf 27	36.80 ± 11.87	< LOD	26.77	< LOD	61.04	172.84 ± 92.51	-	14234.27 ± 315.40	430.39 ± 75.55	< LOD	53.91	< LOD	95.52	1696.62 ± 134.86	< LOD	29.05	2922.21 ± 249.31
xrf 28	99.44 ± 14.77	101.51 ± 21.65	-	< LOD	57.34	< LOD	154.14	25230.93 ± 361.08	362.13 ± 64.57	< LOD	50.80	119.28 ± 71.15	-	2425.14 ± 152.90	< LOD	36.66	5159.24 ± 296.01
xrf 29	106.72 ± 18.54	< LOD	30.39	< LOD	67.84	< LOD	212.06	32556.66 ± 506.65	444.17 ± 87.38	< LOD	65.99	< LOD	140.13	2913.48 ± 200.94	< LOD	58.35	12680.50 ± 494.42
xrf 30	75.71 ± 10.93	26.98 ± 13.21	-	< LOD	42.13	< LOD	126.02	24569.55 ± 299.91	409.72 ± 56.14	< LOD	55.83	127.09 ± 77.51	-	3435.38 ± 169.97	< LOD	41.18	7799.10 ± 326.24
xrf 31	114.22 ± 20.42	< LOD	36.35	< LOD	85.41	< LOD	243.99	37642.92 ± 569.21	534.87 ± 99.75	< LOD	42.38	100.35 ± 56.84	-	1715.64 ± 119.77	48.82 ± 21.98	-	4691.97 ± 242.80
xrf 32	50.07 ± 12.80	35.16 ± 17.72	-	< LOD	55.29	< LOD	148.86	17873.05 ± 345.35	223.93 ± 61.20	< LOD	67.46	169.76 ± 94.22	-	3329.58 ± 201.73	< LOD	53.24	10287.25 ± 447.54
xrf 33	63.69 ± 15.33	< LOD	28.09	< LOD	64.57	< LOD	220.16	37316.01 ± 518.99	516.17 ± 89.72	< LOD	86.17	< LOD	177.83	3717.32 ± 262.12	< LOD	72.54	13790.38 ± 592.19
xrf 34	99.32 ± 20.24	< LOD	36.12	< LOD	74.05	< LOD	202.74	23576.96 ± 484.52	415.14 ± 93.38	< LOD	51.52	< LOD	100.44	1699.23 ± 149.15	< LOD	119.87	72843.19 ± 1000.46
xrf 34a	68.57 ± 14.33	41.81 ± 18.62	-	< LOD	57.94	< LOD	159.24	21631.30 ± 382.40	958.68 ± 104.58	< LOD	69.87	< LOD	155.68	4083.91 ± 227.89	< LOD	43.52	6003.48 ± 368.61
xrf 35	122.21 ± 17.16	63.01 ± 20.84	-	< LOD	61.38	< LOD	185.73	33002.60 ± 441.59	451.99 ± 76.69	< LOD	52.09	< LOD	93.28	1719.33 ± 135.38	< LOD	73.75	29583.11 ± 624.05
xrf 36	132.40 ± 19.55	41.58 ± 20.78	-	< LOD	65.56	< LOD	173.77	21561.03 ± 412.48	365.18 ± 78.20	< LOD	54.15	171.18 ± 77.25	-	2521.05 ± 162.01	< LOD	45.67	8530.96 ± 372.00
xrf 37	85.63 ± 16.64	31.36 ± 20.68	-	< LOD	64.90	< LOD	188.35	28823.40 ± 456.34	491.87 ± 86.11	< LOD	50.62	< LOD	103.26	2367.92 ± 151.28	< LOD	43.15	8992.60 ± 355.76
xrf 38	93.91 ± 17.01	33.71 ± 20.48	-	< LOD	65.31	< LOD	165.18	20185.91 ± 393.34	422.26 ± 80.62	< LOD	50.77	115.70 ± 71.56	-	2494.27 ± 153.11	< LOD	39.29	7921.41 ± 338.26
xrf 39	594.68 ± 24.28	28.21 ± 12.58	-	< LOD	38.95	< LOD	77.27	9381.20 ± 178.81	323.34 ± 46.35	< LOD	42.60	< LOD	81.18	1501.16 ± 115.27	< LOD	28.15	3740.49 ± 227.79
xrf 40	72.77 ± 15.65	42.48 ± 20.67	-	< LOD	63.79	< LOD	173.04	21480.92 ± 408.01	178.24 ± 64.08	187.66 ± 47.13	-	132.47 ± 84.40	-	3151.94 ± 183.38	< LOD	44.78	7477.28 ± 363.70
xrf 41	99.62 ± 15.85	< LOD	25.51	< LOD	58.64	< LOD	150.30	19025.04 ± 354.50	469.77 ± 77.12	< LOD	61.45	< LOD	132.04	3405.51 ± 193.27	< LOD	39.91	6042.08 ± 332.58
xrf 42	70.64 ± 16.18	46.80 ± 21.89	-	< LOD	63.87	< LOD	185.75	24025.44 ± 442.56	386.81 ± 82.45	< LOD	49.60	< LOD	99.77	2526.82 ± 149.69	< LOD	33.36	5315.81 ± 287.19
xrf 43	74.06 ± 13.00	64.38 ± 17.82	-	< LOD	54.69	< LOD	189.32	46057.33 ± 454.80	358.13 ± 64.54	< LOD	60.31	130.75 ± 83.84	-	2315.75 ± 174.18	< LOD	33.91	2299.49 ± 253.50
xrf 44	33.75 ± 9.77	34.05 ± 15.24	-	< LOD	47.02	< LOD	138.90	26081.42 ± 328.86	164.57 ± 46.91	< LOD	37.18	89.57 ± 50.04	-	2176.88 ± 107.35	< LOD	24.83	4172.53 ± 195.32
xrf 45	75.17 ± 10.98	22.15 ± 13.02	-	< LOD	42.27	< LOD	103.19	15168.65 ± 242.64	300.18 ± 49.68	< LOD	59.26	< LOD	112.42	1674.90 ± 153.86	< LOD	39.97	5782.94 ± 347.82
xrf 46	80.80 ± 17.34	< LOD	34.06	< LOD	69.75	< LOD	161.15	16548.59 ± 380.41	235.71 ± 70.30	< LOD	42.32	102.47 ± 55.52	-	1472.53 ± 113.97	< LOD	30.68	5330.85 ± 259.67
xrf 47	150.06 ± 15.68	35.53 ± 15.99	-	< LOD	51.57	< LOD	155.20	31766.85 ± 372.84	550.67 ± 69.80	< LOD	54.92	< LOD	111.61	2525.06 ± 162.63	< LOD	41.75	7294.63 ± 347.94
xrf 48	186.05 ± 15.53	34.25 ± 13.91	-	< LOD	45.85	< LOD	138.00	28969.58 ± 329.40	529.98 ± 62.99	< LOD	60.96	157.61 ± 85.84	-	3134.13 ± 182.37	< LOD	38.20	5003.94 ± 302.85
xrf 49	47.14 ± 15.11	< LOD	36.40	< LOD	78.19	< LOD	183.65	22556.47 ± 435.14	237.28 ± 72.94	< LOD	32.52	103.26 ± 46.59	-	1486.71 ± 96.97	< LOD	21.37	2295.09 ± 165.64
xrf 50	142.77 ± 21.37	77.89 ± 24.99	-	< LOD	71.06	< LOD	215.75	32550.34 ± 518.49	512.44 ± 93.91	< LOD	57.05	< LOD	114.00	2009.63 ± 158.70	< LOD	37.81	5340.34 ± 315.62
xrf 51	142.47 ± 15.04	70.12 ± 17.57	-	< LOD	49.20	< LOD	125.09	20333.45 ± 296.88	273.05 ± 53.26	< LOD	45.81	113.14 ± 56.07	-	1595.80 ± 115.69	< LOD	34.70	6600.02 ± 287.14
xrf 52	97.41 ± 18.97	51.02 ± 23.53	-	< LOD	70.12	< LOD	197.83	24689.17 ± 471.13	288.78 ± 79.74	< LOD	56.72	< LOD	109.22	2554.32 ± 158.01	< LOD	43.39	7863.89 ± 350.98
xrf 100	94.87 ± 13.20	30.45 ± 15.75	-	< LOD	51.35	< LOD	140.78	24941.94 ± 331.05	816.94 ± 79.79	72.68 ± 29.79	-	< LOD	84.92	2532.27 ± 124.51	< LOD	26.25	3641.62 ± 212.57
xrf 101	52.15 ± 11.17	< LOD	22.25	< LOD	47.81	< LOD	108.54	12065.77 ± 254.91	175.84 ± 48.73	< LOD	52.63	151.78 ± 72.09	-	2306.26 ± 150.26	< LOD	30.00	2743.65 ± 256.60
xrf 102	99.51 ± 13.72	30.79 ± 15.52	-	< LOD	50.18	< LOD	142.00	24630.78 ± 343.27	654.36 ± 75.86	< LOD	55.55	< LOD	139.15	4207.66 ± 207.98	< LOD	71.62	22519.68 ± 592.78
xrf 110	78.12 ± 13.96	61.11 ± 19.88	-	< LOD	58.61	< LOD	172.80	32656.98 ± 412.07	341.62 ± 65.60	< LOD	43.75	< LOD	86.92	1676.54 ± 122.33	< LOD	31.24	4562.54 ± 250.99
xrf 130	30.13 ± 8.38	< LOD	19.56	< LOD	42.35	< LOD	83.63	9222.04 ± 193.16	136.54 ± 38.38	< LOD	44.94	< LOD	91.60	2479.98 ± 136.17	< LOD	21.91	1761.32 ± 177.70
xrf 140	81.03 ± 14.80	29.13 ± 17.72	-	< LOD	60.13	< LOD	159.41	22999.93 ± 385.43	1653.05 ± 129.25	< LOD	64.97	< LOD	137.45	3064.58 ± 199.52	< LOD	48.54	8158.73 ± 401.64
xrf 150	69.03 ± 14.58	< LOD	26.75	< LOD	58.77	< LOD	169.53	23483.20 ± 402.78	305.96 ± 69.67	< LOD	63.71	149.81 ± 87.39	-	2489.56 ± 182.42	< LOD	48.86	8047.81 ± 395.86
xrf 151	270.73 ± 29.84	43.51 ± 25.88	-	< LOD	79.61	< LOD	233.82	33315.70 ± 569.71	513.40 ± 102.78	< LOD	48.84	102.32 ± 63.27	-	1952.41 ± 138.46	< LOD	85.95	40292.42 ± 714.74
xrf 152	94.56 ± 15.91	60.79 ± 20.30	-	< LOD	58.99	< LOD	176.52	27554.14 ± 419.40	447.09 ± 77.20	< LOD	57.23	144.71 ± 80.75	-	2641.80 ± 170.98	< LOD	44.30	7959.44 ± 361.53
xrf 301	726.64 ± 31.78	145.31 ± 21.57	-	< LOD	55.46	< LOD	191.50	46170.46 ± 458.22	872.78 ± 87.44	< LOD	71.14	148.88 ± 97.12	-	2855.64 ± 204.85	< LOD	55.27	10227.29 ± 467.25
xrf 302	47.42 ± 13.32	32.41 ± 18.63	-	< LOD	60.45	< LOD	166.73	21880.41 ± 395.07	334.96 ± 72.99	< LOD	64.59	< LOD	136.14	3327.39 ± 197.24	< LOD	39.62	4688.66 ± 324.99
xrf 303	31.49 ± 11.31	< LOD	24.40	< LOD	53.50	< LOD	126.41	12542.93 ± 295.67	178.5 ± 56.27	< LOD	57.36	< LOD	122.08	3046.09 ± 177.16	< LOD	29.36	2067.88 ± 237.69
xrf 304	34.76 ± 16.24	< LOD	41.90	< LOD	83.96	< LOD	165.45	14043.32 ± 392.8	155.68 ± 70.24	< LOD	27.37	< LOD	50.62	854.06 ± 70.2	< LOD	14.33	1297.89 ± 113.17
xrf 305	71.75 ± 19.22	< LOD	37.78	< LOD	82.92	< LOD	250.48	34907.35 ± 600.36	253.94 ± 86.23	< LOD	51.79	125.8 ± 78.24	-	2488.92 ± 165.28	< LOD	41.08	7623.87 ± 344.55
xrf 306	38.79 ± 16.56	48.04 ± 25.87	-	< LOD	81.01	< LOD	272.44	43105.28 ± 651.15	120.12 ± 76.37	< LOD	57.21	< LOD	114.34	1728.44 ± 157.26	< LOD	25.98	1275.51 ± 202.01
xrf 307	79.21 ± 15.98	< LOD	28.13	< LOD	61.70	< LOD	183.48	26017.94 ± 438	256.13 ± 69.52	< LOD	68.47	< LOD	150.82	3914.05 ± 223.35	< LOD	42.10	5178.91 ± 346.21
xrf 500	74.16 ± 17.41	< LOD	33.01	< LOD	70.54	< LOD	205.39	26983.94 ± 490.51	853.96 ± 116.34	< LOD	61.89	< LOD	134.51	3666.08 ± 198.30	< LOD	49.91	9849.09 ± 410.55

Notes:
1. All values in ppm
2. LOD: Limit of Detection
3. (± 2Σs.d.): Plus or minus two standard deviation

Table C5: X-ray Fluoresence (XRF) Raw Data - Page 3 of 3

SAMPLE	K (± 2Σs.d.)	S (± 2Σs.d.)	S LOD	Ba (± 2Σs.d.)	Ba LOD	Cs (± 2Σs.d.)	Cs LOD	Te (± 2Σs.d.)	Te LOD	Sb (± 2Σs.d.)	Sb LOD	Sn (± 2Σs.d.)	Sn LOD	Cd (± 2Σs.d	Cd LOD	Ag (± 2Σs.d.)	Ag LOD	Pd (± 2Σs.d.	Pd LOD
xrf 1	4453.35 ± 292.41	< LOD	699.53	373.41 ± 52.38	-	116.61 ± 18.61	-	245.44 ± 60.61	-	86.70 ± 22.43	-	< LOD	20.97	< LOD	19.87	20.25 ± 10.30	-	< LOD	20.58
xrf 2	7463.86 ± 298.05	1151.67 ± 508.24	-	97.45 ± 34.41	-	< LOD	18.51	< LOD	60.16	< LOD	22.13	< LOD	13.95	< LOD	12.98	< LOD	9.96	< LOD	12.98
xrf 3	11404.98 ± 611.77	1622.67 ± 982.87	-	375.52 ± 42.13	-	86.09 ± 14.71	-	186.34 ± 47.96	-	81.21 ± 18.01	-	21.09 ± 11.23	-	26.11 ± 11.02	-	14.91 ± 8.11	-	< LOD	15.73
xrf 4	7761.07 ± 433.44	< LOD	992.76	< LOD	45.71	< LOD	16.56	< LOD	53.34	< LOD	19.73	< LOD	12.44	< LOD	12.07	< LOD	8.87	< LOD	12.44
xrf 5	12628.71 ± 668.40	< LOD	1347.89	121.89 ± 33.52	-	< LOD	17.85	< LOD	57.35	< LOD	21.24	< LOD	13.63	< LOD	12.82	< LOD	9.33	< LOD	12.94
xrf 6	14601.21 ± 741.96	< LOD	1408.74	126.13 ± 31.38	-	< LOD	16.76	< LOD	53.66	< LOD	19.85	< LOD	12.83	< LOD	11.87	< LOD	8.77	< LOD	12.03
xrf 7	6876.63 ± 448.42	< LOD	1114.32	< LOD	49.54	< LOD	18.00	< LOD	56.96	< LOD	21.21	< LOD	13.38	< LOD	12.82	< LOD	9.68	< LOD	12.76
xrf 8	8657.00 ± 573.51	2191.55 ± 1144.24	-	< LOD	40.02	< LOD	14.66	< LOD	46.11	< LOD	16.92	< LOD	10.89	< LOD	10.39	< LOD	7.52	< LOD	10.62
xrf 9	13735.86 ± 644.54	< LOD	1346.54	280.41 ± 36.67	-	61.76 ± 12.92	-	134.62 ± 42.09	-	61.61 ± 15.74	-	21.55 ± 9.98	-	< LOD	13.98	< LOD	10.45	< LOD	14.07
xrf 10	10872.80 ± 676.70	2552.34 ± 1340.47	-	611.26 ± 45.53	-	156.25 ± 15.60	-	322.46 ± 51.08	-	111.13 ± 18.98	-	51.68 ± 12.14	-	29.37 ± 11.44	-	22.99 ± 8.66	-	< LOD	17.00
xrf 13	13797.04 ± 774.14	< LOD	1853.09	221.18 ± 34.22	-	55.07 ± 12.17	-	89.40 ± 39.34	-	35.25 ± 14.53	-	15.76 ± 9.35	-	< LOD	13.00	< LOD	9.58	< LOD	12.76
xrf 14	12415.67 ± 713.57	3033.91 ± 1340.32	-	210.59 ± 33.54	-	42.07 ± 11.87	-	< LOD	57.13	< LOD	21.04	< LOD	13.51	< LOD	12.84	< LOD	9.60	< LOD	12.63
xrf 15	9933.20 ± 611.96	2250.62 ± 1147.96	-	301.46 ± 36.81	-	55.53 ± 12.86	-	150.21 ± 42.20	-	58.28 ± 15.66	-	< LOD	14.77	< LOD	13.90	< LOD	10.16	< LOD	13.85
xrf 16	5973.04 ± 464.96	< LOD	1209.93	191.57 ± 34.23	-	38.24 ± 12.16	-	73.32 ± 39.44	-	< LOD	21.40	< LOD	13.79	< LOD	13.08	< LOD	9.60	< LOD	12.85
xrf 17	21324.85 ± 916.53	< LOD	1635.40	64.58 ± 28.00	-	< LOD	15.13	< LOD	48.44	< LOD	17.85	< LOD	11.34	< LOD	10.43	< LOD	7.84	< LOD	10.77
xrf 18	7676.49 ± 455.05	1535.08 ± 849.47	-	479.08 ± 48.10	-	131.34 ± 16.78	-	261.03 ± 54.61	-	87.72 ± 20.20	-	42.05 ± 12.98	-	30.81 ± 12.43	-	21.85 ± 9.34	-	< LOD	17.98
xrf 19	12072.38 ± 700.99	3742.95 ± 1399.37	-	127.69 ± 33.14	-	< LOD	17.72	< LOD	56.42	< LOD	21.15	< LOD	13.36	< LOD	12.87	< LOD	9.12	< LOD	12.48
xrf 20	8516.97 ± 456.03	< LOD	1031.21	337.73 ± 41.16	-	82.70 ± 14.47	-	208.53 ± 47.57	-	76.95 ± 17.67	-	< LOD	16.42	17.63 ± 10.62	-	< LOD	11.66	25.15 ± 11.35	-
xrf 21	7449.76 ± 655.08	< LOD	1764.48	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
xrf 22	11402.34 ± 694.34	< LOD	1574.00	298.91 ± 34.44	-	49.84 ± 11.98	-	75.75 ± 38.66	-	38.68 ± 14.40	-	< LOD	13.70	< LOD	12.98	< LOD	9.27	< LOD	13.20
xrf 23	6705.94 ± 530.48	< LOD	1289.35	363.58 ± 39.20	-	75.44 ± 13.61	-	107.44 ± 43.74	-	33.10 ± 16.03	-	22.48 ± 10.46	-	< LOD	14.39	< LOD	10.48	< LOD	14.81
xrf 24	9418.94 ± 677.68	< LOD	1703.20	325.84 ± 34.97	-	71.57 ± 12.23	-	119.93 ± 39.53	-	49.69 ± 14.68	-	25.92 ± 9.49	-	< LOD	13.19	< LOD	9.81	< LOD	13.42
xrf 25	6429.97 ± 575.17	< LOD	1551.67	307.85 ± 33.93	-	62.99 ± 11.86	-	158.12 ± 38.94	-	23.41 ± 13.96	-	19.18 ± 9.13	-	< LOD	12.84	< LOD	9.13	< LOD	12.88
xrf 26	4861.96 ± 469.58	< LOD	1614.10	279.31 ± 35.60	-	55.33 ± 12.48	-	79.27 ± 40.20	-	29.73 ± 14.82	-	23.51 ± 9.72	-	< LOD	13.34	< LOD	10.21	< LOD	13.49
xrf 26	4639.29 ± 420.80	< LOD	1303.89	178.46 ± 32.90	-	20.02 ± 11.61	-	< LOD	56.30	< LOD	20.40	< LOD	13.38	< LOD	12.31	< LOD	9.20	< LOD	12.68
xrf 27	15209.27 ± 681.54	2240.30 ± 1031.38	-	< LOD	43.49	< LOD	15.77	< LOD	50.22	< LOD	18.38	< LOD	11.88	< LOD	11.10	< LOD	8.09	< LOD	11.96
xrf 28	11630.69 ± 611.64	< LOD	1340.15	110.79 ± 38.37	-	< LOD	20.68	< LOD	66.80	< LOD	24.67	< LOD	15.61	16.77 ± 10.43	-	< LOD	11.44	< LOD	15.69
xrf 29	12632.55 ± 730.53	< LOD	1791.72	163.87 ± 34.46	-	23.00 ± 12.24	-	< LOD	59.26	27.70 ± 14.72	-	< LOD	13.99	< LOD	13.08	< LOD	9.87	< LOD	13.63
xrf 30	9016.94 ± 513.92	< LOD	1333.20	125.92 ± 32.17	-	< LOD	17.11	< LOD	54.58	< LOD	20.23	< LOD	13.01	< LOD	12.34	< LOD	9.13	< LOD	12.25
xrf 31	6554.75 ± 423.68	< LOD	986.69	270.93 ± 44.03	-	54.26 ± 15.52	-	106.05 ± 50.20	-	50.74 ± 18.74	-	23.42 ± 12.02	-	< LOD	17.22	< LOD	12.64	< LOD	17.49
xrf 32	16126.34 ± 792.56	< LOD	1537.80	144.16 ± 30.64	-	24.67 ± 10.94	-	< LOD	52.91	< LOD	19.53	< LOD	12.49	< LOD	11.65	< LOD	8.63	< LOD	11.82
xrf 33	13898.28 ± 875.56	< LOD	2052.17	66.72 ± 30.71	-	< LOD	16.57	< LOD	53.02	< LOD	19.64	< LOD	12.54	< LOD	11.58	< LOD	8.44	< LOD	11.52
xrf 34	9864.13 ± 618.52	< LOD	1850.73	221.00 ± 36.43	-	46.94 ± 12.91	-	68.81 ± 41.60	-	< LOD	22.93	< LOD	14.73	< LOD	14.10	< LOD	10.08	< LOD	13.78
xrf 34a	16170.21 ± 807.61	< LOD	1535.22	191.70 ± 32.01	-	26.62 ± 11.30	-	< LOD	54.42	20.94 ± 13.49	-	< LOD	13.08	< LOD	12.06	< LOD	9.07	< LOD	11.96
xrf 35	7873.66 ± 522.32	< LOD	1400.93	153.85 ± 39.22	-	22.26 ± 13.98	-	< LOD	67.33	< LOD	24.87	< LOD	15.99	< LOD	15.06	< LOD	11.13	< LOD	15.48
xrf 36	10704.47 ± 606.78	< LOD	1516.80	219.81 ± 34.23	-	48.95 ± 12.14	-	61.86 ± 39.03	-	32.15 ± 14.50	-	< LOD	13.97	< LOD	13.10	< LOD	9.60	< LOD	12.99
xrf 37	6831.58 ± 476.70	1399.46 ± 924.53	-	159.08 ± 37.79	-	36.64 ± 13.55	-	87.22 ± 44.08	-	< LOD	23.91	< LOD	15.42	< LOD	14.74	< LOD	10.89	< LOD	14.22
xrf 38	13812.27 ± 632.19	< LOD	1188.66	214.09 ± 36.29	-	41.65 ± 12.85	-	< LOD	61.63	27.72 ± 15.33	-	< LOD	14.71	< LOD	14.08	< LOD	10.15	< LOD	13.64
xrf 39	6066.33 ± 409.70	< LOD	1014.61	< LOD	41.68	< LOD	15.26	< LOD	48.78	< LOD	18.02	< LOD	11.43	< LOD	11.05	< LOD	7.77	< LOD	11.32
xrf 40	12834.02 ± 671.38	< LOD	1489.67	141.16 ± 33.71	-	18.11 ± 12.02	-	< LOD	58.47	21.99 ± 14.42	-	< LOD	14.03	< LOD	13.01	< LOD	9.76	< LOD	13.32
xrf 41	8891.10 ± 576.72	< LOD	1430.39	144.88 ± 31.53	-	< LOD	16.77	< LOD	54.13	< LOD	19.97	< LOD	12.70	< LOD	11.71	< LOD	8.93	< LOD	12.59
xrf 42	10206.75 ± 557.78	< LOD	1185.77	215.34 ± 39.15	-	44.12 ± 13.90	-	96.54 ± 45.13	-	32.18 ± 16.60	-	< LOD	15.84	< LOD	15.16	< LOD	11.19	< LOD	15.03
xrf 43	14096.59 ± 723.58	3056.70 ± 1275.04	-	< LOD	48.79	< LOD	17.28	< LOD	54.32	< LOD	20.16	< LOD	12.65	< LOD	11.46	< LOD	8.70	< LOD	11.95
xrf 44	11583.29 ± 435.85	1590.95 ± 688.00	-	224.01 ± 35.54	-	56.55 ± 12.66	-	107.01 ± 41.00	-	38.39 ± 15.10	-	18.21 ± 9.75	-	< LOD	13.42	17.50 ± 7.17	-	< LOD	13.71
xrf 45	19953.39 ± 832.87	2388.61 ± 1180.67	-	< LOD	43.09	< LOD	15.40	< LOD	48.75	< LOD	18.09	< LOD	11.61	< LOD	11.05	< LOD	8.23	< LOD	10.72
xrf 46	7937.18 ± 459.08	1345.24 ± 790.56	-	250.04 ± 37.43	-	46.77 ± 13.19	-	103.28 ± 42.88	-	48.59 ± 15.96	-	< LOD	15.11	< LOD	13.98	< LOD	10.45	< LOD	14.45
xrf 47	10737.17 ± 608.99	1587.76 ± 1023.41	-	276.03 ± 38.00	-	62.69 ± 13.40	-	113.34 ± 43.38	-	37.11 ± 15.93	-	21.97 ± 10.35	-	< LOD	14.16	< LOD	10.67	< LOD	14.61
xrf 48	13914.90 ± 671.53	2313.08 ± 1117.18	-	230.00 ± 34.17	-	39.47 ± 12.04	-	76.18 ± 39.02	-	30.51 ± 14.42	-	< LOD	13.75	< LOD	13.08	< LOD	9.67	< LOD	12.79
xrf 49	8552.55 ± 417.83	< LOD	837.27	435.32 ± 55.15	-	117.44 ± 19.37	-	288.39 ± 63.64	-	107.78 ± 23.74	-	44.12 ± 15.03	-	30.70 ± 14.36	-	22.53 ± 10.82	-	31.36 ± 15.25	-
xrf 50	14994.36 ± 709.43	1958.87 ± 1072.70	-	57.23 ± 33.75	-	< LOD	18.24	< LOD	58.48	< LOD	21.87	< LOD	13.70	< LOD	13.08	< LOD	9.68	< LOD	13.32
xrf 51	9379.64 ± 494.73	1554.92 ± 838.75	-	95.65 ± 33.81	-	< LOD	18.14	< LOD	58.29	< LOD	21.50	< LOD	13.62	< LOD	12.89	< LOD	9.69	< LOD	13.59
xrf 52	13093.73 ± 643.79	< LOD	1207.62	354.42 ± 37.10	-	90.33 ± 13.01	-	173.20 ± 42.30	-	50.84 ± 15.50	-	26.33 ± 10.01	-	< LOD	14.07	< LOD	10.41	14.94 ± 9.73	-
xrf 100	16470.63 ± 566.48	1651.42 ± 779.94	-	296.60 ± 37.76	-	48.99 ± 13.15	-	76.85 ± 42.41	-	31.12 ± 15.65	-	15.53 ± 10.11	-	< LOD	13.88	< LOD	10.40	< LOD	14.47
xrf 101	21761.28 ± 799.41	< LOD	1408.57	91.65 ± 30.62	-	18.84 ± 11.06	-	< LOD	53.70	22.03 ± 13.28	-	< LOD	12.57	< LOD	11.90	< LOD	8.98	< LOD	12.14
xrf 102	15268.63 ± 736.26	< LOD	1528.89	< LOD	45.76	< LOD	16.60	< LOD	53.07	< LOD	19.57	< LOD	12.60	< LOD	11.94	< LOD	8.72	< LOD	11.44
xrf 110	9494.12 ± 509.40	1765.76 ± 872.86	-	340.08 ± 43.27	-	88.33 ± 15.25	-	165.83 ± 49.38	-	68.61 ± 18.42	-	< LOD	17.22	19.19 ± 11.19	-	< LOD	12.33	< LOD	16.36
xrf 130	6022.77 ± 408.56	< LOD	1106.94	144.06 ± 31.26	-	28.22 ± 11.18	-	< LOD	54.09	< LOD	20.00	< LOD	12.78	< LOD	11.99	< LOD	9.17	< LOD	12.26
xrf 140	12009.13 ± 700.63	2061.04 ± 1214.26	-	204.86 ± 33.02	-	29.50 ± 11.64	-	< LOD	56.34	29.50 ± 14.01	-	< LOD	13.48	< LOD	12.70	< LOD	9.29	< LOD	12.58
xrf 150	12880.78 ± 710.56	< LOD	1625.25	256.57 ± 33.88	-	54.97 ± 11.94	-	64.36 ± 38.30	-	35.14 ± 14.25	-	16.49 ± 9.18	-	< LOD	12.65	< LOD	9.33	< LOD	12.45
xrf 151	7371.71 ± 509.38	< LOD	1510.38	192.76 ± 40.96	-	46.51 ± 14.64	-	87.43 ± 47.36	-	< LOD	25.91	< LOD	16.59	< LOD	15.65	12.35 ± 8.12	-	< LOD	15.50
xrf 152	9839.40 ± 587.56	< LOD	1287.24	239.43 ± 35.77	-	36.14 ± 12.55	-	< LOD	60.57	27.81 ± 15.00	-	< LOD	14.51	< LOD	13.59	< LOD	9.86	< LOD	13.72
xrf 301	17537.81 ± 867.5	5541.57 ± 1692.45	-	506.73 ± 41.38	-	116.27 ± 14.22	-	210.61 ± 46.04	-	107.08 ± 17.53	-	38.96 ± 11.04	-	< LOD	15.32	18.79 ± 7.88	-	16.82 ± 10.59	-
xrf 302	16066.42 ± 774.8	< LOD	1550.27	61.76 ± 29.8	-	< LOD	15.99	< LOD	51.70	< LOD	19.09	< LOD	12.26	< LOD	11.39	< LOD	8.55	< LOD	11.66
xrf 303	14428.5 ± 695.13	< LOD	1312.32	269.01 ± 32.64	-	64.36 ± 11.53	-	109.51 ± 37.3	-	62.95 ± 14.07	-	13.93 ± 8.81	-	< LOD	12.40	< LOD	9.29	< LOD	12.77
xrf 304	4811.28 ± 288.29	< LOD	614.04	246.57 ± 42.48	-	32.85 ± 14.89	-	< LOD	71.38	60.2 ± 18.29	-	< LOD	16.71	< LOD	15.83	< LOD	11.66	< LOD	15.94
xrf 305	11000.75 ± 598.27	1950.9 ± 1029.93	-	560.55 ± 43.5	-	90.96 ± 14.6	-	165.46 ± 47.21	-	83.83 ± 17.84	-	21.27 ± 11.11	-	< LOD	15.79	< LOD	11.25	21.38 ± 11.2	-
xrf 306	10579.67 ± 623.8	1803.28 ± 1052.11	-	283.06 ± 40.05	-	61.28 ± 14.11	-	140.71 ± 45.99	-	62.18 ± 17.16	-	21.3 ± 10.89	-	< LOD	15.08	16.05 ± 7.91	-	< LOD	15.39
xrf 307	16329.59 ± 804.85	< LOD	1567.70	189.48 ± 32.85	-	39.92 ± 11.69	-	61.29 ± 37.74	-	29.8 ± 13.99	-	< LOD	-	< LOD	12.61	< LOD	9.19	< LOD	12.38
xrf 500	11609.24 ± 653.32	< LOD	1489.19	396.68 ± 38.47	-	83.58 ± 13.32	-	128.47 ± 42.87	-	51.70 ± 15.90	-	16.90 ± 10.12	-	< LOD	14.20	< LOD	10.50	< LOD	13.94

Notes:
1. All values in ppm
2. LOD: Limit of Detection
3. (± 2Σs.d.): Plus or minus two standard deviation

Table C6: QA/QC Marco digestion compared to standard digestion technique				
		MOA015 0.1	MOA015 0.1 (duplicate)	%RPD[2]
		947142.11	947142.17	
Total Recoverable Antimony	g/m^3	6.8	4.5	40.7%
Total Recoverable Arsenic	g/m^3	128	106	18.8%
Total Recoverable Cadmium	g/m^3	< 0.10	< 0.10	nc
Total Recoverable Chromium	g/m^3	11	10	9.5%
Total Recoverable Lead	g/m^3	38	35	8.2%
Total Recoverable Mercury	g/m^3	28	28	0.0%
Total Recoverable Nickel	g/m^3	1.02	1.07	-4.8%
Total Recoverable Zinc	g/m^3	105	96	9.0%

Notes:
1. nc: Not Calculated
2. %RPD Relative Percent Difference

Table C7: Soil Gas Readings																
Sample Location	MOA 001	MOA 001	MOA 002	MOA 003	MOA 005	MOA 005	MOA 006	MOA 006	MOA007	MOA007	MOA 008	MOA 008	MOA009	MOA009	MOA010	MOA 011
Probe Depth (m)	0.5	0.8	wet	wet	0.5	1.0	0.5	0.8	0.5	1.0	0.5	1.0	0.5	1.0	0.5	1.0
LEL CH_4					2.0%	Low Flow	2.0%	2.0%			1.0%	1.0%	2.0%	2.0%	1.0%	Low Flow
Peak CH_4	0.0%	0.0%			0.1%	Low Flow	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	Low Flow
Peak CO_2	1.5%	2.1%			3.2%	Low Flow	3.3%	3.3%	0.4%	8.2%	1.2%	1.3%	6.3%	9.3%	1.9%	Low Flow
Min O_2	19.6%	18.9%			17.5%	Low Flow	18.2%	19.4%	19.8%	11.5%	19.8%	19.6%	16.8%	15.7%	19.3%	Low Flow
BAL	79.3%	79.1%			79.5%	Low Flow	80.1%	80.2%	79.7%	80.0%	79.3%	79.3%	76.7%	76.5%	79.6%	Low Flow
CO (ppm)		1			2	Low Flow	0	2	0	0	3	0	3	0	0	Low Flow
H_2 (ppm)		0			0	Low Flow	0	0	0	0	0	0	0	0	0	Low Flow
H_2S (pmm)		0			0	Low Flow	0	0	0	0	0	0	0	0	0	Low Flow

Notes:
1. Soft soils clogging gause = Low Flow
High water table >0.4m

Appendix D
Lab Reports and C.O.C.

Hill Laboratories
BETTER TESTING BETTER RESULTS

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ANALYSIS REPORT

Client:	Pattle Delamore Partners Ltd	**Lab No:**	947724	SUPv1
Contact:	Natalie Webster	**Date Registered:**	28-Oct-2011	
	C/- Pattle Delamore Partners Ltd	**Date Reported:**	17-Nov-2011	
	PO Box 9528	**Quote No:**	46451	
	Newmarket	**Order No:**		
	AUCKLAND 1149	**Client Reference:**	AO2469100	
		Submitted By:	Chris Foote	

Sample Type: Soil

	Sample Name:	MOA001 0.1 27-Oct-2011	MOA001 0.5 27-Oct-2011	MOA001 1.0 27-Oct-2011	MOA002 0.1 27-Oct-2011
	Lab Number:	947724.1	947724.2	947724.3	947724.5
Individual Tests					
Dry Matter	g/100g as rcvd	-	-	-	68
Total Recoverable Antimony	mg/kg dry wt	0.70 ± 0.29	1.72 ± 0.41	6.7 ± 1.3	7.5 ± 1.4
Total Recoverable Arsenic	mg/kg dry wt	24.1 ± 2.8	95.6 ± 9.7	185 ± 19	65.5 ± 6.7
Total Recoverable Cadmium	mg/kg dry wt	0.185 ± 0.073	< 0.10 ± 0.067	< 0.10 ± 0.067	0.122 ± 0.068
Total Recoverable Chromium	mg/kg dry wt	48.3 ± 5.1	6.8 ± 1.5	8.7 ± 1.6	8.3 ± 1.6
Total Recoverable Copper	mg/kg dry wt	31.8 ± 4.7	35.4 ± 5.2	48.4 ± 6.9	21.6 ± 3.3
Total Recoverable Lead	mg/kg dry wt	33.4 ± 4.7	9.9 ± 1.5	6.9 ± 1.0	31.7 ± 4.5
Total Recoverable Mercury	mg/kg dry wt	0.334 ± 0.077	0.488 ± 0.088	2.24 ± 0.28	0.394 ± 0.081
Total Recoverable Zinc	mg/kg dry wt	83.6 ± 8.8	24.8 ± 3.7	27.2 ± 3.8	52.8 ± 5.9
Total Petroleum Hydrocarbons in Soil					
C7 - C9	mg/kg dry wt	-	-	-	< 10 ± 5.5
C10 - C14	mg/kg dry wt	-	-	-	< 20 ± 7.8
C15 - C36	mg/kg dry wt	-	-	-	< 40 ± 9.5
Total hydrocarbons (C7 - C36)	mg/kg dry wt	-	-	-	< 70 ± 14

	Sample Name:	MOA002 0.5 27-Oct-2011	MOA006 0.1 27-Oct-2011	MOA006 0.5 27-Oct-2011	MOA006 1.0 27-Oct-2011
	Lab Number:	947724.6	947724.8	947724.9	947724.10
Individual Tests					
Dry Matter	g/100g as rcvd	78	-	-	-
Total Recoverable Antimony	mg/kg dry wt	1.68 ± 0.40	3.31 ± 0.65	2.14 ± 0.47	1.66 ± 0.40
Total Recoverable Arsenic	mg/kg dry wt	54.1 ± 5.6	39.4 ± 4.2	57.6 ± 6.0	36.9 ± 4.0
Total Recoverable Cadmium	mg/kg dry wt	< 0.10 ± 0.067	0.364 ± 0.092	< 0.10 ± 0.067	< 0.10 ± 0.067
Total Recoverable Chromium	mg/kg dry wt	7.7 ± 1.6	12.0 ± 1.8	9.0 ± 1.6	5.8 ± 1.5
Total Recoverable Copper	mg/kg dry wt	26.4 ± 4.0	30.1 ± 4.5	23.8 ± 3.6	15.6 ± 2.6
Total Recoverable Lead	mg/kg dry wt	13.8 ± 2.0	35.2 ± 5.0	7.0 ± 1.1	5.16 ± 0.77
Total Recoverable Mercury	mg/kg dry wt	0.360 ± 0.079	0.63 ± 0.11	0.514 ± 0.091	0.82 ± 0.12
Total Recoverable Zinc	mg/kg dry wt	46.0 ± 5.4	99 ± 11	14.7 ± 3.1	6.8 ± 2.8
Total Petroleum Hydrocarbons in Soil					
C7 - C9	mg/kg dry wt	< 9 ± 5.4	-	-	-
C10 - C14	mg/kg dry wt	< 20 ± 7.7	-	-	-
C15 - C36	mg/kg dry wt	< 40 ± 9.4	-	-	-
Total hydrocarbons (C7 - C36)	mg/kg dry wt	< 70 ± 14	-	-	-

	Sample Name:	MOA011 0.1 27-Oct-2011	MOA011 0.5 27-Oct-2011	MOA021 0.1 27-Oct-2011	MOA021 0.5 27-Oct-2011
	Lab Number:	947724.11	947724.12	947724.13	947724.14
Individual Tests					
Dry Matter	g/100g as rcvd	-	84	85	85

Sample Type: Soil					
	Sample Name:	MOA011 0.1 27-Oct-2011	MOA011 0.5 27-Oct-2011	MOA021 0.1 27-Oct-2011	MOA021 0.5 27-Oct-2011
	Lab Number:	947724.11	947724.12	947724.13	947724.14
Individual Tests					
Total Recoverable Antimony	mg/kg dry wt	1.20 ± 0.34	1.18 ± 0.34	5.4 ± 1.1	7.2 ± 1.4
Total Recoverable Arsenic	mg/kg dry wt	25.2 ± 2.9	31.0 ± 3.4	87.0 ± 8.8	206 ± 21
Total Recoverable Cadmium	mg/kg dry wt	0.336 ± 0.089	0.306 ± 0.085	0.172 ± 0.072	< 0.10 ± 0.067
Total Recoverable Chromium	mg/kg dry wt	15.4 ± 2.1	15.0 ± 2.0	19.7 ± 2.4	9.7 ± 1.7
Total Recoverable Copper	mg/kg dry wt	35.6 ± 5.2	132 ± 19	62.4 ± 8.9	152 ± 22
Total Recoverable Lead	mg/kg dry wt	41.9 ± 5.9	29.5 ± 4.2	81 ± 12	67.8 ± 9.5
Total Recoverable Mercury	mg/kg dry wt	0.64 ± 0.11	0.257 ± 0.073	0.92 ± 0.13	1.39 ± 0.18
Total Recoverable Zinc	mg/kg dry wt	99 ± 11	69.8 ± 7.5	138 ± 15	59.3 ± 6.5
Polycyclic Aromatic Hydrocarbons Screening in Soil					
Acenaphthene	mg/kg dry wt	-	-	< 0.03 ± 0.0099	< 0.03 ± 0.0097
Acenaphthylene	mg/kg dry wt	-	-	0.0311 ± 0.0072	0.0494 ± 0.0080
Anthracene	mg/kg dry wt	-	-	0.052 ± 0.017	0.084 ± 0.026
Benzo[a]anthracene	mg/kg dry wt	-	-	0.245 ± 0.064	0.50 ± 0.13
Benzo[a]pyrene (BAP)	mg/kg dry wt	-	-	0.312 ± 0.025	0.513 ± 0.040
Benzo[b]fluoranthene + Benzo[j] fluoranthene	mg/kg dry wt	-	-	0.54 ± 0.12	1.03 ± 0.21
Benzo[g,h,i]perylene	mg/kg dry wt	-	-	0.353 ± 0.062	0.434 ± 0.075
Benzo[k]fluoranthene	mg/kg dry wt	-	-	0.204 ± 0.027	0.402 ± 0.052
Chrysene	mg/kg dry wt	-	-	0.237 ± 0.036	0.527 ± 0.079
Dibenzo[a,h]anthracene	mg/kg dry wt	-	-	0.072 ± 0.012	0.100 ± 0.015
Fluoranthene	mg/kg dry wt	-	-	0.592 ± 0.060	1.08 ± 0.11
Fluorene	mg/kg dry wt	-	-	< 0.03 ± 0.0074	< 0.03 ± 0.0073
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	-	-	0.302 ± 0.029	0.423 ± 0.040
Naphthalene	mg/kg dry wt	-	-	< 0.14 ± 0.046	< 0.14 ± 0.045
Phenanthrene	mg/kg dry wt	-	-	0.258 ± 0.037	0.505 ± 0.071
Pyrene	mg/kg dry wt	-	-	0.694 ± 0.090	1.00 ± 0.13
Total Petroleum Hydrocarbons in Soil					
C7 - C9	mg/kg dry wt	-	< 8 ± 5.4	< 9 ± 5.4	-
C10 - C14	mg/kg dry wt	-	< 20 ± 7.6	< 20 ± 7.6	-
C15 - C36	mg/kg dry wt	-	< 40 ± 9.3	67.9 ± 9.4	-
Total hydrocarbons (C7 - C36)	mg/kg dry wt	-	< 70 ± 14	< 70 ± 14	-

	Sample Name:	MOA021 1.0 27-Oct-2011	MOA012 0.5 27-Oct-2011	MOA012 0.1 27-Oct-2011	
	Lab Number:	947724.15	947724.16	947724.17	
Individual Tests					
Dry Matter	g/100g as rcvd	78	80	-	-
Total Recoverable Antimony	mg/kg dry wt	9.4 ± 1.8	2.67 ± 0.55	1.60 ± 0.39	-
Total Recoverable Arsenic	mg/kg dry wt	270 ± 28	86.3 ± 8.8	34.9 ± 3.8	-
Total Recoverable Cadmium	mg/kg dry wt	< 0.10 ± 0.067	0.247 ± 0.079	< 0.10 ± 0.067	-
Total Recoverable Chromium	mg/kg dry wt	7.2 ± 1.6	12.3 ± 1.9	13.6 ± 1.9	-
Total Recoverable Copper	mg/kg dry wt	59.0 ± 8.4	92 ± 13	38.2 ± 5.6	-
Total Recoverable Lead	mg/kg dry wt	83 ± 12	119 ± 17	34.7 ± 4.9	-
Total Recoverable Mercury	mg/kg dry wt	6.27 ± 0.76	3.75 ± 0.46	0.570 ± 0.095	-
Total Recoverable Zinc	mg/kg dry wt	37.4 ± 4.6	161 ± 17	90.0 ± 9.4	-
Polycyclic Aromatic Hydrocarbons Screening in Soil					
Acenaphthene	mg/kg dry wt	0.070 ± 0.021	-	-	-
Acenaphthylene	mg/kg dry wt	0.545 ± 0.050	-	-	-
Anthracene	mg/kg dry wt	1.58 ± 0.48	-	-	-
Benzo[a]anthracene	mg/kg dry wt	3.9 ± 1.1	-	-	-
Benzo[a]pyrene (BAP)	mg/kg dry wt	3.57 ± 0.28	-	-	-
Benzo[b]fluoranthene + Benzo[j] fluoranthene	mg/kg dry wt	3.93 ± 0.81	-	-	-
Benzo[g,h,i]perylene	mg/kg dry wt	1.95 ± 0.34	-	-	-
Benzo[k]fluoranthene	mg/kg dry wt	1.71 ± 0.22	-	-	-
Chrysene	mg/kg dry wt	2.72 ± 0.41	-	-	-

Sample Type: Soil					
	Sample Name:	MOA021 1.0 27-Oct-2011	MOA012 0.5 27-Oct-2011	MOA012 0.1 27-Oct-2011	
	Lab Number:	947724.15	947724.16	947724.17	
Polycyclic Aromatic Hydrocarbons Screening in Soil					
Dibenzo[a,h]anthracene	mg/kg dry wt	0.412 ± 0.054	-	-	-
Fluoranthene	mg/kg dry wt	11.1 ± 1.2	-	-	-
Fluorene	mg/kg dry wt	0.306 ± 0.037	-	-	-
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	1.87 ± 0.18	-	-	-
Naphthalene	mg/kg dry wt	0.139 ± 0.046	-	-	-
Phenanthrene	mg/kg dry wt	9.3 ± 1.3	-	-	-
Pyrene	mg/kg dry wt	9.3 ± 1.2	-	-	-
Total Petroleum Hydrocarbons in Soil					
C7 - C9	mg/kg dry wt	< 9 ± 5.4	< 9 ± 5.4	-	-
C10 - C14	mg/kg dry wt	< 20 ± 7.6	< 20 ± 7.7	-	-
C15 - C36	mg/kg dry wt	115 ± 16	< 40 ± 9.4	-	-
Total hydrocarbons (C7 - C36)	mg/kg dry wt	115 ± 18	< 70 ± 14	-	-

The reported uncertainty is an expanded uncertainty with a level of confidence of approximately 95 percent (i.e. two standard deviations, calculated using a coverage factor of 2). Reported uncertainties are calculated from the performance of typical matrices, and do not include variation due to sampling.

For further information on uncertainty of measurement at Hill Laboratories, refer to the technical note on our website: www.hill-laboratories.com/files/Intro_To_UOM.pdf, or contact the laboratory.

Analyst's Comments

Appendix No.1 - Total Petroleum Hydrocarbon Chromatograms

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: Soil			
Test	**Method Description**	**Default Detection Limit**	**Samples**
Environmental Solids Sample Preparation	Air dried at 35°C and sieved, <2mm fraction. Used for sample preparation. May contain a residual moisture content of 2-5%.	-	1-3, 5-6, 8-17
Polycyclic Aromatic Hydrocarbons Screening in Soil	Sonication extraction, Dilution or SPE cleanup (if required), GC-MS SIM analysis (modified US EPA 8270). Tested on as received sample.	-	13-15
Total Petroleum Hydrocarbons in Soil	Sonication extraction in DCM, Silica cleanup, GC-FID analysis US EPA 8015B/MfE Petroleum Industry Guidelines. Tested on as received sample	-	5-6, 12-13, 15-16
Dry Matter (Env)	Dried at 103°C for 4-22hr (removes 3-5% more water than air dry) , gravimetry. US EPA 3550.	0.10 g/100g as rcvd	5-6, 12-16
Total Recoverable digestion	Nitric / hydrochloric acid digestion. US EPA 200.2.	-	1-3, 5-6, 8-17
Total Recoverable Antimony	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.4 mg/kg dry wt	1-3, 5-6, 8-17
Total Recoverable Arsenic	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	2 mg/kg dry wt	1-3, 5-6, 8-17
Total Recoverable Cadmium	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.10 mg/kg dry wt	1-3, 5-6, 8-17
Total Recoverable Chromium	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	2 mg/kg dry wt	1-3, 5-6, 8-17
Total Recoverable Copper	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	2 mg/kg dry wt	1-3, 5-6, 8-17
Total Recoverable Lead	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.4 mg/kg dry wt	1-3, 5-6, 8-17
Total Recoverable Mercury	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.10 mg/kg dry wt	1-3, 5-6, 8-17

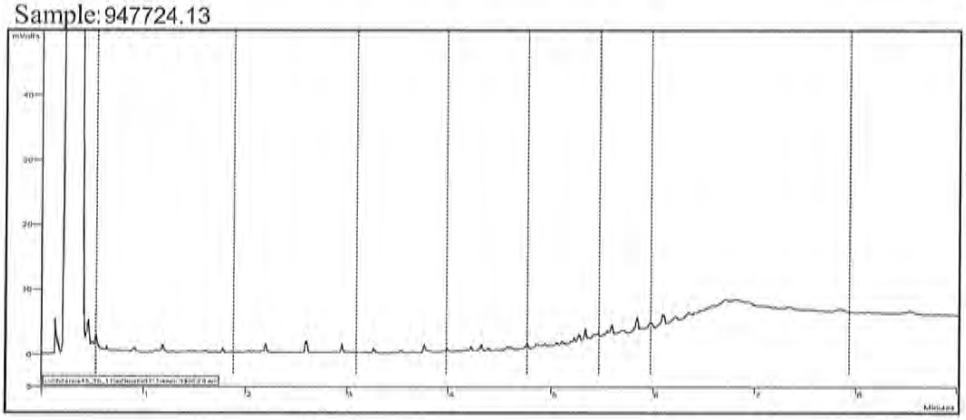
Sample Type: Soil			
Test	**Method Description**	**Default Detection Limit**	**Samples**
Total Recoverable Zinc	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	4 mg/kg dry wt	1-3, 5-6, 8-17

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

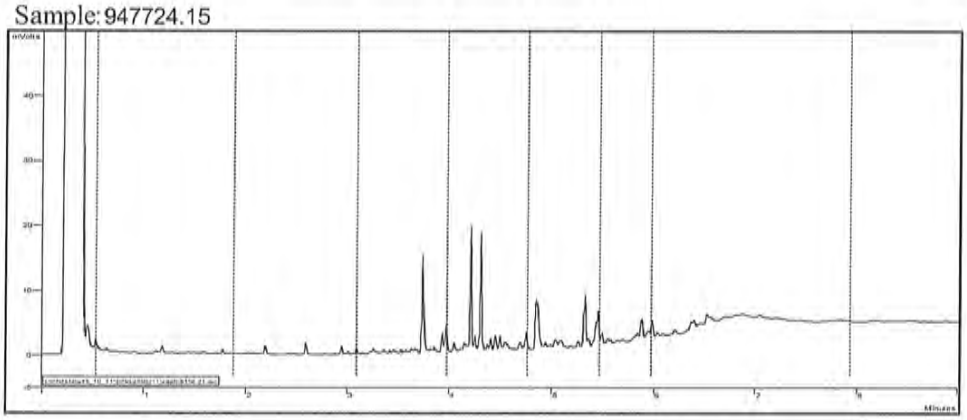
Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.

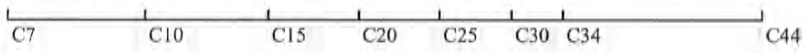
Ara Heron BSc (Tech)
Client Services Manager - Environmental Division

Sample: 947724.13



Sample: 947724.15





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ANALYSIS REPORT

Client:	Pattle Delamore Partners Ltd	**Lab No:**	947724	SPv3
Contact:	Natalie Webster	**Date Registered:**	28-Oct-2011	
	C/- Pattle Delamore Partners Ltd	**Date Reported:**	18-Nov-2011	
	PO Box 9528	**Quote No:**	46451	
	Newmarket	**Order No:**		
	AUCKLAND 1149	**Client Reference:**	AO2469100	
		Submitted By:	Chris Foote	

Amended Report

This report replaces an earlier report issued on the 11 Nov 2011 at 1:12 pm
At the client's request, a thallium result has been added to sample 947724.15.

Sample Type: Soil

Sample Name:		MOA001 0.1 27-Oct-2011	MOA001 0.5 27-Oct-2011	MOA001 1.0 27-Oct-2011	MOA002 0.1 27-Oct-2011	MOA002 0.5 27-Oct-2011
Lab Number:		947724.1	947724.2	947724.3	947724.5	947724.6
Individual Tests						
Dry Matter	g/100g as rcvd	-	-	-	68	78
Total Recoverable Antimony	mg/kg dry wt	0.7	1.7	6.7	7.5	1.7
Total Recoverable Arsenic	mg/kg dry wt	24	96	185	65	54
Total Recoverable Cadmium	mg/kg dry wt	0.18	< 0.10	< 0.10	0.12	< 0.10
Total Recoverable Chromium	mg/kg dry wt	48	7	9	8	8
Total Recoverable Copper	mg/kg dry wt	32	35	48	22	26
Total Recoverable Lead	mg/kg dry wt	33	9.9	6.9	32	13.8
Total Recoverable Mercury	mg/kg dry wt	0.33	0.49	2.2	0.39	0.36
Total Recoverable Zinc	mg/kg dry wt	84	25	27	53	46
Total Petroleum Hydrocarbons in Soil						
C7 - C9	mg/kg dry wt	-	-	-	< 10	< 9
C10 - C14	mg/kg dry wt	-	-	-	< 20	< 20
C15 - C36	mg/kg dry wt	-	-	-	< 40	< 40
Total hydrocarbons (C7 - C36)	mg/kg dry wt	-	-	-	< 70	< 70

Sample Name:		MOA006 0.1 27-Oct-2011	MOA006 0.5 27-Oct-2011	MOA006 1.0 27-Oct-2011	MOA011 0.1 27-Oct-2011	MOA011 0.5 27-Oct-2011
Lab Number:		947724.8	947724.9	947724.10	947724.11	947724.12
Individual Tests						
Dry Matter	g/100g as rcvd	-	-	-	-	84
Total Recoverable Antimony	mg/kg dry wt	3.3	2.1	1.7	1.2	1.2
Total Recoverable Arsenic	mg/kg dry wt	39	58	37	25	31
Total Recoverable Cadmium	mg/kg dry wt	0.36	< 0.10	< 0.10	0.34	0.31
Total Recoverable Chromium	mg/kg dry wt	12	9	6	15	15
Total Recoverable Copper	mg/kg dry wt	30	24	16	36	132
Total Recoverable Lead	mg/kg dry wt	35	7.0	5.2	42	30
Total Recoverable Mercury	mg/kg dry wt	0.63	0.51	0.82	0.64	0.26
Total Recoverable Zinc	mg/kg dry wt	99	15	7	99	70
Total Petroleum Hydrocarbons in Soil						
C7 - C9	mg/kg dry wt	-	-	-	-	< 8
C10 - C14	mg/kg dry wt	-	-	-	-	< 20
C15 - C36	mg/kg dry wt	-	-	-	-	< 40
Total hydrocarbons (C7 - C36)	mg/kg dry wt	-	-	-	-	< 70

Sample Type: Soil						
	Sample Name:	MOA021 0.1 27-Oct-2011	MOA021 0.5 27-Oct-2011	MOA021 1.0 27-Oct-2011	MOA012 0.5 27-Oct-2011	MOA012 0.1 27-Oct-2011
	Lab Number:	947724.13	947724.14	947724.15	947724.16	947724.17
Individual Tests						
Dry Matter	g/100g as rcvd	85	85	78	80	-
Total Recoverable Antimony	mg/kg dry wt	5.4	7.2	9.4	2.7	1.6
Total Recoverable Arsenic	mg/kg dry wt	87	210	270	86	35
Total Recoverable Cadmium	mg/kg dry wt	0.17	< 0.10	< 0.10	0.25	< 0.10
Total Recoverable Chromium	mg/kg dry wt	20	10	7	12	14
Total Recoverable Copper	mg/kg dry wt	62	152	59	92	38
Total Recoverable Lead	mg/kg dry wt	81	68	83	119	35
Total Recoverable Mercury	mg/kg dry wt	0.92	1.39	6.3	3.8	0.57
Total Recoverable Thallium	mg/kg dry wt	-	-	1.9	-	-
Total Recoverable Zinc	mg/kg dry wt	138	59	37	161	90
Polycyclic Aromatic Hydrocarbons Screening in Soil						
Acenaphthene	mg/kg dry wt	< 0.03	< 0.03	0.07	-	-
Acenaphthylene	mg/kg dry wt	0.03	0.05	0.55	-	-
Anthracene	mg/kg dry wt	0.05	0.08	1.58	-	-
Benzo[a]anthracene	mg/kg dry wt	0.24	0.50	3.9	-	-
Benzo[a]pyrene (BAP)	mg/kg dry wt	0.31	0.51	3.6	-	-
Benzo[b]fluoranthene + Benzo[j] fluoranthene	mg/kg dry wt	0.54	1.03	3.9	-	-
Benzo[g,h,i]perylene	mg/kg dry wt	0.35	0.43	1.95	-	-
Benzo[k]fluoranthene	mg/kg dry wt	0.20	0.40	1.71	-	-
Chrysene	mg/kg dry wt	0.24	0.53	2.7	-	-
Dibenzo[a,h]anthracene	mg/kg dry wt	0.07	0.10	0.41	-	-
Fluoranthene	mg/kg dry wt	0.59	1.08	11.1	-	-
Fluorene	mg/kg dry wt	< 0.03	< 0.03	0.31	-	-
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	0.30	0.42	1.87	-	-
Naphthalene	mg/kg dry wt	< 0.14	< 0.14	0.14	-	-
Phenanthrene	mg/kg dry wt	0.26	0.50	9.3	-	-
Pyrene	mg/kg dry wt	0.69	1.00	9.3	-	-
Total Petroleum Hydrocarbons in Soil						
C7 - C9	mg/kg dry wt	< 9	-	< 9	< 9	-
C10 - C14	mg/kg dry wt	< 20	-	< 20	< 20	-
C15 - C36	mg/kg dry wt	68	-	115	< 40	-
Total hydrocarbons (C7 - C36)	mg/kg dry wt	< 70	-	115	< 70	-

Analyst's Comments

Appendix No.1 - Total Petroleum Hydrocarbon Chromatograms

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: Soil			
Test	**Method Description**	**Default Detection Limit**	**Samples**
Environmental Solids Sample Preparation	Air dried at 35°C and sieved, <2mm fraction. Used for sample preparation. May contain a residual moisture content of 2-5%.	-	1-3, 5-6, 8-17
Polycyclic Aromatic Hydrocarbons Screening in Soil	Sonication extraction, Dilution or SPE cleanup (if required), GC-MS SIM analysis (modified US EPA 8270). Tested on as received sample.	-	13-15
Total Petroleum Hydrocarbons in Soil	Sonication extraction in DCM, Silica cleanup, GC-FID analysis US EPA 8015B/MfE Petroleum Industry Guidelines. Tested on as received sample	-	5-6, 12-13, 15-16
Dry Matter (Env)	Dried at 103°C for 4-22hr (removes 3-5% more water than air dry) , gravimetry. US EPA 3550.	0.10 g/100g as rcvd	5-6, 12-16
Total Recoverable digestion	Nitric / hydrochloric acid digestion. US EPA 200.2.	-	1-3, 5-6, 8-17
Total Recoverable Antimony	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.4 mg/kg dry wt	1-3, 5-6, 8-17

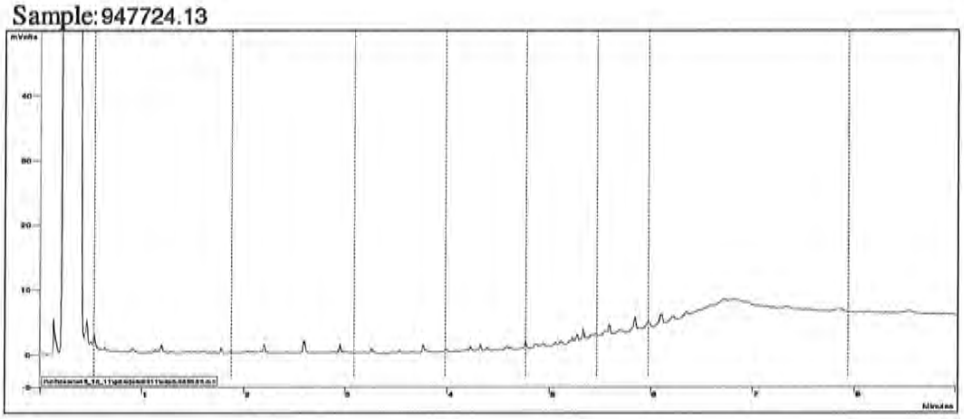
Sample Type: Soil			
Test	**Method Description**	**Default Detection Limit**	**Samples**
Total Recoverable Arsenic	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	2 mg/kg dry wt	1-3, 5-6, 8-17
Total Recoverable Cadmium	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.10 mg/kg dry wt	1-3, 5-6, 8-17
Total Recoverable Chromium	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	2 mg/kg dry wt	1-3, 5-6, 8-17
Total Recoverable Copper	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	2 mg/kg dry wt	1-3, 5-6, 8-17
Total Recoverable Lead	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.4 mg/kg dry wt	1-3, 5-6, 8-17
Total Recoverable Mercury	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.10 mg/kg dry wt	1-3, 5-6, 8-17
Total Recoverable Thallium	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.2 mg/kg dry wt	15
Total Recoverable Zinc	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	4 mg/kg dry wt	1-3, 5-6, 8-17

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

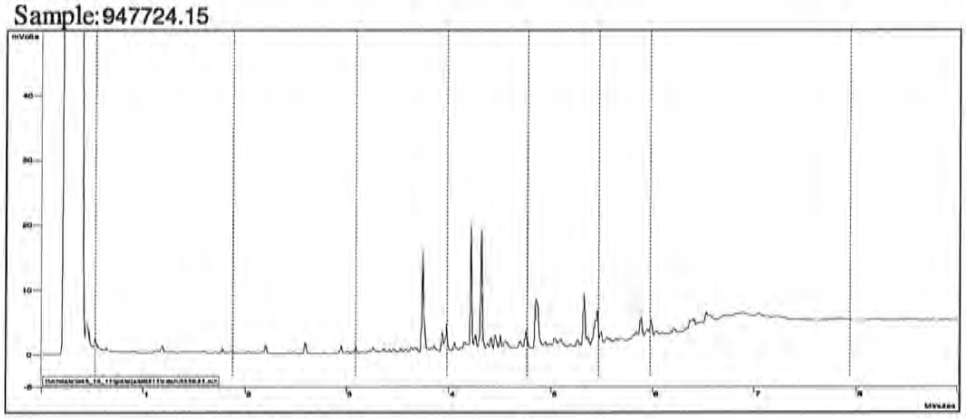
Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.

Ara Heron BSc (Tech)
Client Services Manager - Environmental Division

Sample: 947724.13



Sample: 947724.15



C7 C10 C15 C20 C25 C30 C34 C44

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PATTLE DELAMORE PARTNERS LTD

Request for Analyses

NOTE: Please acknowledge receipt of these samples by signing this form and emailing to submitter.

From: Pattle Delamore Partners Ltd

Address (Refer to base of sheet): ☑ PDP Auckland ☐ PDP Wellington ☐ PDP Christchurch

Submitted by: Chris Foote Ph No.:

To: Hills Lab,

Quote No.: 46451

PDP Job No.: AO24591OO

Chain of Custody Record

Sent:

Name: Chris Foote

Signature: CFoote

Date and time: 28/10/11 8:30am

Received: ☐ Room temp. ☐ Chilled Temp.: 12.3°C

Name: Greg B

Signature:

Date and time: OCT 28 PM 1:45

Notes:

Time Received 28-Oct-2011 2:05:55 pm

Job No 947724

No of Samples 17 No of Fractions 32

0319477240

Results by: ☑ Email submitter: Chris.Foote @pdp.co.nz ☑ Mail (address below)

☑ Email other: Natalie.Webster @pdp.co.nz ☐ Fax (number below)

Priority: ☐ Normal ☑ High ☐ Urgent

Results required by: ___ / ___ / ___

Invoice to: ☑ PDP ☐ Other:

Sample ID	Sample type	No. bottles	Analyses requested	Notes
MOA001 0.1	S	7	HOLD COLD	
MOA001 0.5	S	2	"	
MOA001 1.0	S	2	"	
MOA001 1.5	S	2	"	
MOA002 0.1	S	2	"	
MOA002 0.5	S	2	"	
MOA002 0.9	S	2	"	
MOA006 0.1	S	2	"	
MOA006 0.5	S	2	"	
MOA006 1.0	S	2	"	
MOA011 0.1	S	2 x 1	"	
MOA011 0.5	S	2 x 1	"	
MOA021 0.1	S	2	"	
MOA021 0.5	S	2	"	
MOA021 1.0	S	2	"	
MOA012 0.5	S	2	"	
MOA012 0.1	S	2	"	

Sample type: S Soil GW Groundwater SAL Seawater/saline FW Freshwater LEACH Leachate GEO Geothermal SED Sediment BIO Biota TW Tradewaste WW Wastewater P Potable Other:

Note: Samples may contain dangerous or hazardous substances

PDP Auckland
PDP House, 235 Broadway, Newmarket, Auckland
PO Box 9528, Newmarket, Auckland 1149

PDP Wellington
iSOFT House, Level 1, 111 Customhouse Quay, Wellington
PO Box 6136, Wellington 6141

PDP Christchurch
Radio NZ House, 51 Chester St West, Christchurch
PO Box 389, Christchurch 8140

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Web www.hill-labs.co.nz

ANALYSIS REPORT

Client:	Pattle Delamore Partners Ltd	**Lab No:**	947721	SUPv2
Contact:	Natalie Webster	**Date Registered:**	28-Oct-2011	
	C/- Pattle Delamore Partners Ltd	**Date Reported:**	18-Nov-2011	
	PO Box 9528	**Quote No:**	46451	
	Newmarket	**Order No:**		
	AUCKLAND 1149	**Client Reference:**	AO2469100	
		Submitted By:	Chris Foote	

Amended Report

This report replaces an earlier report issued on the 17 Nov 2011 at 10:29 am
At the client's request, thallium results have been added to samples 947721.2,5 & 17.

Sample Type: Soil

		Sample Name:	MOA007 0.1 27-Oct-2011	MOA007 0.5 27-Oct-2011	MOA007 1.0 27-Oct-2011	MOA022 0.1 27-Oct-2011
		Lab Number:	947721.1	947721.2	947721.3	947721.4
Individual Tests						
Dry Matter	g/100g as rcvd		85	80	75	-
Total Recoverable Antimony	mg/kg dry wt		0.61 ± 0.28	3.03 ± 0.61	3.96 ± 0.76	9.1 ± 1.7
Total Recoverable Arsenic	mg/kg dry wt		24.0 ± 2.8	166 ± 17	139 ± 15	113 ± 12
Total Recoverable Cadmium	mg/kg dry wt		0.210 ± 0.075	< 0.10 ± 0.067	0.185 ± 0.073	0.391 ± 0.096
Total Recoverable Chromium	mg/kg dry wt		15.3 ± 2.1	28.1 ± 3.2	15.3 ± 2.1	11.7 ± 1.8
Total Recoverable Copper	mg/kg dry wt		24.9 ± 3.8	37.1 ± 5.4	34.0 ± 5.0	44.2 ± 6.4
Total Recoverable Lead	mg/kg dry wt		50.8 ± 7.2	18.0 ± 2.6	36.3 ± 5.1	106 ± 15
Total Recoverable Mercury	mg/kg dry wt		0.398 ± 0.082	1.14 ± 0.16	0.572 ± 0.095	2.46 ± 0.31
Total Recoverable Thallium	mg/kg dry wt		-	1.41 ± 0.22	-	-
Total Recoverable Zinc	mg/kg dry wt		115 ± 12	38.5 ± 4.7	117 ± 13	172 ± 18
Total Petroleum Hydrocarbons in Soil						
C7 - C9	mg/kg dry wt		< 8 ± 5.4	< 9 ± 5.4	< 10 ± 5.5	-
C10 - C14	mg/kg dry wt		< 20 ± 7.6	< 20 ± 7.6	< 20 ± 7.8	-
C15 - C36	mg/kg dry wt		< 40 ± 9.3	< 40 ± 9.4	< 40 ± 9.5	-
Total hydrocarbons (C7 - C36)	mg/kg dry wt		< 70 ± 14	< 70 ± 14	< 70 ± 14	-

		Sample Name:	MOA022 0.5 27-Oct-2011	MOA022 1.0 27-Oct-2011	MOA005 0.1 27-Oct-2011	MOA005 0.5 27-Oct-2011
		Lab Number:	947721.5	947721.6	947721.7	947721.8
Individual Tests						
Dry Matter	g/100g as rcvd		-	83	-	83
Total Recoverable Antimony	mg/kg dry wt		11.9 ± 2.2	72	3.09 ± 0.62	6.8
Total Recoverable Arsenic	mg/kg dry wt		204 ± 21	370	74.8 ± 7.6	128
Total Recoverable Cadmium	mg/kg dry wt		0.308 ± 0.085	1.48	0.169 ± 0.072	< 0.10
Total Recoverable Chromium	mg/kg dry wt		8.5 ± 1.6	2	18.0 ± 2.3	11
Total Recoverable Copper	mg/kg dry wt		66.2 ± 9.4	97	35.0 ± 5.1	38
Total Recoverable Lead	mg/kg dry wt		350 ± 50	290	64.7 ± 9.1	28
Total Recoverable Mercury	mg/kg dry wt		5.18 ± 0.63	21	1.28 ± 0.17	1.02
Total Recoverable Thallium	mg/kg dry wt		1.64 ± 0.24	-	-	-
Total Recoverable Zinc	mg/kg dry wt		150 ± 16	360	153 ± 16	105
Total Petroleum Hydrocarbons in Soil						
C7 - C9	mg/kg dry wt		-	< 9 ± 5.4	-	< 8 ± 5.4
C10 - C14	mg/kg dry wt		-	< 20 ± 7.7	-	< 20 ± 7.6
C15 - C36	mg/kg dry wt		-	< 40 ± 9.4	-	< 40 ± 9.3
Total hydrocarbons (C7 - C36)	mg/kg dry wt		-	< 70 ± 14	-	< 70 ± 14

Sample Type: Soil					
	Sample Name:	MOA005 1.5 27-Oct-2011	MOA003 0.1 27-Oct-2011	MOA003 0.5 27-Oct-2011	MOA003 1.0 27-Oct-2011
	Lab Number:	947721.10	947721.11	947721.12	947721.13
Individual Tests					
Dry Matter	g/100g as rcvd	73	-	-	-
Total Recoverable Antimony	mg/kg dry wt	18.0	1.58 ± 0.39	1.07 ± 0.33	3.07 ± 0.61
Total Recoverable Arsenic	mg/kg dry wt	290	29.7 ± 3.3	40.9 ± 4.3	66.2 ± 6.8
Total Recoverable Cadmium	mg/kg dry wt	0.40 #1	0.261 ± 0.080	< 0.10 ± 0.067	< 0.10 ± 0.067
Total Recoverable Chromium	mg/kg dry wt	25 #1	17.4 ± 2.2	5.0 ± 1.5	8.5 ± 1.6
Total Recoverable Copper	mg/kg dry wt	83	33.9 ± 5.0	22.5 ± 3.5	53.0 ± 7.6
Total Recoverable Lead	mg/kg dry wt	189	91 ± 13	10.9 ± 1.6	9.1 ± 1.4
Total Recoverable Mercury	mg/kg dry wt	3.7	0.282 ± 0.074	0.407 ± 0.082	0.170 ± 0.069
Total Recoverable Zinc	mg/kg dry wt	210	153 ± 16	11.8 ± 2.9	12.3 ± 3.0
Total Petroleum Hydrocarbons in Soil					
C7 - C9	mg/kg dry wt	< 9 ± 5.4	-	-	-
C10 - C14	mg/kg dry wt	< 20 ± 7.7	-	-	-
C15 - C36	mg/kg dry wt	< 40 ± 9.4	-	-	-
Total hydrocarbons (C7 - C36)	mg/kg dry wt	< 70 ± 14	-	-	-

	Sample Name:	MOA022 1.5 27-Oct-2011	MOA026 0.1 27-Oct-2011	MOA005 0.5 (duplicate)	
	Lab Number:	947721.16	947721.17	947721.18	
Individual Tests					
Dry Matter	g/100g as rcvd	-	89	-	-
Total Recoverable Antimony	mg/kg dry wt	-	10.1 ± 1.9	4.47 ± 0.85	-
Total Recoverable Arsenic	mg/kg dry wt	-	135 ± 14	106 ± 11	-
Total Recoverable Cadmium	mg/kg dry wt	-	0.233 ± 0.077	< 0.10 ± 0.067	-
Total Recoverable Chromium	mg/kg dry wt	-	14.2 ± 2.0	10.3 ± 1.7	-
Total Recoverable Copper	mg/kg dry wt	-	137 ± 20	35.3 ± 5.2	-
Total Recoverable Lead	mg/kg dry wt	-	121 ± 17	27.6 ± 3.9	-
Total Recoverable Mercury	mg/kg dry wt	-	4.82 ± 0.59	1.07 ± 0.15	-
Total Recoverable Thallium	mg/kg dry wt	-	1.10 ± 0.19	-	-
Total Recoverable Zinc	mg/kg dry wt	-	183 ± 19	96 ± 10	-
Metals extensive suite, screen level (33 metals)					
Total Recoverable Aluminium	mg/kg dry wt	1,480 ± 180	-	-	-
Total Recoverable Antimony	mg/kg dry wt	44.9 ± 8.1	-	-	-
Total Recoverable Arsenic	mg/kg dry wt	920 ± 93	-	-	-
Total Recoverable Barium	mg/kg dry wt	206 ± 13	-	-	-
Total Recoverable Bismuth	mg/kg dry wt	< 0.4 ± 0.27	-	-	-
Total Recoverable Boron	mg/kg dry wt	< 20 ± 14	-	-	-
Total Recoverable Cadmium	mg/kg dry wt	2.81 ± 0.52	-	-	-
Total Recoverable Caesium	mg/kg dry wt	5.77 ± 0.60	-	-	-
Total Recoverable Calcium	mg/kg dry wt	275 ± 76	-	-	-
Total Recoverable Chromium	mg/kg dry wt	< 2 ± 1.4	-	-	-
Total Recoverable Cobalt	mg/kg dry wt	7.4 ± 1.1	-	-	-
Total Recoverable Copper	mg/kg dry wt	361 ± 51	-	-	-
Total Recoverable Iron	mg/kg dry wt	27,700 ± 2,800	-	-	-
Total Recoverable Lanthanum	mg/kg dry wt	2.30 ± 0.23	-	-	-
Total Recoverable Lead	mg/kg dry wt	177 ± 25	-	-	-
Total Recoverable Lithium	mg/kg dry wt	< 0.4 ± 0.27	-	-	-
Total Recoverable Magnesium	mg/kg dry wt	76 ± 28	-	-	-
Total Recoverable Manganese	mg/kg dry wt	33.3 ± 3.4	-	-	-
Total Recoverable Mercury	mg/kg dry wt	24.4 ± 3.0	-	-	-
Total Recoverable Molybdenum	mg/kg dry wt	17.0 ± 3.1	-	-	-
Total Recoverable Nickel	mg/kg dry wt	4.3 ± 1.5	-	-	-
Total Recoverable Phosphorus	mg/kg dry wt	56 ± 27	-	-	-
Total Recoverable Potassium*	mg/kg dry wt	790 ± 130	-	-	-
Total Recoverable Rubidium	mg/kg dry wt	5.73 ± 0.64	-	-	-
Total Recoverable Selenium	mg/kg dry wt	< 20 ± 14	-	-	-

Sample Type: Soil					
Sample Name:		MOA022 1.5 27-Oct-2011	MOA026 0.1 27-Oct-2011	MOA005 0.5 (duplicate)	
Lab Number:		947721.16	947721.17	947721.18	
Metals extensive suite, screen level (33 metals)					
Total Recoverable Sodium	mg/kg dry wt	< 40 ± 27	-	-	-
Total Recoverable Strontium	mg/kg dry wt	4.02 ± 0.78	-	-	-
Total Recoverable Thallium	mg/kg dry wt	5.72 ± 0.70	-	-	-
Total Recoverable Tin	mg/kg dry wt	< 1.0 ± 0.67	-	-	-
Total Recoverable Uranium	mg/kg dry wt	< 0.10 ± 0.067	-	-	-
Total Recoverable Vanadium	mg/kg dry wt	< 100 ± 67	-	-	-
Total Recoverable Zinc	mg/kg dry wt	447 ± 45	-	-	-
Total Petroleum Hydrocarbons in Soil					
C7 - C9	mg/kg dry wt	-	< 8 ± 5.4	-	-
C10 - C14	mg/kg dry wt	-	< 20 ± 7.6	-	-
C15 - C36	mg/kg dry wt	-	56.6 ± 9.6	-	-
Total hydrocarbons (C7 - C36)	mg/kg dry wt	-	< 70 ± 14	-	-

The reported uncertainty is an expanded uncertainty with a level of confidence of approximately 95 percent (i.e. two standard deviations, calculated using a coverage factor of 2). Reported uncertainties are calculated from the performance of typical matrices, and do not include variation due to sampling.

For further information on uncertainty of measurement at Hill Laboratories, refer to the technical note on our website: www.hill-laboratories.com/files/Intro_To_UOM.pdf, or contact the laboratory.

Analyst's Comments

#1 It should be noted that the replicate analyses performed on this sample as part of our in-house Quality Assurance procedures showed greater variation than would normally be expected. This may reflect the heterogeneity of the sample.

Appendix No.1 - Total Petroleum Hydrocarbon Chromatograms

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: Soil			
Test	**Method Description**	**Default Detection Limit**	**Samples**
Environmental Solids Sample Preparation	Air dried at 35°C and sieved, <2mm fraction. Used for sample preparation. May contain a residual moisture content of 2-5%.	-	1-5, 7, 11-13, 16-18
Environmental Solids Sample Preparation	Air dried at 35°C.	-	6, 8, 10
Metals extensive suite, screen level (33 metals)*	Dried sample, <2mm fraction. Nitric/Hydrochloric acid digestion, ICP-MS, screen level.	-	16
Total Petroleum Hydrocarbons in Soil	Sonication extraction in DCM, Silica cleanup, GC-FID analysis US EPA 8015B/MfE Petroleum Industry Guidelines. Tested on as received sample	-	1-3, 6, 8, 10, 17
Dry Matter (Env)	Dried at 103°C for 4-22hr (removes 3-5% more water than air dry) , gravimetry. US EPA 3550.	0.10 g/100g as rcvd	1-3, 6, 8, 10, 17
Macro Total Recoverable digestion	Nitric / hydrochloric acid digestion. US EPA 200.2.	-	6, 8, 10
Total Recoverable digestion	Nitric / hydrochloric acid digestion. US EPA 200.2.	-	1-5, 7, 11-13, 16-18
Total Recoverable Antimony	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.4 mg/kg dry wt	1-5, 7, 11-13, 17-18
Total Recoverable Antimony	Dried sample, Nitric/Hydrochloric acid digestion, ICP-MS, screen level.	0.4 mg/kg dry wt	6, 8, 10
Total Recoverable Arsenic	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	2 mg/kg dry wt	1-5, 7, 11-13, 17-18
Total Recoverable Arsenic	Dried sample, Nitric/Hydrochloric acid digestion, ICP-MS, screen level.	2 mg/kg dry wt	6, 8, 10
Total Recoverable Cadmium	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.10 mg/kg dry wt	1-5, 7, 11-13, 17-18

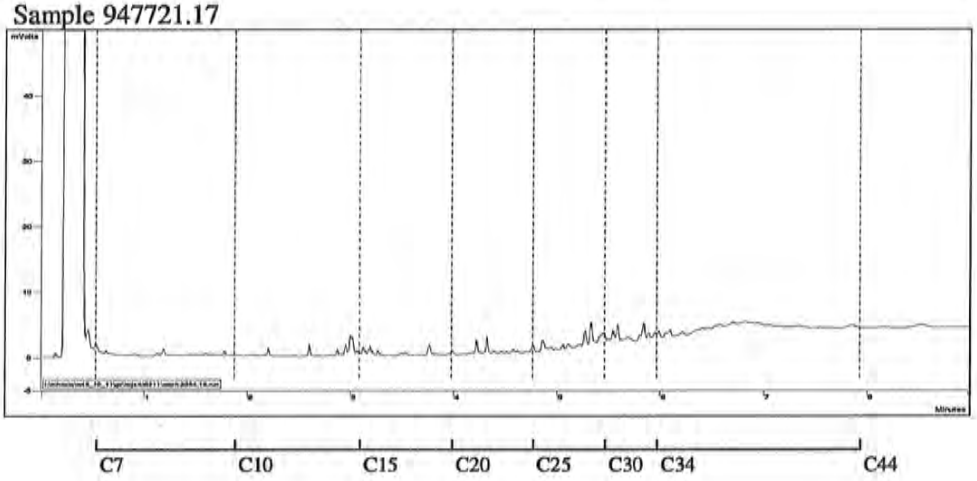
Sample Type: Soil			
Test	**Method Description**	**Default Detection Limit**	**Samples**
Total Recoverable Cadmium	Dried sample, Nitric/Hydrochloric acid digestion, ICP-MS, screen level.	0.10 mg/kg dry wt	6, 8, 10
Total Recoverable Chromium	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	2 mg/kg dry wt	1-5, 7, 11-13, 17-18
Total Recoverable Chromium	Dried sample, Nitric/Hydrochloric acid digestion, ICP-MS, screen level.	2 mg/kg dry wt	6, 8, 10
Total Recoverable Copper	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	2 mg/kg dry wt	1-5, 7, 11-13, 17-18
Total Recoverable Copper	Dried sample, Nitric/Hydrochloric acid digestion, ICP-MS, screen level.	2 mg/kg dry wt	6, 8, 10
Total Recoverable Lead	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.4 mg/kg dry wt	1-5, 7, 11-13, 17-18
Total Recoverable Lead	Dried sample, Nitric/Hydrochloric acid digestion, ICP-MS, screen level.	0.4 mg/kg dry wt	6, 8, 10
Total Recoverable Mercury	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.10 mg/kg dry wt	1-5, 7, 11-13, 17-18
Total Recoverable Mercury	Dried sample, Nitric/Hydrochloric acid digestion, ICP-MS, screen level.	0.10 mg/kg dry wt	6, 8, 10
Total Recoverable Thallium	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.2 mg/kg dry wt	2, 5, 17
Total Recoverable Zinc	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	4 mg/kg dry wt	1-5, 7, 11-13, 17-18
Total Recoverable Zinc	Dried sample, Nitric/Hydrochloric acid digestion, ICP-MS, screen level.	4 mg/kg dry wt	6, 8, 10

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.

Ara Heron BSc (Tech)
Client Services Manager - Environmental Division

Sample 947721.17



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ANALYSIS REPORT

Client:	Pattle Delamore Partners Ltd	**Lab No:**	947721	SPv6
Contact:	Natalie Webster	**Date Registered:**	28-Oct-2011	
	C/- Pattle Delamore Partners Ltd	**Date Reported:**	18-Nov-2011	
	PO Box 9528	**Quote No:**	46451	
	Newmarket	**Order No:**		
	AUCKLAND 1149	**Client Reference:**	AO2469100	
		Submitted By:	Chris Foote	

Amended Report

This report replaces an earlier report issued on the 16 Nov 2011 at 1:28 pm
At the client's request, thallium results have been added to samples 947721.2,5 & 17.

Sample Type: Soil

	Sample Name:	MOA007 0.1 27-Oct-2011	MOA007 0.5 27-Oct-2011	MOA007 1.0 27-Oct-2011	MOA022 0.1 27-Oct-2011	MOA022 0.5 27-Oct-2011
	Lab Number:	947721.1	947721.2	947721.3	947721.4	947721.5
Individual Tests						
Dry Matter	g/100g as rcvd	85	80	75	-	-
Total Recoverable Antimony	mg/kg dry wt	0.6	3.0	4.0	9.1	11.9
Total Recoverable Arsenic	mg/kg dry wt	24	166	139	113	200
Total Recoverable Cadmium	mg/kg dry wt	0.21	< 0.10	0.18	0.39	0.31
Total Recoverable Chromium	mg/kg dry wt	15	28	15	12	9
Total Recoverable Copper	mg/kg dry wt	25	37	34	44	66
Total Recoverable Lead	mg/kg dry wt	51	18.0	36	106	350
Total Recoverable Mercury	mg/kg dry wt	0.40	1.14	0.57	2.5	5.2
Total Recoverable Thallium	mg/kg dry wt	-	1.4	-	-	1.6
Total Recoverable Zinc	mg/kg dry wt	115	38	117	172	150
Total Petroleum Hydrocarbons in Soil						
C7 - C9	mg/kg dry wt	< 8	< 9	< 10	-	-
C10 - C14	mg/kg dry wt	< 20	< 20	< 20	-	-
C15 - C36	mg/kg dry wt	< 40	< 40	< 40	-	-
Total hydrocarbons (C7 - C36)	mg/kg dry wt	< 70	< 70	< 70	-	-

	Sample Name:	MOA022 1.0 27-Oct-2011	MOA005 0.1 27-Oct-2011	MOA005 0.5 27-Oct-2011	MOA005 1.5 27-Oct-2011	MOA003 0.1 27-Oct-2011
	Lab Number:	947721.6	947721.7	947721.8	947721.10	947721.11
Individual Tests						
Dry Matter	g/100g as rcvd	83	-	83	73	-
Total Recoverable Antimony	mg/kg dry wt	72	3.1	6.8	18.0	1.6
Total Recoverable Arsenic	mg/kg dry wt	370	75	128	290	30
Total Recoverable Cadmium	mg/kg dry wt	1.48	0.17	< 0.10	0.40 #1	0.26
Total Recoverable Chromium	mg/kg dry wt	2	18	11	25 #1	17
Total Recoverable Copper	mg/kg dry wt	97	35	38	83	34
Total Recoverable Lead	mg/kg dry wt	290	65	28	189	91
Total Recoverable Mercury	mg/kg dry wt	21	1.28	1.02	3.7	0.28
Total Recoverable Zinc	mg/kg dry wt	360	153	105	210	153
Total Petroleum Hydrocarbons in Soil						
C7 - C9	mg/kg dry wt	< 9	-	< 8	< 9	-
C10 - C14	mg/kg dry wt	< 20	-	< 20	< 20	-
C15 - C36	mg/kg dry wt	< 40	-	< 40	< 40	-
Total hydrocarbons (C7 - C36)	mg/kg dry wt	< 70	-	< 70	< 70	-

Sample Type: Soil							
	Sample Name:	MOA003 0.5 27-Oct-2011	MOA003 1.0 27-Oct-2011	MOA022 1.5 27-Oct-2011	MOA026 0.1 27-Oct-2011	MOA005 0.5 (duplicate)
	Lab Number:	947721.12	947721.13	947721.16	947721.17	947721.18
Individual Tests						
Dry Matter	g/100g as rcvd	-	-	-	89	-
Total Recoverable Antimony	mg/kg dry wt	1.1	3.1	-	10.1	4.5
Total Recoverable Arsenic	mg/kg dry wt	41	66	-	135	106
Total Recoverable Cadmium	mg/kg dry wt	< 0.10	< 0.10	-	0.23	< 0.10
Total Recoverable Chromium	mg/kg dry wt	5	9	-	14	10
Total Recoverable Copper	mg/kg dry wt	22	53	-	137	35
Total Recoverable Lead	mg/kg dry wt	10.9	9.1	-	121	28
Total Recoverable Mercury	mg/kg dry wt	0.41	0.17	-	4.8	1.07
Total Recoverable Thallium	mg/kg dry wt	-	-	-	1.1	-
Total Recoverable Zinc	mg/kg dry wt	12	12	-	183	96
Metals extensive suite, screen level (33 metals)						
Total Recoverable Aluminium	mg/kg dry wt	-	-	1,480	-	-
Total Recoverable Antimony	mg/kg dry wt	-	-	45	-	-
Total Recoverable Arsenic	mg/kg dry wt	-	-	920	-	-
Total Recoverable Barium	mg/kg dry wt	-	-	210	-	-
Total Recoverable Bismuth	mg/kg dry wt	-	-	< 0.4	-	-
Total Recoverable Boron	mg/kg dry wt	-	-	< 20	-	-
Total Recoverable Cadmium	mg/kg dry wt	-	-	2.8	-	-
Total Recoverable Caesium	mg/kg dry wt	-	-	5.8	-	-
Total Recoverable Calcium	mg/kg dry wt	-	-	280	-	-
Total Recoverable Chromium	mg/kg dry wt	-	-	< 2	-	-
Total Recoverable Cobalt	mg/kg dry wt	-	-	7.4	-	-
Total Recoverable Copper	mg/kg dry wt	-	-	360	-	-
Total Recoverable Iron	mg/kg dry wt	-	-	28,000	-	-
Total Recoverable Lanthanum	mg/kg dry wt	-	-	2.3	-	-
Total Recoverable Lead	mg/kg dry wt	-	-	177	-	-
Total Recoverable Lithium	mg/kg dry wt	-	-	< 0.4	-	-
Total Recoverable Magnesium	mg/kg dry wt	-	-	76	-	-
Total Recoverable Manganese	mg/kg dry wt	-	-	33	-	-
Total Recoverable Mercury	mg/kg dry wt	-	-	24	-	-
Total Recoverable Molybdenum	mg/kg dry wt	-	-	17.0	-	-
Total Recoverable Nickel	mg/kg dry wt	-	-	4	-	-
Total Recoverable Phosphorus	mg/kg dry wt	-	-	56	-	-
Total Recoverable Potassium*	mg/kg dry wt	-	-	790	-	-
Total Recoverable Rubidium	mg/kg dry wt	-	-	5.7	-	-
Total Recoverable Selenium	mg/kg dry wt	-	-	< 20	-	-
Total Recoverable Sodium	mg/kg dry wt	-	-	< 40	-	-
Total Recoverable Strontium	mg/kg dry wt	-	-	4.0	-	-
Total Recoverable Thallium	mg/kg dry wt	-	-	5.7	-	-
Total Recoverable Tin	mg/kg dry wt	-	-	< 1.0	-	-
Total Recoverable Uranium	mg/kg dry wt	-	-	< 0.10	-	-
Total Recoverable Vanadium	mg/kg dry wt	-	-	< 100	-	-
Total Recoverable Zinc	mg/kg dry wt	-	-	450	-	-
Total Petroleum Hydrocarbons in Soil						
C7 - C9	mg/kg dry wt	-	-	-	< 8	-
C10 - C14	mg/kg dry wt	-	-	-	< 20	-
C15 - C36	mg/kg dry wt	-	-	-	57	-
Total hydrocarbons (C7 - C36)	mg/kg dry wt	-	-	-	< 70	-

Analyst's Comments

#1 It should be noted that the replicate analyses performed on this sample as part of our in-house Quality Assurance procedures showed greater variation than would normally be expected. This may reflect the heterogeneity of the sample.

Appendix No.1 - Total Petroleum Hydrocarbon Chromatograms

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: Soil

Test	Method Description	Default Detection Limit	Samples
Environmental Solids Sample Preparation	Air dried at 35°C and sieved, <2mm fraction. Used for sample preparation. May contain a residual moisture content of 2-5%.	-	1-5, 7, 11-13, 16-18
Environmental Solids Sample Preparation	Air dried at 35°C.	-	6, 8, 10
Metals extensive suite, screen level (33 metals)*	Dried sample, <2mm fraction. Nitric/Hydrochloric acid digestion, ICP-MS, screen level.	-	16
Total Petroleum Hydrocarbons in Soil	Sonication extraction in DCM, Silica cleanup, GC-FID analysis US EPA 8015B/MfE Petroleum Industry Guidelines. Tested on as received sample	-	1-3, 6, 8, 10, 17
Dry Matter (Env)	Dried at 103°C for 4-22hr (removes 3-5% more water than air dry) , gravimetry. US EPA 3550.	0.10 g/100g as rcvd	1-3, 6, 8, 10, 17
Macro Total Recoverable digestion	Nitric / hydrochloric acid digestion. US EPA 200.2.	-	6, 8, 10
Total Recoverable digestion	Nitric / hydrochloric acid digestion. US EPA 200.2.	-	1-5, 7, 11-13, 16-18
Total Recoverable Antimony	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.4 mg/kg dry wt	1-5, 7, 11-13, 17-18
Total Recoverable Antimony	Dried sample, Nitric/Hydrochloric acid digestion, ICP-MS, screen level.	0.4 mg/kg dry wt	6, 8, 10
Total Recoverable Arsenic	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	2 mg/kg dry wt	1-5, 7, 11-13, 17-18
Total Recoverable Arsenic	Dried sample, Nitric/Hydrochloric acid digestion, ICP-MS, screen level.	2 mg/kg dry wt	6, 8, 10
Total Recoverable Cadmium	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.10 mg/kg dry wt	1-5, 7, 11-13, 17-18
Total Recoverable Cadmium	Dried sample, Nitric/Hydrochloric acid digestion, ICP-MS, screen level.	0.10 mg/kg dry wt	6, 8, 10
Total Recoverable Chromium	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	2 mg/kg dry wt	1-5, 7, 11-13, 17-18
Total Recoverable Chromium	Dried sample, Nitric/Hydrochloric acid digestion, ICP-MS, screen level.	2 mg/kg dry wt	6, 8, 10
Total Recoverable Copper	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	2 mg/kg dry wt	1-5, 7, 11-13, 17-18
Total Recoverable Copper	Dried sample, Nitric/Hydrochloric acid digestion, ICP-MS, screen level.	2 mg/kg dry wt	6, 8, 10
Total Recoverable Lead	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.4 mg/kg dry wt	1-5, 7, 11-13, 17-18
Total Recoverable Lead	Dried sample, Nitric/Hydrochloric acid digestion, ICP-MS, screen level.	0.4 mg/kg dry wt	6, 8, 10
Total Recoverable Mercury	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.10 mg/kg dry wt	1-5, 7, 11-13, 17-18
Total Recoverable Mercury	Dried sample, Nitric/Hydrochloric acid digestion, ICP-MS, screen level.	0.10 mg/kg dry wt	6, 8, 10
Total Recoverable Thallium	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.2 mg/kg dry wt	2, 5, 17
Total Recoverable Zinc	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	4 mg/kg dry wt	1-5, 7, 11-13, 17-18
Total Recoverable Zinc	Dried sample, Nitric/Hydrochloric acid digestion, ICP-MS, screen level.	4 mg/kg dry wt	6, 8, 10

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.

Ara Heron BSc (Tech)
Client Services Manager - Environmental Division

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Request for Analyses

NOTE: Please acknowledge receipt of these samples by signing this form and emailing to submitter.

From: Pattle Delamore Partners Ltd
Address (Refer to base of sheet): ☑ PDP Auckland ☐ PDP Wellington ☐ PDP Christchurch
Submitted by: Chris Foote Ph No.:

To: Hills Lab
Quote No.: 46451
PDP Job No.: A02469100

Chain of Custody Record

Sent:
Name: Chris Foote
Signature: CFoote
Date and time: 28/10/11 8:30am

Received: ☐ Room temp. ☐ Chilled Temp.: 14.1 °C
Name: Lisa Bailey
Signature: LBailey
Date and time: OCT 28 PM1:56

Notes:

Time Received 28-Oct-2011 2:06:09 pm
Job No 947721
No of Samples 17 No of Fractions 31
0319477217

Results by: ☑ Email submitter: Chris.Foote @pdp.co.nz ☑ Mail (address below)
☑ Email other: Natalie.Webster @pdp.co.nz ☐ Fax (number below)

Priority: ☐ Normal ☑ High ☐ Urgent
Results required by: ___/___/___

Invoice to: ☑ PDP ☐ Other:

Sample ID	Sample type	No. bottles	Analyses requested	Notes
MOA007 0.1	S	2	HOLD COLD	
MOA007 0.5	S	2	"	
MOA007 1.0	S	2	"	
MOA022 0.1	S	2	"	
MOA022 0.5	S	2	"	
MOA022 1.0	S	2	"	
MOA005 0.1	S	2	"	
MOA005 0.5	S	2	"	
MOA005 1.0	S	2	"	
MOA005 1.5	S	1	"	
MOA003 0.1	S	2	"	
MOA003 0.5	S	2	"	
MOA003 1.0	S	2	"	
MOA003 1.5	S	2	"	
MOA007 1.5	S	1	"	
MOA022 1.5	S	1	"	
MOA026 0.1	S	2	"	

Sample type: S Soil GW Groundwater SAL Seawater/saline FW Freshwater LEACH Leachate GEO Geothermal
SED Sediment BIO Biota TW Tradewaste WW Wastewater P Potable Other:

Note: Samples may contain dangerous or hazardous substances

DP Auckland
DP House, 235 Broadway, Newmarket, Auckland
O Box 9528, Newmarket, Auckland 1149

PDP Wellington
iSOFT House, Level 1, 111 Customhouse Quay, Wellington
PO Box 6136, Wellington 6141

PDP Christchurch
Radio NZ House, 51 Chester St West, Christchurch
PO Box 389, Christchurch 8140

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ANALYSIS REPORT

Client:	Pattle Delamore Partners Ltd	**Lab No:**	947142	SUPv2
Contact:	Natalie Webster	**Date Registered:**	27-Oct-2011	
	C/- Pattle Delamore Partners Ltd	**Date Reported:**	18-Nov-2011	
	PO Box 9528	**Quote No:**	46451	
	Newmarket	**Order No:**		
	AUCKLAND 1149	**Client Reference:**	AO2469100	
		Submitted By:	Chris Foote	

Amended Report

This report replaces an earlier report issued on the 17 Nov 2011 at 10:28 am
At the client's request, thallium results have been added to samples 947142.8 & 11.

Sample Type: Soil

		Sample Name:	MOA 004 0.1 26-Oct-2011	MOA 004 0.5 26-Oct-2011	MOA 004 1.0 26-Oct-2011	MOA 009 0.1 26-Oct-2011
		Lab Number:	947142.1	947142.2	947142.3	947142.4
Individual Tests						
Dry Matter	g/100g as rcvd		-	88	86	-
Total Recoverable Antimony	mg/kg dry wt		2.69 ± 0.55	15.6 ± 2.9	20.0 ± 3.7	1.40 ± 0.36
Total Recoverable Arsenic	mg/kg dry wt		45.3 ± 4.8	16.6 ± 2.2	39.5 ± 4.2	21.1 ± 2.5
Total Recoverable Cadmium	mg/kg dry wt		0.258 ± 0.080	< 0.10 ± 0.067	0.384 ± 0.095	0.185 ± 0.073
Total Recoverable Chromium	mg/kg dry wt		21.0 ± 2.5	6.3 ± 1.5	10.6 ± 1.7	12.9 ± 1.9
Total Recoverable Copper	mg/kg dry wt		39.9 ± 5.8	8.9 ± 1.9	52.3 ± 7.5	26.0 ± 3.9
Total Recoverable Lead	mg/kg dry wt		99 ± 14	22.9 ± 3.3	64.2 ± 9.0	40.9 ± 5.8
Total Recoverable Mercury	mg/kg dry wt		1.23 ± 0.17	0.87 ± 0.13	0.494 ± 0.089	0.68 ± 0.11
Total Recoverable Zinc	mg/kg dry wt		180 ± 19	21.2 ± 3.4	185 ± 19	100 ± 11
Total Petroleum Hydrocarbons in Soil						
C7 - C9	mg/kg dry wt		-	< 8 ± 5.4	< 8 ± 5.4	-
C10 - C14	mg/kg dry wt		-	< 20 ± 7.6	< 20 ± 7.6	-
C15 - C36	mg/kg dry wt		-	< 40 ± 9.3	< 40 ± 9.3	-
Total hydrocarbons (C7 - C36)	mg/kg dry wt		-	< 70 ± 14	< 70 ± 14	-

		Sample Name:	MOA 009 0.5 26-Oct-2011	MOA 010 0.1 26-Oct-2011	MOA 010 0.5 26-Oct-2011	MOA 010 1.0 26-Oct-2011
		Lab Number:	947142.5	947142.7	947142.8	947142.9
Individual Tests						
Total Recoverable Antimony	mg/kg dry wt		2.48 ± 0.52	1.71 ± 0.41	1.81 ± 0.42	2.43 ± 0.51
Total Recoverable Arsenic	mg/kg dry wt		37.3 ± 4.0	61.6 ± 6.4	41.9 ± 4.4	92.9 ± 9.4
Total Recoverable Cadmium	mg/kg dry wt		0.152 ± 0.070	0.401 ± 0.097	< 0.10 ± 0.067	< 0.10 ± 0.067
Total Recoverable Chromium	mg/kg dry wt		20.2 ± 2.5	13.6 ± 1.9	6.3 ± 1.5	14.6 ± 2.0
Total Recoverable Copper	mg/kg dry wt		25.1 ± 3.8	54.8 ± 7.8	59.4 ± 8.5	31.6 ± 4.7
Total Recoverable Lead	mg/kg dry wt		20.7 ± 3.0	65.8 ± 9.3	7.6 ± 1.2	8.8 ± 1.3
Total Recoverable Mercury	mg/kg dry wt		1.68 ± 0.22	0.70 ± 0.11	0.90 ± 0.13	0.99 ± 0.14
Total Recoverable Thallium	mg/kg dry wt		-	-	1.49 ± 0.23	-
Total Recoverable Zinc	mg/kg dry wt		71.2 ± 7.6	146 ± 15	16.2 ± 3.1	18.6 ± 3.3

		Sample Name:	MOA 015 0.1 26-Oct-2011	MOA 015 0.5 26-Oct-2011	MOA 015 1.0 26-Oct-2011	MOA 015 0.1 (duplicate)
		Lab Number:	947142.11	947142.12	947142.13	947142.17
Individual Tests						
Total Recoverable Antimony	mg/kg dry wt		26.9 ± 4.9	-	-	-
Total Recoverable Arsenic	mg/kg dry wt		353 ± 36	-	-	-
Total Recoverable Cadmium	mg/kg dry wt		0.200 ± 0.074	-	-	-

Sample Type: Soil					
Sample Name:		MOA 015 0.1 26-Oct-2011	MOA 015 0.5 26-Oct-2011	MOA 015 1.0 26-Oct-2011	MOA 015 0.1 (duplicate)
Lab Number:		947142.11	947142.12	947142.13	947142.17
Individual Tests					
Total Recoverable Chromium	mg/kg dry wt	8.4 ± 1.6	-	-	-
Total Recoverable Copper	mg/kg dry wt	43.4 ± 6.3	-	-	-
Total Recoverable Lead	mg/kg dry wt	106 ± 15	-	-	-
Total Recoverable Mercury	mg/kg dry wt	26.6 ± 3.2	-	-	-
Total Recoverable Thallium	mg/kg dry wt	2.66 ± 0.35	-	-	-
Total Recoverable Zinc	mg/kg dry wt	101 ± 11	-	-	-
Metals extensive suite, screen level (33 metals)					
Total Recoverable Aluminium	mg/kg dry wt	-	5,920 ± 720	2,570 ± 310	5,630 ± 680
Total Recoverable Antimony	mg/kg dry wt	-	36.6 ± 6.6	34.9 ± 6.3	29.0 ± 5.3
Total Recoverable Arsenic	mg/kg dry wt	-	683 ± 69	1,020 ± 110	333 ± 34
Total Recoverable Barium	mg/kg dry wt	-	241 ± 15	183 ± 11	264 ± 16
Total Recoverable Bismuth	mg/kg dry wt	-	< 0.4 ± 0.27	< 0.4 ± 0.27	< 0.4 ± 0.27
Total Recoverable Boron	mg/kg dry wt	-	< 20 ± 14	< 20 ± 14	< 20 ± 14
Total Recoverable Cadmium	mg/kg dry wt	-	0.250 ± 0.079	0.318 ± 0.087	0.183 ± 0.073
Total Recoverable Caesium	mg/kg dry wt	-	3.15 ± 0.35	7.23 ± 0.74	2.04 ± 0.25
Total Recoverable Calcium	mg/kg dry wt	-	2,220 ± 320	970 ± 160	2,830 ± 410
Total Recoverable Chromium	mg/kg dry wt	-	13.2 ± 1.9	5.5 ± 1.5	9.6 ± 1.7
Total Recoverable Cobalt	mg/kg dry wt	-	5.38 ± 0.80	5.00 ± 0.75	4.26 ± 0.66
Total Recoverable Copper	mg/kg dry wt	-	147 ± 21	97 ± 14	48.9 ± 7.0
Total Recoverable Iron	mg/kg dry wt	-	51,900 ± 5,200	59,200 ± 6,000	31,400 ± 3,200
Total Recoverable Lanthanum	mg/kg dry wt	-	6.93 ± 0.58	2.64 ± 0.25	4.46 ± 0.39
Total Recoverable Lead	mg/kg dry wt	-	156 ± 22	123 ± 18	112 ± 16
Total Recoverable Lithium	mg/kg dry wt	-	3.80 ± 0.53	0.58 ± 0.28	3.53 ± 0.50
Total Recoverable Magnesium	mg/kg dry wt	-	646 ± 70	158 ± 31	1,070 ± 120
Total Recoverable Manganese	mg/kg dry wt	-	155 ± 16	44.2 ± 4.5	195 ± 20
Total Recoverable Mercury	mg/kg dry wt	-	43.2 ± 5.2	77.6 ± 9.4	25.8 ± 3.2
Total Recoverable Molybdenum	mg/kg dry wt	-	5.21 ± 0.98	12.6 ± 2.3	4.59 ± 0.87
Total Recoverable Nickel	mg/kg dry wt	-	5.7 ± 1.6	4.4 ± 1.5	3.4 ± 1.4
Total Recoverable Phosphorus	mg/kg dry wt	-	350 ± 44	411 ± 49	376 ± 46
Total Recoverable Potassium*	mg/kg dry wt	-	560 ± 110	690 ± 120	570 ± 110
Total Recoverable Rubidium	mg/kg dry wt	-	5.17 ± 0.59	6.49 ± 0.71	5.84 ± 0.65
Total Recoverable Selenium	mg/kg dry wt	-	< 20 ± 14	< 20 ± 14	< 20 ± 14
Total Recoverable Sodium	mg/kg dry wt	-	193 ± 41	42 ± 27	150 ± 36
Total Recoverable Strontium	mg/kg dry wt	-	41.4 ± 4.2	12.6 ± 1.5	23.4 ± 2.5
Total Recoverable Thallium	mg/kg dry wt	-	7.49 ± 0.91	5.35 ± 0.66	2.47 ± 0.33
Total Recoverable Tin	mg/kg dry wt	-	45.6 ± 9.2	3.36 ± 0.93	4.4 ± 1.1
Total Recoverable Uranium	mg/kg dry wt	-	0.237 ± 0.068	< 0.10 ± 0.067	0.148 ± 0.067
Total Recoverable Vanadium	mg/kg dry wt	-	< 100 ± 67	< 100 ± 67	< 100 ± 67
Total Recoverable Zinc	mg/kg dry wt	-	217 ± 22	132 ± 14	111 ± 12

The reported uncertainty is an expanded uncertainty with a level of confidence of approximately 95 percent (i.e. two standard deviations, calculated using a coverage factor of 2). Reported uncertainties are calculated from the performance of typical matrices, and do not include variation due to sampling.

For further information on uncertainty of measurement at Hill Laboratories, refer to the technical note on our website: www.hill-laboratories.com/files/Intro_To_UOM.pdf, or contact the laboratory.

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: Soil			
Test	**Method Description**	**Default Detection Limit**	**Samples**
Environmental Solids Sample Preparation	Air dried at 35°C and sieved, <2mm fraction. Used for sample preparation. May contain a residual moisture content of 2-5%.	-	1-5, 7-9, 11-13, 17

Sample Type: Soil			
Test	**Method Description**	**Default Detection Limit**	**Samples**
Metals extensive suite, screen level (33 metals)*	Dried sample, <2mm fraction. Nitric/Hydrochloric acid digestion, ICP-MS, screen level.	-	12-13, 17
Total Petroleum Hydrocarbons in Soil	Sonication extraction in DCM, Silica cleanup, GC-FID analysis US EPA 8015B/MfE Petroleum Industry Guidelines. Tested on as received sample	-	2-3
Dry Matter (Env)	Dried at 103°C for 4-22hr (removes 3-5% more water than air dry) , gravimetry. US EPA 3550.	0.10 g/100g as rcvd	2-3
Total Recoverable digestion	Nitric / hydrochloric acid digestion. US EPA 200.2.	-	1-5, 7-9, 11-13, 17
Total Recoverable Antimony	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.4 mg/kg dry wt	1-5, 7-9, 11
Total Recoverable Arsenic	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	2 mg/kg dry wt	1-5, 7-9, 11
Total Recoverable Cadmium	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.10 mg/kg dry wt	1-5, 7-9, 11
Total Recoverable Chromium	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	2 mg/kg dry wt	1-5, 7-9, 11
Total Recoverable Copper	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	2 mg/kg dry wt	1-5, 7-9, 11
Total Recoverable Lead	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.4 mg/kg dry wt	1-5, 7-9, 11
Total Recoverable Mercury	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.10 mg/kg dry wt	1-5, 7-9, 11
Total Recoverable Thallium	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.2 mg/kg dry wt	8, 11
Total Recoverable Zinc	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	4 mg/kg dry wt	1-5, 7-9, 11

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.

Ara Heron BSc (Tech)
Client Services Manager - Environmental Division

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ANALYSIS REPORT

Client:	Pattle Delamore Partners Ltd	**Lab No:**	947142	SPv6
Contact:	Natalie Webster	**Date Registered:**	27-Oct-2011	
	C/- Pattle Delamore Partners Ltd	**Date Reported:**	18-Nov-2011	
	PO Box 9528	**Quote No:**	46451	
	Newmarket	**Order No:**		
	AUCKLAND 1149	**Client Reference:**	AO2469100	
		Submitted By:	Chris Foote	

Amended Report

This report replaces an earlier report issued on the 16 Nov 2011 at 2:51 pm
At the client's request, thallium results have been added to samples 947142.8 & 11.

Sample Type: Soil

Sample Name:		MOA 004 0.1 26-Oct-2011	MOA 004 0.5 26-Oct-2011	MOA 004 1.0 26-Oct-2011	MOA 009 0.1 26-Oct-2011	MOA 009 0.5 26-Oct-2011
Lab Number:		947142.1	947142.2	947142.3	947142.4	947142.5
Individual Tests						
Dry Matter	g/100g as rcvd	-	88	86	-	-
Total Recoverable Antimony	mg/kg dry wt	2.7	15.6	20	1.4	2.5
Total Recoverable Arsenic	mg/kg dry wt	45	17	40	21	37
Total Recoverable Cadmium	mg/kg dry wt	0.26	< 0.10	0.38	0.18	0.15
Total Recoverable Chromium	mg/kg dry wt	21	6	11	13	20
Total Recoverable Copper	mg/kg dry wt	40	9	52	26	25
Total Recoverable Lead	mg/kg dry wt	99	23	64	41	21
Total Recoverable Mercury	mg/kg dry wt	1.23	0.87	0.49	0.68	1.68
Total Recoverable Zinc	mg/kg dry wt	180	21	185	100	71
Total Petroleum Hydrocarbons in Soil						
C7 - C9	mg/kg dry wt	-	< 8	< 8	-	-
C10 - C14	mg/kg dry wt	-	< 20	< 20	-	-
C15 - C36	mg/kg dry wt	-	< 40	< 40	-	-
Total hydrocarbons (C7 - C36)	mg/kg dry wt	-	< 70	< 70	-	-

Sample Name:		MOA 010 0.1 26-Oct-2011	MOA 010 0.5 26-Oct-2011	MOA 010 1.0 26-Oct-2011	MOA 015 0.1 26-Oct-2011	MOA 015 0.5 26-Oct-2011
Lab Number:		947142.7	947142.8	947142.9	947142.11	947142.12
Individual Tests						
Total Recoverable Antimony	mg/kg dry wt	1.7	1.8	2.4	27	-
Total Recoverable Arsenic	mg/kg dry wt	62	42	93	350	-
Total Recoverable Cadmium	mg/kg dry wt	0.40	< 0.10	< 0.10	0.20	-
Total Recoverable Chromium	mg/kg dry wt	14	6	15	8	-
Total Recoverable Copper	mg/kg dry wt	55	59	32	43	-
Total Recoverable Lead	mg/kg dry wt	66	7.6	8.8	106	-
Total Recoverable Mercury	mg/kg dry wt	0.70	0.90	0.99	27	-
Total Recoverable Thallium	mg/kg dry wt	-	1.5	-	2.7	-
Total Recoverable Zinc	mg/kg dry wt	146	16	19	101	-
Metals extensive suite, screen level (33 metals)						
Total Recoverable Aluminium	mg/kg dry wt	-	-	-	-	5,900
Total Recoverable Antimony	mg/kg dry wt	-	-	-	-	37
Total Recoverable Arsenic	mg/kg dry wt	-	-	-	-	680
Total Recoverable Barium	mg/kg dry wt	-	-	-	-	240
Total Recoverable Bismuth	mg/kg dry wt	-	-	-	-	< 0.4
Total Recoverable Boron	mg/kg dry wt	-	-	-	-	< 20
Total Recoverable Cadmium	mg/kg dry wt	-	-	-	-	0.25

Sample Type: Soil						
	Sample Name:	MOA 010 0.1 26-Oct-2011	MOA 010 0.5 26-Oct-2011	MOA 010 1.0 26-Oct-2011	MOA 015 0.1 26-Oct-2011	MOA 015 0.5 26-Oct-2011
	Lab Number:	947142.7	947142.8	947142.9	947142.11	947142.12
Metals extensive suite, screen level (33 metals)						
Total Recoverable Caesium	mg/kg dry wt	-	-	-	-	3.1
Total Recoverable Calcium	mg/kg dry wt	-	-	-	-	2,200
Total Recoverable Chromium	mg/kg dry wt	-	-	-	-	13
Total Recoverable Cobalt	mg/kg dry wt	-	-	-	-	5.4
Total Recoverable Copper	mg/kg dry wt	-	-	-	-	147
Total Recoverable Iron	mg/kg dry wt	-	-	-	-	52,000
Total Recoverable Lanthanum	mg/kg dry wt	-	-	-	-	6.9
Total Recoverable Lead	mg/kg dry wt	-	-	-	-	156
Total Recoverable Lithium	mg/kg dry wt	-	-	-	-	3.8
Total Recoverable Magnesium	mg/kg dry wt	-	-	-	-	650
Total Recoverable Manganese	mg/kg dry wt	-	-	-	-	155
Total Recoverable Mercury	mg/kg dry wt	-	-	-	-	43
Total Recoverable Molybdenum	mg/kg dry wt	-	-	-	-	5.2
Total Recoverable Nickel	mg/kg dry wt	-	-	-	-	6
Total Recoverable Phosphorus	mg/kg dry wt	-	-	-	-	350
Total Recoverable Potassium*	mg/kg dry wt	-	-	-	-	560
Total Recoverable Rubidium	mg/kg dry wt	-	-	-	-	5.2
Total Recoverable Selenium	mg/kg dry wt	-	-	-	-	< 20
Total Recoverable Sodium	mg/kg dry wt	-	-	-	-	193
Total Recoverable Strontium	mg/kg dry wt	-	-	-	-	41
Total Recoverable Thallium	mg/kg dry wt	-	-	-	-	7.5
Total Recoverable Tin	mg/kg dry wt	-	-	-	-	46
Total Recoverable Uranium	mg/kg dry wt	-	-	-	-	0.24
Total Recoverable Vanadium	mg/kg dry wt	-	-	-	-	< 100
Total Recoverable Zinc	mg/kg dry wt	-	-	-	-	220

	Sample Name:	MOA 015 1.0 26-Oct-2011	MOA 015 0.1 (duplicate)			
	Lab Number:	947142.13	947142.17			
Metals extensive suite, screen level (33 metals)						
Total Recoverable Aluminium	mg/kg dry wt	2,600	5,600	-	-	-
Total Recoverable Antimony	mg/kg dry wt	35	29	-	-	-
Total Recoverable Arsenic	mg/kg dry wt	1,020	330	-	-	-
Total Recoverable Barium	mg/kg dry wt	183	260	-	-	-
Total Recoverable Bismuth	mg/kg dry wt	< 0.4	< 0.4	-	-	-
Total Recoverable Boron	mg/kg dry wt	< 20	< 20	-	-	-
Total Recoverable Cadmium	mg/kg dry wt	0.32	0.18	-	-	-
Total Recoverable Caesium	mg/kg dry wt	7.2	2.0	-	-	-
Total Recoverable Calcium	mg/kg dry wt	970	2,800	-	-	-
Total Recoverable Chromium	mg/kg dry wt	6	10	-	-	-
Total Recoverable Cobalt	mg/kg dry wt	5.0	4.3	-	-	-
Total Recoverable Copper	mg/kg dry wt	97	49	-	-	-
Total Recoverable Iron	mg/kg dry wt	59,000	31,000	-	-	-
Total Recoverable Lanthanum	mg/kg dry wt	2.6	4.5	-	-	-
Total Recoverable Lead	mg/kg dry wt	123	112	-	-	-
Total Recoverable Lithium	mg/kg dry wt	0.6	3.5	-	-	-
Total Recoverable Magnesium	mg/kg dry wt	158	1,070	-	-	-
Total Recoverable Manganese	mg/kg dry wt	44	195	-	-	-
Total Recoverable Mercury	mg/kg dry wt	78	26	-	-	-
Total Recoverable Molybdenum	mg/kg dry wt	12.6	4.6	-	-	-
Total Recoverable Nickel	mg/kg dry wt	4	3	-	-	-
Total Recoverable Phosphorus	mg/kg dry wt	410	380	-	-	-
Total Recoverable Potassium*	mg/kg dry wt	690	570	-	-	-
Total Recoverable Rubidium	mg/kg dry wt	6.5	5.8	-	-	-
Total Recoverable Selenium	mg/kg dry wt	< 20	< 20	-	-	-
Total Recoverable Sodium	mg/kg dry wt	42	150	-	-	-

Sample Type: Soil						
Sample Name:		MOA 015 1.0 26-Oct-2011	MOA 015 0.1 (duplicate)			
Lab Number:		947142.13	947142.17			
Metals extensive suite, screen level (33 metals)						
Total Recoverable Strontium	mg/kg dry wt	12.6	23	-	-	-
Total Recoverable Thallium	mg/kg dry wt	5.4	2.5	-	-	-
Total Recoverable Tin	mg/kg dry wt	3.4	4.4	-	-	-
Total Recoverable Uranium	mg/kg dry wt	< 0.10	0.15	-	-	-
Total Recoverable Vanadium	mg/kg dry wt	< 100	< 100	-	-	-
Total Recoverable Zinc	mg/kg dry wt	132	111	-	-	-

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: Soil			
Test	**Method Description**	**Default Detection Limit**	**Samples**
Environmental Solids Sample Preparation	Air dried at 35°C and sieved, <2mm fraction. Used for sample preparation. May contain a residual moisture content of 2-5%.	-	1-5, 7-9, 11-13, 17
Metals extensive suite, screen level (33 metals)*	Dried sample, <2mm fraction. Nitric/Hydrochloric acid digestion, ICP-MS, screen level.	-	12-13, 17
Total Petroleum Hydrocarbons in Soil	Sonication extraction in DCM, Silica cleanup, GC-FID analysis US EPA 8015B/MfE Petroleum Industry Guidelines. Tested on as received sample	-	2-3
Dry Matter (Env)	Dried at 103°C for 4-22hr (removes 3-5% more water than air dry) , gravimetry. US EPA 3550.	0.10 g/100g as rcvd	2-3
Total Recoverable digestion	Nitric / hydrochloric acid digestion. US EPA 200.2.	-	1-5, 7-9, 11-13, 17
Total Recoverable Antimony	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.4 mg/kg dry wt	1-5, 7-9, 11
Total Recoverable Arsenic	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	2 mg/kg dry wt	1-5, 7-9, 11
Total Recoverable Cadmium	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.10 mg/kg dry wt	1-5, 7-9, 11
Total Recoverable Chromium	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	2 mg/kg dry wt	1-5, 7-9, 11
Total Recoverable Copper	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	2 mg/kg dry wt	1-5, 7-9, 11
Total Recoverable Lead	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.4 mg/kg dry wt	1-5, 7-9, 11
Total Recoverable Mercury	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.10 mg/kg dry wt	1-5, 7-9, 11
Total Recoverable Thallium	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.2 mg/kg dry wt	8, 11
Total Recoverable Zinc	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	4 mg/kg dry wt	1-5, 7-9, 11

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.

Ara Heron BSc (Tech)
Client Services Manager - Environmental Division

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ATTLE DELAMORE PARTNERS LTD

Time Received 27-Oct-2011 2:15:21 pm

Requ Job No. 947142

No. of Samples 16 No. of Fractions 29

NOTE: ... of these samp... form and emailing ...

From: Pattle Delamore Partners Ltd

Address (Refer to base of sheet): ☑ PDP Auckland ☐ PDP

Submitted by: Chris Foote Ph No.:

: Hills Labs

ote No.: 46451

JP Job No.: A02469100

Chain of Custody Record

Sent:
Name: Chris Foote
Signature: CF
Date and time: 27/10/11

Received: ☐ Room temp. ☑ Chilled Temp.: 11.7°C
Name: Emily A.
Signature:
Date and time: OCT 27 PM1:09

Notes:
2x Extra sample received (not in CoC)
MOA011 0.1 & MOA011 0.5

Results by: ☑ Email submitter: Chris.Foote @pdp.co.nz ☑ Mail (address below)
☑ Email other: Natalie.Webster @pdp.co.nz ☐ Fax (number below)

Priority: ☐ Normal ☐ High ☐ Urgent
Results required by: ___/___/___

Invoice to: ☐ PDP ☐ Other:

Sample ID	Sample type	No. bottles	Analyses requested	Notes
~~MOA 0.1~~				
~~MOA~~				
MOA004 0.1	S	2	HOLD COLD	
MOA004 0.5	S	2	"	
MOA004 1.0	S	2	"	
MOA009 0.1	S	2	"	
MOA009 0.5	S	2	"	
MOA009 1.0	S	2	"	
MOA010 0.1	S	2	"	
MOA010 0.5	S	2	"	
MOA010 1.0	S	2	"	
MOA010 1.5	S	2	"	
MOA015 0.1	S	2	"	
MOA015 0.5	S	2	"	
MOA015 1.0	S	2	"	
MOA015 1.5	S	1	"	

Sample type: S Soil GW Groundwater SAL Seawater/saline FW Freshwater LEACH Leachate GEO Geothermal
SED Sediment BIO Biota TW Tradewaste WW Wastewater P Potable Other:

Note: Samples may contain dangerous or hazardous substances

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PDP House, 235 Broadway, Newmarket, Auckland
PO Box 9528, Newmarket, Auckland 1149

PDP Wellington
iSOFT House, Level 1, 111 Customhouse Quay, Wellington
PO Box 6136, Wellington 6141

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ANALYSIS REPORT

Client:	Pattle Delamore Partners Ltd	**Lab No:**	947878	SUPv1
Contact:	Natalie Webster	**Date Registered:**	29-Oct-2011	
	C/- Pattle Delamore Partners Ltd	**Date Reported:**	17-Nov-2011	
	PO Box 9528	**Quote No:**	46451	
	Newmarket	**Order No:**		
	AUCKLAND 1149	**Client Reference:**	AO2469100	
		Submitted By:	Chris Foote	

Sample Type: Soil

		Sample Name:	MOA027 0.1 28-Oct-2011	MOA027 0.5 28-Oct-2011	MOA028 0.1 28-Oct-2011	MOA028 0.5 28-Oct-2011
		Lab Number:	947878.1	947878.2	947878.4	947878.5
Total Recoverable Antimony	mg/kg dry wt		2.52 ± 0.53	2.75 ± 0.56	1.22 ± 0.34	1.29 ± 0.35
Total Recoverable Arsenic	mg/kg dry wt		39.8 ± 4.2	88.3 ± 9.0	24.0 ± 2.8	53.1 ± 5.5
Total Recoverable Cadmium	mg/kg dry wt		0.52 ± 0.12	0.303 ± 0.085	0.240 ± 0.078	0.141 ± 0.070
Total Recoverable Chromium	mg/kg dry wt		19.1 ± 2.4	15.7 ± 2.1	15.4 ± 2.1	11.3 ± 1.8
Total Recoverable Copper	mg/kg dry wt		46.6 ± 6.7	54.7 ± 7.8	33.3 ± 4.9	40.0 ± 5.8
Total Recoverable Lead	mg/kg dry wt		113 ± 16	202 ± 29	45.9 ± 6.5	46.0 ± 6.5
Total Recoverable Mercury	mg/kg dry wt		0.434 ± 0.084	1.56 ± 0.20	0.456 ± 0.086	0.82 ± 0.12
Total Recoverable Zinc	mg/kg dry wt		606 ± 61	154 ± 16	98 ± 11	56.5 ± 6.3

		Sample Name:	MOA028 1.0 28-Oct-2011			
		Lab Number:	947878.6			
Total Recoverable Antimony	mg/kg dry wt		1.26 ± 0.35	-	-	-
Total Recoverable Arsenic	mg/kg dry wt		25.4 ± 2.9	-	-	-
Total Recoverable Cadmium	mg/kg dry wt		0.272 ± 0.081	-	-	-
Total Recoverable Chromium	mg/kg dry wt		17.1 ± 2.2	-	-	-
Total Recoverable Copper	mg/kg dry wt		32.5 ± 4.8	-	-	-
Total Recoverable Lead	mg/kg dry wt		45.2 ± 6.4	-	-	-
Total Recoverable Mercury	mg/kg dry wt		0.460 ± 0.086	-	-	-
Total Recoverable Zinc	mg/kg dry wt		108 ± 12	-	-	-

The reported uncertainty is an expanded uncertainty with a level of confidence of approximately 95 percent (i.e. two standard deviations, calculated using a coverage factor of 2). Reported uncertainties are calculated from the performance of typical matrices, and do not include variation due to sampling.

For further information on uncertainty of measurement at Hill Laboratories, refer to the technical note on our website: www.hill-laboratories.com/files/Intro_To_UOM.pdf, or contact the laboratory.

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: Soil

Test	Method Description	Default Detection Limit	Samples
Environmental Solids Sample Preparation	Air dried at 35°C and sieved, <2mm fraction. Used for sample preparation. May contain a residual moisture content of 2-5%.	-	1-2, 4-6
Total Recoverable digestion	Nitric / hydrochloric acid digestion. US EPA 200.2.	-	1-2, 4-6
Total Recoverable Antimony	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.4 mg/kg dry wt	1-2, 4-6

Sample Type: Soil			
Test	**Method Description**	**Default Detection Limit**	**Samples**
Total Recoverable Arsenic	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	2 mg/kg dry wt	1-2, 4-6
Total Recoverable Cadmium	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.10 mg/kg dry wt	1-2, 4-6
Total Recoverable Chromium	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	2 mg/kg dry wt	1-2, 4-6
Total Recoverable Copper	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	2 mg/kg dry wt	1-2, 4-6
Total Recoverable Lead	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.4 mg/kg dry wt	1-2, 4-6
Total Recoverable Mercury	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.10 mg/kg dry wt	1-2, 4-6
Total Recoverable Zinc	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	4 mg/kg dry wt	1-2, 4-6

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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Client Services Manager - Environmental Division

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Web www.hill-labs.co.nz

ANALYSIS REPORT

Client:	Pattle Delamore Partners Ltd	**Lab No:**	947878	SPv3
Contact:	Natalie Webster	**Date Registered:**	29-Oct-2011	
	C/- Pattle Delamore Partners Ltd	**Date Reported:**	15-Nov-2011	
	PO Box 9528	**Quote No:**	46451	
	Newmarket	**Order No:**		
	AUCKLAND 1149	**Client Reference:**	AO2469100	
		Submitted By:	Chris Foote	

Amended Report

This report replaces an earlier report issued on the 08 Nov 2011 at 3:55 pm
At the client's request, metal analyses have been added to sample MOA028 0.1.

Sample Type: Soil

	Sample Name:	MOA027 0.1 28-Oct-2011	MOA027 0.5 28-Oct-2011	MOA028 0.1 28-Oct-2011	MOA028 0.5 28-Oct-2011	MOA028 1.0 28-Oct-2011
	Lab Number:	947878.1	947878.2	947878.4	947878.5	947878.6
Total Recoverable Antimony	mg/kg dry wt	2.5	2.7	1.2	1.3	1.3
Total Recoverable Arsenic	mg/kg dry wt	40	88	24	53	25
Total Recoverable Cadmium	mg/kg dry wt	0.52	0.30	0.24	0.14	0.27
Total Recoverable Chromium	mg/kg dry wt	19	16	15	11	17
Total Recoverable Copper	mg/kg dry wt	47	55	33	40	32
Total Recoverable Lead	mg/kg dry wt	113	200	46	46	45
Total Recoverable Mercury	mg/kg dry wt	0.43	1.56	0.46	0.82	0.46
Total Recoverable Zinc	mg/kg dry wt	610	154	98	56	108

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: Soil

Test	Method Description	Default Detection Limit	Samples
Environmental Solids Sample Preparation	Air dried at 35°C and sieved, <2mm fraction. Used for sample preparation. May contain a residual moisture content of 2-5%.	-	1-2, 4-6
Total Recoverable digestion	Nitric / hydrochloric acid digestion. US EPA 200.2.	-	1-2, 4-6
Total Recoverable Antimony	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.4 mg/kg dry wt	1-2, 4-6
Total Recoverable Arsenic	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	2 mg/kg dry wt	1-2, 4-6
Total Recoverable Cadmium	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.10 mg/kg dry wt	1-2, 4-6
Total Recoverable Chromium	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	2 mg/kg dry wt	1-2, 4-6
Total Recoverable Copper	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	2 mg/kg dry wt	1-2, 4-6
Total Recoverable Lead	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.4 mg/kg dry wt	1-2, 4-6
Total Recoverable Mercury	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.10 mg/kg dry wt	1-2, 4-6
Total Recoverable Zinc	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	4 mg/kg dry wt	1-2, 4-6

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PATTLE DELAMORE PARTNERS LTD

Request for Analyses

NOTE: Please acknowledge receipt of these samples by signing this form and emailing to submitter.

From: Pattle Delamore Partners Ltd

Address (Refer to base of sheet): ☑ PDP Auckland ☐ PDP Wellington ☐ PDP Christchurch

Submitted by: Chris Fook Ph No.: 5236900

To: HRLS Lab

Quote No.: 4645/

PDP Job No.: A024691 00

Time Received 29-Oct-2011 8:57:50 am

Job No **947878**

No of Samples 6 No of Fractions 10

0319478786

29 AM 7:58

Chain of Custody Record

Sent:

Name: Chris Fook

Signature: CFook

Date and time: 28/10/11 3pm

Received: ☐ Room temp. ☐ Chilled Temp.

Name: Jess

Signature:

Date and time:

Results by: ☑ Email submitter: Chris.Fook @pdp.co.nz ☑ Mail (address below)

☐ Email other: Natalie Webster @pdp.co.nz ☐ Fax (number below)

Priority: ☐ Normal ☑ High ☐ Urgent

Results required by: ___ / ___ / ___

Invoice to: ☐ PDP ☐ Other:

Sample ID	Sample type	No. bottles	Analyses requested	Notes
MOA027 0·1	S	2	HOLD COLD	
MOA0270·5	S	2	" "	
MOA0271·0	S	2	" "	
MOA0280·1	S	2	" "	
MOA0280·5	S	1	" "	
MOA0281·0	S	1	" "	

Temperature On Arrival

12.3 °C

Temperature was measured on one or more arbitrarily chosen samples in this batch.

Sample type: S Soil GW Groundwater SAL Seawater/saline FW Freshwater LEACH Leachate GEO Geothermal

SED Sediment BIO Biota TW Tradewaste WW Wastewater P Potable Other:

Note: Samples may contain dangerous or hazardous substances

PDP Auckland
PDP House, 235 Broadway, Newmarket, Auckland
PO Box 9528, Newmarket, Auckland 1149

PDP Wellington
ISOFT House, Level 1, 111 Customhouse Quay, Wellington
PO Box 6136, Wellington 6141

PDP Christchurch
Radio NZ House, 51 Chester St West, Christchurch
PO Box 389, Christchurch 8140

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Hamilton 3240, New Zealand

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Fax +64 7 858 2001
Email mail@hill-labs.co.nz
Web www.hill-labs.co.nz

ANALYSIS REPORT

Client:	Pattle Delamore Partners Ltd	**Lab No:**	947915	SUPv2
Contact:	Natalie Webster	**Date Registered:**	29-Oct-2011	
	C/- Pattle Delamore Partners Ltd	**Date Reported:**	18-Nov-2011	
	PO Box 9528	**Quote No:**	46451	
	Newmarket	**Order No:**		
	AUCKLAND 1149	**Client Reference:**	AO2469100	
		Submitted By:	Chris Foote	

Amended Report

This report replaces an earlier report issued on the 17 Nov 2011 at 10:31 am
At the client's request, thallium results have been added to samples 947915.3, 6, 9 & 14.

Sample Type: Soil

	Sample Name:	MOA 013 0.1 27-Oct-2011	MOA 013 0.5 27-Oct-2011	MOA 013 1.0 27-Oct-2011	MOA 023 0.1 27-Oct-2011
	Lab Number:	947915.1	947915.2	947915.3	947915.5
Total Recoverable Antimony	mg/kg dry wt	5.21 ± 0.98	4.44 ± 0.84	9.0 ± 1.7	9.7 ± 1.8
Total Recoverable Arsenic	mg/kg dry wt	57.5 ± 5.9	118 ± 12	230 ± 23	119 ± 12
Total Recoverable Cadmium	mg/kg dry wt	< 0.10 ± 0.067	0.129 ± 0.069	0.255 ± 0.079	0.400 ± 0.097
Total Recoverable Chromium	mg/kg dry wt	10.4 ± 1.7	9.9 ± 1.7	14.4 ± 2.0	11.7 ± 1.8
Total Recoverable Copper	mg/kg dry wt	25.9 ± 3.9	39.8 ± 5.8	202 ± 29	46.9 ± 6.7
Total Recoverable Lead	mg/kg dry wt	36.7 ± 5.2	40.5 ± 5.7	182 ± 26	166 ± 24
Total Recoverable Mercury	mg/kg dry wt	1.11 ± 0.15	2.33 ± 0.29	4.98 ± 0.61	1.31 ± 0.18
Total Recoverable Thallium	mg/kg dry wt	-	-	1.07 ± 0.19	-
Total Recoverable Zinc	mg/kg dry wt	63.7 ± 6.9	68.3 ± 7.4	130 ± 14	241 ± 25

	Sample Name:	MOA 023 0.5 27-Oct-2011	MOA 025 0.1 27-Oct-2011	MOA 025 0.5 27-Oct-2011	MOA 008 0.1 28-Oct-2011
	Lab Number:	947915.6	947915.9	947915.10	947915.13
Total Recoverable Antimony	mg/kg dry wt	10.3 ± 1.9	10.7 ± 2.0	2.62 ± 0.54	5.24 ± 0.98
Total Recoverable Arsenic	mg/kg dry wt	414 ± 42	132 ± 14	114 ± 12	51.5 ± 5.4
Total Recoverable Cadmium	mg/kg dry wt	0.238 ± 0.078	< 0.10 ± 0.067	< 0.10 ± 0.067	0.138 ± 0.069
Total Recoverable Chromium	mg/kg dry wt	10.3 ± 1.7	8.9 ± 1.6	7.7 ± 1.6	11.0 ± 1.8
Total Recoverable Copper	mg/kg dry wt	56.4 ± 8.0	36.4 ± 5.3	34.0 ± 5.0	21.0 ± 3.3
Total Recoverable Lead	mg/kg dry wt	113 ± 16	103 ± 15	40.1 ± 5.7	32.3 ± 4.6
Total Recoverable Mercury	mg/kg dry wt	13.9 ± 1.7	3.05 ± 0.38	1.92 ± 0.24	0.481 ± 0.088
Total Recoverable Thallium	mg/kg dry wt	2.24 ± 0.30	1.17 ± 0.20	-	-
Total Recoverable Zinc	mg/kg dry wt	160 ± 17	60.9 ± 6.7	25.1 ± 3.7	79.5 ± 8.4

	Sample Name:	MOA 008 0.5 28-Oct-2011			
	Lab Number:	947915.14			
Total Recoverable Antimony	mg/kg dry wt	8.5 ± 1.6	-	-	-
Total Recoverable Arsenic	mg/kg dry wt	156 ± 16	-	-	-
Total Recoverable Cadmium	mg/kg dry wt	< 0.10 ± 0.067	-	-	-
Total Recoverable Chromium	mg/kg dry wt	6.8 ± 1.5	-	-	-
Total Recoverable Copper	mg/kg dry wt	33.9 ± 5.0	-	-	-
Total Recoverable Lead	mg/kg dry wt	23.8 ± 3.4	-	-	-
Total Recoverable Mercury	mg/kg dry wt	1.37 ± 0.18	-	-	-
Total Recoverable Thallium	mg/kg dry wt	1.12 ± 0.19	-	-	-
Total Recoverable Zinc	mg/kg dry wt	84.7 ± 8.9	-	-	-

The reported uncertainty is an expanded uncertainty with a level of confidence of approximately 95 percent (i.e. two standard deviations, calculated using a coverage factor of 2). Reported uncertainties are calculated from the performance of typical matrices, and do not include variation due to sampling.

For further information on uncertainty of measurement at Hill Laboratories, refer to the technical note on our website: www.hill-laboratories.com/files/Intro_To_UOM.pdf, or contact the laboratory.

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: Soil			
Test	**Method Description**	**Default Detection Limit**	**Samples**
Environmental Solids Sample Preparation	Air dried at 35°C and sieved, <2mm fraction. Used for sample preparation. May contain a residual moisture content of 2-5%.	-	1-3, 5-6, 9-10, 13-14
Total Recoverable digestion	Nitric / hydrochloric acid digestion. US EPA 200.2.	-	1-3, 5-6, 9-10, 13-14
Total Recoverable Antimony	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.4 mg/kg dry wt	1-3, 5-6, 9-10, 13-14
Total Recoverable Arsenic	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	2 mg/kg dry wt	1-3, 5-6, 9-10, 13-14
Total Recoverable Cadmium	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.10 mg/kg dry wt	1-3, 5-6, 9-10, 13-14
Total Recoverable Chromium	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	2 mg/kg dry wt	1-3, 5-6, 9-10, 13-14
Total Recoverable Copper	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	2 mg/kg dry wt	1-3, 5-6, 9-10, 13-14
Total Recoverable Lead	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.4 mg/kg dry wt	1-3, 5-6, 9-10, 13-14
Total Recoverable Mercury	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.10 mg/kg dry wt	1-3, 5-6, 9-10, 13-14
Total Recoverable Thallium	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.2 mg/kg dry wt	3, 6, 9, 14
Total Recoverable Zinc	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	4 mg/kg dry wt	1-3, 5-6, 9-10, 13-14

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.

Ara Heron BSc (Tech)
Client Services Manager - Environmental Division

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ANALYSIS REPORT

Client:	Pattle Delamore Partners Ltd	**Lab No:**	947915	SPv3
Contact:	Natalie Webster	**Date Registered:**	29-Oct-2011	
	C/- Pattle Delamore Partners Ltd	**Date Reported:**	18-Nov-2011	
	PO Box 9528	**Quote No:**	46451	
	Newmarket	**Order No:**		
	AUCKLAND 1149	**Client Reference:**	AO2469100	
		Submitted By:	Chris Foote	

Amended Report

This report replaces an earlier report issued on the 08 Nov 2011 at 11:39 am
At the client's request, thallium results have been added to samples 947915.3, 6, 9 & 14.

Sample Type: Soil

	Sample Name:	MOA 013 0.1 27-Oct-2011	MOA 013 0.5 27-Oct-2011	MOA 013 1.0 27-Oct-2011	MOA 023 0.1 27-Oct-2011	MOA 023 0.5 27-Oct-2011
	Lab Number:	947915.1	947915.2	947915.3	947915.5	947915.6
Total Recoverable Antimony	mg/kg dry wt	5.2	4.4	9.0	9.7	10.3
Total Recoverable Arsenic	mg/kg dry wt	57	118	230	119	410
Total Recoverable Cadmium	mg/kg dry wt	< 0.10	0.13	0.25	0.40	0.24
Total Recoverable Chromium	mg/kg dry wt	10	10	14	12	10
Total Recoverable Copper	mg/kg dry wt	26	40	200	47	56
Total Recoverable Lead	mg/kg dry wt	37	40	182	166	113
Total Recoverable Mercury	mg/kg dry wt	1.11	2.3	5.0	1.31	13.9
Total Recoverable Thallium	mg/kg dry wt	-	-	1.1	-	2.2
Total Recoverable Zinc	mg/kg dry wt	64	68	130	240	160

	Sample Name:	MOA 025 0.1 27-Oct-2011	MOA 025 0.5 27-Oct-2011	MOA 008 0.1 28-Oct-2011	MOA 008 0.5 28-Oct-2011	
	Lab Number:	947915.9	947915.10	947915.13	947915.14	
Total Recoverable Antimony	mg/kg dry wt	10.7	2.6	5.2	8.5	-
Total Recoverable Arsenic	mg/kg dry wt	132	114	51	156	-
Total Recoverable Cadmium	mg/kg dry wt	< 0.10	< 0.10	0.14	< 0.10	-
Total Recoverable Chromium	mg/kg dry wt	9	8	11	7	-
Total Recoverable Copper	mg/kg dry wt	36	34	21	34	-
Total Recoverable Lead	mg/kg dry wt	103	40	32	24	-
Total Recoverable Mercury	mg/kg dry wt	3.1	1.92	0.48	1.37	-
Total Recoverable Thallium	mg/kg dry wt	1.2	-	-	1.1	-
Total Recoverable Zinc	mg/kg dry wt	61	25	79	85	-

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: Soil

Test	Method Description	Default Detection Limit	Samples
Environmental Solids Sample Preparation	Air dried at 35°C and sieved, <2mm fraction. Used for sample preparation. May contain a residual moisture content of 2-5%.	-	1-3, 5-6, 9-10, 13-14
Total Recoverable digestion	Nitric / hydrochloric acid digestion. US EPA 200.2.	-	1-3, 5-6, 9-10, 13-14
Total Recoverable Antimony	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.4 mg/kg dry wt	1-3, 5-6, 9-10, 13-14
Total Recoverable Arsenic	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	2 mg/kg dry wt	1-3, 5-6, 9-10, 13-14

Sample Type: Soil			
Test	**Method Description**	**Default Detection Limit**	**Samples**
Total Recoverable Cadmium	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.10 mg/kg dry wt	1-3, 5-6, 9-10, 13-14
Total Recoverable Chromium	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	2 mg/kg dry wt	1-3, 5-6, 9-10, 13-14
Total Recoverable Copper	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	2 mg/kg dry wt	1-3, 5-6, 9-10, 13-14
Total Recoverable Lead	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.4 mg/kg dry wt	1-3, 5-6, 9-10, 13-14
Total Recoverable Mercury	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.10 mg/kg dry wt	1-3, 5-6, 9-10, 13-14
Total Recoverable Thallium	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.2 mg/kg dry wt	3, 6, 9, 14
Total Recoverable Zinc	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	4 mg/kg dry wt	1-3, 5-6, 9-10, 13-14

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.

Ara Heron BSc (Tech)
Client Services Manager - Environmental Division

PATTLE DELAMORE PARTNERS LTD

Request for Analyses

NOTE: Please acknowledge receipt of these samples by signing this form and emailing to submitter.

From: Pattle Delamore Partners Ltd
Address (Refer to base of sheet): ☑ PDP Auckland ☐ PDP Wellington ☐ PDP Christchurch
Submitted by: Chris Foote Ph No.:

To: Hills Lab
Quote No.: 46451
PDP Job No.: 4026469.100

Chain of Custody Record

Time Received 28-Oct-2011 9:26 am
Job No **947915**
No of Samples **16** No of Fractions **0**

Sent:
Name: Chris Foote
Signature: CFoote
Date and time: 28/10/11 3.30pm

Received: ☐ Room temp. ☐ Chilled Temp.: 13.1 °C
Name: Rose Ryan
Signature: RyR
Date and time: OCT 29 AM8:02

Notes:

Results by: ☑ Email submitter: Chris.Foote @pdp.co.nz ☑ Mail (address below)
☐ Email other: Natalie.Webster @pdp.co.nz ☐ Fax (number below)

Priority: ☐ Normal ☐ High ☐ Urgent
Results required by: ___ / ___ / ___

Invoice to: ☐ PDP ☐ Other:

Sample ID	Sample type	No. bottles	Analyses requested	Notes
MOA013 0.1	S	2	HOLD COLD	
MOA013 0.5	S	2	"	
MOA013 1.0	S	2	"	
MOA013 1.5	S	2	"	
MOA023 0.1	S	2	"	
MOA023 0.5	S	2	"	
MOA023 1.0	S	2	"	
MOA023 1.5	S	2	"	
MOA025 0.1	S	1	"	
MOA025 0.5	S	1	"	
MOA025 1.0	S	1	"	
MOA025 1.5	S	1	"	
MOA008 0.1	S	2	"	
MOA008 0.5	S	2	"	
MOA008 1.0	S	2	"	
MOA008 1.5	S	1	"	

Sample type: S Soil GW Groundwater SAL Seawater/saline FW Freshwater LEACH Leachate GEO Geothermal
SED Sediment BIO Biota TW Tradewaste WW Wastewater P Potable Other:

Note: Samples may contain dangerous or hazardous substances

PDP Auckland
PDP House, 235 Broadway, Newmarket, Auckland
PO Box 9528, Newmarket, Auckland 1149

PDP Wellington
iSOFT House, Level 1, 111 Customhouse Quay, Wellington
PO Box 6136, Wellington 6141

PDP Christchurch
Radio NZ House, 51 Chester St West, Christchurch
PO Box 389, Christchurch 8140

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ANALYSIS REPORT

Client:	Pattle Delamore Partners Ltd	**Lab No:**	947769	SUPv2
Contact:	Natalie Webster	**Date Registered:**	28-Oct-2011	
	C/- Pattle Delamore Partners Ltd	**Date Reported:**	18-Nov-2011	
	PO Box 9528	**Quote No:**	46451	
	Newmarket	**Order No:**		
	AUCKLAND 1149	**Client Reference:**	AO2469100	
		Submitted By:	Chris Foote	

Amended Report

This report replaces an earlier report issued on the 17 Nov 2011 at 10:30 am
At the client's request, thallium results have been added to samples 947769.5, 11, 12, 13, 14, 15, 18, 20 & 23.

Sample Type: Soil

		Sample Name:	MOA014 0.1	MOA014 0.5	MOA014 1.0	MOA016 0.1
		Lab Number:	947769.1	947769.2	947769.3	947769.5
Individual Tests						
Dry Matter	g/100g as rcvd		71	79	74	76
Total Recoverable Antimony	mg/kg dry wt		3.99 ± 0.77	2.57 ± 0.53	2.30 ± 0.49	4.59 ± 0.87
Total Recoverable Arsenic	mg/kg dry wt		88.2 ± 9.0	101 ± 11	111 ± 12	187 ± 19
Total Recoverable Cadmium	mg/kg dry wt		< 0.10 ± 0.067	0.146 ± 0.070	< 0.10 ± 0.067	0.224 ± 0.076
Total Recoverable Chromium	mg/kg dry wt		8.5 ± 1.6	10.2 ± 1.7	8.5 ± 1.6	13.2 ± 1.9
Total Recoverable Copper	mg/kg dry wt		27.7 ± 4.1	41.7 ± 6.0	38.9 ± 5.7	48.9 ± 7.0
Total Recoverable Lead	mg/kg dry wt		34.6 ± 4.9	51.6 ± 7.3	18.9 ± 2.7	82 ± 12
Total Recoverable Mercury	mg/kg dry wt		1.28 ± 0.17	2.93 ± 0.36	1.98 ± 0.25	3.89 ± 0.48
Total Recoverable Thallium	mg/kg dry wt		-	-	-	1.16 ± 0.20
Total Recoverable Zinc	mg/kg dry wt		67.7 ± 7.3	74.0 ± 7.9	28.2 ± 3.9	148 ± 16
Total Petroleum Hydrocarbons in Soil						
C7 - C9	mg/kg dry wt		< 11 ± 5.6	< 10 ± 5.5	< 10 ± 5.5	< 9 ± 5.4
C10 - C14	mg/kg dry wt		< 30 ± 7.9	< 20 ± 7.7	< 20 ± 7.7	< 20 ± 7.7
C15 - C36	mg/kg dry wt		< 50 ± 9.7	< 40 ± 9.5	43.8 ± 9.8	< 40 ± 9.4
Total hydrocarbons (C7 - C36)	mg/kg dry wt		< 80 ± 14	< 70 ± 14	< 70 ± 14	< 70 ± 14

		Sample Name:	MOA016 0.5	MOA017 0.1	MOA017 0.5	MOA018 0.1
		Lab Number:	947769.6	947769.7	947769.8	947769.11
Individual Tests						
Dry Matter	g/100g as rcvd		83	-	-	-
Total Recoverable Antimony	mg/kg dry wt		0.68 ± 0.29	2.06 ± 0.46	0.90 ± 0.31	12.8 ± 2.4
Total Recoverable Arsenic	mg/kg dry wt		549 ± 55	49.7 ± 5.2	54.7 ± 5.7	248 ± 25
Total Recoverable Cadmium	mg/kg dry wt		< 0.10 ± 0.067	0.302 ± 0.085	0.103 ± 0.067	0.54 ± 0.12
Total Recoverable Chromium	mg/kg dry wt		20.6 ± 2.5	11.7 ± 1.8	12.5 ± 1.9	15.1 ± 2.1
Total Recoverable Copper	mg/kg dry wt		36.1 ± 5.3	31.2 ± 4.6	29.0 ± 4.3	73 ± 11
Total Recoverable Lead	mg/kg dry wt		8.8 ± 1.3	58.2 ± 8.2	71 ± 10	140 ± 20
Total Recoverable Mercury	mg/kg dry wt		1.18 ± 0.16	1.10 ± 0.15	0.600 ± 0.098	10.4 ± 1.3
Total Recoverable Thallium	mg/kg dry wt		-	-	-	1.88 ± 0.27
Total Recoverable Zinc	mg/kg dry wt		44.1 ± 5.2	124 ± 13	189 ± 20	162 ± 17
Total Petroleum Hydrocarbons in Soil						
C7 - C9	mg/kg dry wt		< 8 ± 5.4	-	-	-
C10 - C14	mg/kg dry wt		< 20 ± 7.6	-	-	-
C15 - C36	mg/kg dry wt		< 40 ± 9.3	-	-	-
Total hydrocarbons (C7 - C36)	mg/kg dry wt		< 70 ± 14	-	-	-

Sample Type: Soil						
	Sample Name:	MOA018 0.5	MOA018 1.0	MOA019 0.1	MOA019 0.5
	Lab Number:	947769.12	947769.13	947769.14	947769.15
Individual Tests					
Total Recoverable Antimony	mg/kg dry wt	14.1 ± 2.6	19.0 ± 3.5	7.3 ± 1.4	19.5 ± 3.6
Total Recoverable Arsenic	mg/kg dry wt	562 ± 57	598 ± 60	151 ± 16	464 ± 47
Total Recoverable Cadmium	mg/kg dry wt	0.388 ± 0.095	< 0.10 ± 0.067	0.74 ± 0.15	0.72 ± 0.15
Total Recoverable Chromium	mg/kg dry wt	8.2 ± 1.6	6.9 ± 1.5	15.2 ± 2.1	10.4 ± 1.7
Total Recoverable Copper	mg/kg dry wt	55.7 ± 8.0	33.2 ± 4.9	53.6 ± 7.7	130 ± 19
Total Recoverable Lead	mg/kg dry wt	139 ± 20	123 ± 18	215 ± 31	850 ± 120
Total Recoverable Mercury	mg/kg dry wt	16.7 ± 2.1	28.8 ± 3.5	11.5 ± 1.4	24.1 ± 2.9
Total Recoverable Thallium	mg/kg dry wt	3.24 ± 0.42	6.18 ± 0.76	1.29 ± 0.21	3.89 ± 0.49
Total Recoverable Zinc	mg/kg dry wt	134 ± 14	58.1 ± 6.4	253 ± 26	258 ± 26

	Sample Name:	MOA019 1.0	MOA020 0.1	MOA020 0.5	MOA020 1.0
	Lab Number:	947769.16	947769.18	947769.19	947769.20
Individual Tests					
Total Recoverable Antimony	mg/kg dry wt	-	18.1 ± 3.3	-	7.0 ± 1.3
Total Recoverable Arsenic	mg/kg dry wt	-	315 ± 32	-	549 ± 55
Total Recoverable Cadmium	mg/kg dry wt	-	0.162 ± 0.071	-	0.164 ± 0.071
Total Recoverable Chromium	mg/kg dry wt	-	8.3 ± 1.6	-	11.7 ± 1.8
Total Recoverable Copper	mg/kg dry wt	-	27.5 ± 4.1	-	51.1 ± 7.3
Total Recoverable Lead	mg/kg dry wt	-	117 ± 17	-	42.1 ± 6.0
Total Recoverable Mercury	mg/kg dry wt	-	13.2 ± 1.6	-	8.4 ± 1.1
Total Recoverable Thallium	mg/kg dry wt	-	2.00 ± 0.28	-	1.95 ± 0.27
Total Recoverable Zinc	mg/kg dry wt	-	76.4 ± 8.1	-	155 ± 16
Metals extensive suite, screen level (33 metals)					
Total Recoverable Aluminium	mg/kg dry wt	1,800 ± 220	-	3,290 ± 400	-
Total Recoverable Antimony	mg/kg dry wt	16.6 ± 3.1	-	26.6 ± 4.8	-
Total Recoverable Arsenic	mg/kg dry wt	4,740 ± 480	-	1,450 ± 150	-
Total Recoverable Barium	mg/kg dry wt	157.8 ± 9.5	-	256 ± 16	-
Total Recoverable Bismuth	mg/kg dry wt	< 0.4 ± 0.27	-	3.20 ± 0.52	-
Total Recoverable Boron	mg/kg dry wt	< 20 ± 14	-	< 20 ± 14	-
Total Recoverable Cadmium	mg/kg dry wt	0.306 ± 0.085	-	< 0.10 ± 0.067	-
Total Recoverable Caesium	mg/kg dry wt	3.83 ± 0.41	-	4.42 ± 0.47	-
Total Recoverable Calcium	mg/kg dry wt	1,240 ± 190	-	2,140 ± 310	-
Total Recoverable Chromium	mg/kg dry wt	6.9 ± 1.5	-	6.9 ± 1.5	-
Total Recoverable Cobalt	mg/kg dry wt	0.48 ± 0.27 #1	-	3.34 ± 0.54	-
Total Recoverable Copper	mg/kg dry wt	42.1 ± 6.1	-	30.9 ± 4.6	-
Total Recoverable Iron	mg/kg dry wt	34,600 ± 3,500	-	46,900 ± 4,700	-
Total Recoverable Lanthanum	mg/kg dry wt	6.50 ± 0.54	-	3.34 ± 0.30	-
Total Recoverable Lead	mg/kg dry wt	67.9 ± 9.6	-	250 ± 36	-
Total Recoverable Lithium	mg/kg dry wt	0.41 ± 0.27	-	1.79 ± 0.34	-
Total Recoverable Magnesium	mg/kg dry wt	128 ± 30	-	571 ± 63	-
Total Recoverable Manganese	mg/kg dry wt	22.5 ± 2.4	-	104 ± 11	-
Total Recoverable Mercury	mg/kg dry wt	43.3 ± 5.3	-	28.9 ± 3.5	-
Total Recoverable Molybdenum	mg/kg dry wt	4.91 ± 0.93	-	9.4 ± 1.8	-
Total Recoverable Nickel	mg/kg dry wt	< 2 ± 1.4	-	3.1 ± 1.4	-
Total Recoverable Phosphorus	mg/kg dry wt	153 ± 31	-	412 ± 49	-
Total Recoverable Potassium*	mg/kg dry wt	1,190 ± 180	-	870 ± 140	-
Total Recoverable Rubidium	mg/kg dry wt	5.48 ± 0.61	-	5.86 ± 0.65	-
Total Recoverable Selenium	mg/kg dry wt	< 20 ± 14	-	< 20 ± 14	-
Total Recoverable Sodium	mg/kg dry wt	199 ± 42 #1	-	212 ± 43	-
Total Recoverable Strontium	mg/kg dry wt	13.2 ± 1.5	-	31.3 ± 3.3	-
Total Recoverable Thallium	mg/kg dry wt	4.97 ± 0.62	-	5.00 ± 0.62	-
Total Recoverable Tin	mg/kg dry wt	1.46 ± 0.70	-	9.1 ± 2.0	-
Total Recoverable Uranium	mg/kg dry wt	< 0.10 ± 0.067	-	< 0.10 ± 0.067	-
Total Recoverable Vanadium	mg/kg dry wt	< 100 ± 67	-	< 100 ± 67	-
Total Recoverable Zinc	mg/kg dry wt	83.5 ± 8.8	-	62.4 ± 6.8	-

Sample Type: Soil					
	Sample Name:	MOA024 0.1	MOA024 0.5	MOA024 1.0	MOA016 0.1 (duplicate)
	Lab Number:	947769.21	947769.22	947769.23	947769.25
Individual Tests					
Total Recoverable Antimony	mg/kg dry wt	4.83 ± 0.91	0.51 ± 0.28	22.6 ± 4.1	-
Total Recoverable Arsenic	mg/kg dry wt	45.5 ± 4.8	17.6 ± 2.3	505 ± 51	-
Total Recoverable Cadmium	mg/kg dry wt	0.176 ± 0.072	< 0.10 ± 0.067	0.160 ± 0.071	-
Total Recoverable Chromium	mg/kg dry wt	12.2 ± 1.8	10.1 ± 1.7	6.6 ± 1.5	-
Total Recoverable Copper	mg/kg dry wt	37.4 ± 5.4	43.1 ± 6.2	41.0 ± 5.9	-
Total Recoverable Lead	mg/kg dry wt	129 ± 19	11.6 ± 1.7	157 ± 22	-
Total Recoverable Mercury	mg/kg dry wt	1.98 ± 0.25	0.112 ± 0.067	132 ± 16	-
Total Recoverable Thallium	mg/kg dry wt	-	-	2.85 ± 0.37	-
Total Recoverable Zinc	mg/kg dry wt	102 ± 11	27.4 ± 3.9	57.0 ± 6.3	-
Metals extensive suite, screen level (33 metals)					
Total Recoverable Aluminium	mg/kg dry wt	-	-	-	12,300 ± 1,500
Total Recoverable Antimony	mg/kg dry wt	-	-	-	5.20 ± 0.98
Total Recoverable Arsenic	mg/kg dry wt	-	-	-	191 ± 20
Total Recoverable Barium	mg/kg dry wt	-	-	-	82.4 ± 5.0
Total Recoverable Bismuth	mg/kg dry wt	-	-	-	< 0.4 ± 0.27
Total Recoverable Boron	mg/kg dry wt	-	-	-	< 20 ± 14
Total Recoverable Cadmium	mg/kg dry wt	-	-	-	0.305 ± 0.085
Total Recoverable Caesium	mg/kg dry wt	-	-	-	2.27 ± 0.27
Total Recoverable Calcium	mg/kg dry wt	-	-	-	5,700 ± 810
Total Recoverable Chromium	mg/kg dry wt	-	-	-	14.0 ± 2.0
Total Recoverable Cobalt	mg/kg dry wt	-	-	-	9.6 ± 1.4
Total Recoverable Copper	mg/kg dry wt	-	-	-	51.7 ± 7.4
Total Recoverable Iron	mg/kg dry wt	-	-	-	41,500 ± 4,200
Total Recoverable Lanthanum	mg/kg dry wt	-	-	-	9.09 ± 0.74
Total Recoverable Lead	mg/kg dry wt	-	-	-	78 ± 11
Total Recoverable Lithium	mg/kg dry wt	-	-	-	7.27 ± 0.92
Total Recoverable Magnesium	mg/kg dry wt	-	-	-	1,800 ± 190
Total Recoverable Manganese	mg/kg dry wt	-	-	-	543 ± 55
Total Recoverable Mercury	mg/kg dry wt	-	-	-	3.85 ± 0.47
Total Recoverable Molybdenum	mg/kg dry wt	-	-	-	1.13 ± 0.33
Total Recoverable Nickel	mg/kg dry wt	-	-	-	7.2 ± 1.7
Total Recoverable Phosphorus	mg/kg dry wt	-	-	-	438 ± 52
Total Recoverable Potassium*	mg/kg dry wt	-	-	-	1,140 ± 180
Total Recoverable Rubidium	mg/kg dry wt	-	-	-	8.92 ± 0.93
Total Recoverable Selenium	mg/kg dry wt	-	-	-	< 20 ± 14
Total Recoverable Sodium	mg/kg dry wt	-	-	-	472 ± 80
Total Recoverable Strontium	mg/kg dry wt	-	-	-	37.9 ± 3.9
Total Recoverable Thallium	mg/kg dry wt	-	-	-	1.11 ± 0.19
Total Recoverable Tin	mg/kg dry wt	-	-	-	1.18 ± 0.68
Total Recoverable Uranium	mg/kg dry wt	-	-	-	0.292 ± 0.069
Total Recoverable Vanadium	mg/kg dry wt	-	-	-	< 100 ± 67
Total Recoverable Zinc	mg/kg dry wt	-	-	-	168 ± 18

	Sample Name:	MOA018 0.1 (duplicate)	MOA020 0.1 (duplicate)	MOA019 0.1 (duplicate)	
	Lab Number:	947769.26	947769.27	947769.28	
Metals extensive suite, screen level (33 metals)					
Total Recoverable Aluminium	mg/kg dry wt	16,300 ± 2,000	6,710 ± 810	13,600 ± 1,700	-
Total Recoverable Antimony	mg/kg dry wt	14.4 ± 2.7	23.1 ± 4.2	10.9 ± 2.0	-
Total Recoverable Arsenic	mg/kg dry wt	222 ± 23	375 ± 38	226 ± 23	-
Total Recoverable Barium	mg/kg dry wt	222 ± 14	149.2 ± 9.0	191 ± 12	-
Total Recoverable Bismuth	mg/kg dry wt	< 0.4 ± 0.27	0.99 ± 0.30	< 0.4 ± 0.27	-
Total Recoverable Boron	mg/kg dry wt	< 20 ± 14	< 20 ± 14	< 20 ± 14	-
Total Recoverable Cadmium	mg/kg dry wt	0.49 ± 0.11	0.204 ± 0.074	0.64 ± 0.14	-
Total Recoverable Caesium	mg/kg dry wt	1.87 ± 0.23	3.03 ± 0.34	1.61 ± 0.21	-

Sample Type: Soil					
Sample Name:		MOA018 0.1 (duplicate)	MOA020 0.1 (duplicate)	MOA019 0.1 (duplicate)	
Lab Number:		947769.26	947769.27	947769.28	
Metals extensive suite, screen level (33 metals)					
Total Recoverable Calcium	mg/kg dry wt	4,340 ± 620	2,660 ± 380	6,000 ± 850	-
Total Recoverable Chromium	mg/kg dry wt	14.3 ± 2.0	11.6 ± 1.8	12.5 ± 1.9	-
Total Recoverable Cobalt	mg/kg dry wt	10.0 ± 1.5	5.86 ± 0.87	9.8 ± 1.5	-
Total Recoverable Copper	mg/kg dry wt	78 ± 12	32.0 ± 4.7	73 ± 11	-
Total Recoverable Iron	mg/kg dry wt	35,100 ± 3,600	31,400 ± 3,200	31,600 ± 3,200	-
Total Recoverable Lanthanum	mg/kg dry wt	16.3 ± 1.4	5.07 ± 0.43	7.43 ± 0.61	-
Total Recoverable Lead	mg/kg dry wt	156 ± 22	131 ± 19	237 ± 34	-
Total Recoverable Lithium	mg/kg dry wt	6.75 ± 0.86	3.14 ± 0.46	4.96 ± 0.66	-
Total Recoverable Magnesium	mg/kg dry wt	1,550 ± 160	1,230 ± 130	2,280 ± 240	-
Total Recoverable Manganese	mg/kg dry wt	1,160 ± 120	308 ± 31	623 ± 63	-
Total Recoverable Mercury	mg/kg dry wt	10.6 ± 1.3	15.0 ± 1.8	12.3 ± 1.5	-
Total Recoverable Molybdenum	mg/kg dry wt	2.63 ± 0.54	6.2 ± 1.2	2.33 ± 0.50	-
Total Recoverable Nickel	mg/kg dry wt	6.6 ± 1.6	5.3 ± 1.6	5.8 ± 1.6	-
Total Recoverable Phosphorus	mg/kg dry wt	1,000 ± 110	488 ± 56	529 ± 60	-
Total Recoverable Potassium*	mg/kg dry wt	850 ± 140	1,080 ± 170	820 ± 140	-
Total Recoverable Rubidium	mg/kg dry wt	7.18 ± 0.77	6.59 ± 0.71	7.62 ± 0.81	-
Total Recoverable Selenium	mg/kg dry wt	< 20 ± 14	< 20 ± 14	< 20 ± 14	-
Total Recoverable Sodium	mg/kg dry wt	255 ± 49	261 ± 50	356 ± 63	-
Total Recoverable Strontium	mg/kg dry wt	31.5 ± 3.3	20.7 ± 2.2	40.1 ± 4.1	-
Total Recoverable Thallium	mg/kg dry wt	1.92 ± 0.27	2.35 ± 0.32	1.76 ± 0.25	-
Total Recoverable Tin	mg/kg dry wt	4.2 ± 1.1	3.46 ± 0.94	6.6 ± 1.5	-
Total Recoverable Uranium	mg/kg dry wt	0.686 ± 0.079	0.143 ± 0.067	0.330 ± 0.070	-
Total Recoverable Vanadium	mg/kg dry wt	< 100 ± 67	< 100 ± 67	< 100 ± 67	-
Total Recoverable Zinc	mg/kg dry wt	173 ± 18	93.9 ± 9.8	263 ± 27	-

The reported uncertainty is an expanded uncertainty with a level of confidence of approximately 95 percent (i.e. two standard deviations, calculated using a coverage factor of 2). Reported uncertainties are calculated from the performance of typical matrices, and do not include variation due to sampling.

For further information on uncertainty of measurement at Hill Laboratories, refer to the technical note on our website: www.hill-laboratories.com/files/Intro_To_UOM.pdf, or contact the laboratory.

Analyst's Comments

#1 It should be noted that the replicate analyses performed on this sample as part of our in-house Quality Assurance procedures showed greater variation than would normally be expected. This may reflect the heterogeneity of the sample.

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: Soil			
Test	**Method Description**	**Default Detection Limit**	**Samples**
Environmental Solids Sample Preparation	Air dried at 35°C and sieved, <2mm fraction. Used for sample preparation. May contain a residual moisture content of 2-5%.	-	1-3, 5-8, 11-16, 18-23, 25-28
Metals extensive suite, screen level (33 metals)*	Dried sample, <2mm fraction. Nitric/Hydrochloric acid digestion, ICP-MS, screen level.	-	16, 19, 25-28
Total Petroleum Hydrocarbons in Soil	Sonication extraction in DCM, Silica cleanup, GC-FID analysis US EPA 8015B/MfE Petroleum Industry Guidelines. Tested on as received sample	-	1-3, 5-6
Dry Matter (Env)	Dried at 103°C for 4-22hr (removes 3-5% more water than air dry) , gravimetry. US EPA 3550.	0.10 g/100g as rcvd	1-3, 5-6
Total Recoverable digestion	Nitric / hydrochloric acid digestion. US EPA 200.2.	-	1-3, 5-8, 11-16, 18-23, 25-28
Total Recoverable Antimony	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.4 mg/kg dry wt	1-3, 5-8, 11-15, 18, 20-23

Sample Type: Soil			
Test	**Method Description**	**Default Detection Limit**	**Samples**
Total Recoverable Arsenic	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	2 mg/kg dry wt	1-3, 5-8, 11-15, 18, 20-23
Total Recoverable Cadmium	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.10 mg/kg dry wt	1-3, 5-8, 11-15, 18, 20-23
Total Recoverable Chromium	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	2 mg/kg dry wt	1-3, 5-8, 11-15, 18, 20-23
Total Recoverable Copper	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	2 mg/kg dry wt	1-3, 5-8, 11-15, 18, 20-23
Total Recoverable Lead	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.4 mg/kg dry wt	1-3, 5-8, 11-15, 18, 20-23
Total Recoverable Mercury	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.10 mg/kg dry wt	1-3, 5-8, 11-15, 18, 20-23
Total Recoverable Thallium	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.2 mg/kg dry wt	5, 11-15, 18, 20, 23
Total Recoverable Zinc	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	4 mg/kg dry wt	1-3, 5-8, 11-15, 18, 20-23

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.

Ara Heron BSc (Tech)
Client Services Manager - Environmental Division

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ANALYSIS REPORT

Client:	Pattle Delamore Partners Ltd	**Lab No:**	947769	SPv6
Contact:	Natalie Webster	**Date Registered:**	28-Oct-2011	
	C/- Pattle Delamore Partners Ltd	**Date Reported:**	18-Nov-2011	
	PO Box 9528	**Quote No:**	46451	
	Newmarket	**Order No:**		
	AUCKLAND 1149	**Client Reference:**	AO2469100	
		Submitted By:	Chris Foote	

Amended Report

This report replaces an earlier report issued on the 16 Nov 2011 at 3:04 pm
At the client's request, thallium results have been added to samples 947769.5, 11, 12, 13, 14, 15, 18, 20 & 23.

Sample Type: Soil

	Sample Name:	MOA014 0.1	MOA014 0.5	MOA014 1.0	MOA016 0.1	MOA016 0.5
	Lab Number:	947769.1	947769.2	947769.3	947769.5	947769.6
Individual Tests						
Dry Matter	g/100g as rcvd	71	79	74	76	83
Total Recoverable Antimony	mg/kg dry wt	4.0	2.6	2.3	4.6	0.7
Total Recoverable Arsenic	mg/kg dry wt	88	101	111	187	550
Total Recoverable Cadmium	mg/kg dry wt	< 0.10	0.15	< 0.10	0.22	< 0.10
Total Recoverable Chromium	mg/kg dry wt	8	10	9	13	21
Total Recoverable Copper	mg/kg dry wt	28	42	39	49	36
Total Recoverable Lead	mg/kg dry wt	35	52	18.9	82	8.8
Total Recoverable Mercury	mg/kg dry wt	1.28	2.9	1.98	3.9	1.18
Total Recoverable Thallium	mg/kg dry wt	-	-	-	1.2	-
Total Recoverable Zinc	mg/kg dry wt	68	74	28	148	44
Total Petroleum Hydrocarbons in Soil						
C7 - C9	mg/kg dry wt	< 11	< 10	< 10	< 9	< 8
C10 - C14	mg/kg dry wt	< 30	< 20	< 20	< 20	< 20
C15 - C36	mg/kg dry wt	< 50	< 40	44	< 40	< 40
Total hydrocarbons (C7 - C36)	mg/kg dry wt	< 80	< 70	< 70	< 70	< 70

	Sample Name:	MOA017 0.1	MOA017 0.5	MOA018 0.1	MOA018 0.5	MOA018 1.0
	Lab Number:	947769.7	947769.8	947769.11	947769.12	947769.13
Individual Tests						
Total Recoverable Antimony	mg/kg dry wt	2.1	0.9	12.8	14.1	19.0
Total Recoverable Arsenic	mg/kg dry wt	50	55	250	560	600
Total Recoverable Cadmium	mg/kg dry wt	0.30	0.10	0.54	0.39	< 0.10
Total Recoverable Chromium	mg/kg dry wt	12	12	15	8	7
Total Recoverable Copper	mg/kg dry wt	31	29	73	56	33
Total Recoverable Lead	mg/kg dry wt	58	71	140	139	123
Total Recoverable Mercury	mg/kg dry wt	1.10	0.60	10.4	16.7	29
Total Recoverable Thallium	mg/kg dry wt	-	-	1.9	3.2	6.2
Total Recoverable Zinc	mg/kg dry wt	124	189	162	134	58

	Sample Name:	MOA019 0.1	MOA019 0.5	MOA019 1.0	MOA020 0.1	MOA020 0.5
	Lab Number:	947769.14	947769.15	947769.16	947769.18	947769.19
Individual Tests						
Total Recoverable Antimony	mg/kg dry wt	7.3	19.5	-	18.1	-
Total Recoverable Arsenic	mg/kg dry wt	151	460	-	320	-
Total Recoverable Cadmium	mg/kg dry wt	0.74	0.72	-	0.16	-
Total Recoverable Chromium	mg/kg dry wt	15	10	-	8	-

Sample Type: Soil						
	Sample Name:	MOA019 0.1	MOA019 0.5	MOA019 1.0	MOA020 0.1	MOA020 0.5
	Lab Number:	947769.14	947769.15	947769.16	947769.18	947769.19
Individual Tests						
Total Recoverable Copper	mg/kg dry wt	54	130	-	28	-
Total Recoverable Lead	mg/kg dry wt	220	850	-	117	-
Total Recoverable Mercury	mg/kg dry wt	11.5	24	-	13.2	-
Total Recoverable Thallium	mg/kg dry wt	1.3	3.9	-	2.0	-
Total Recoverable Zinc	mg/kg dry wt	250	260	-	76	-
Metals extensive suite, screen level (33 metals)						
Total Recoverable Aluminium	mg/kg dry wt	-	-	1,800	-	3,300
Total Recoverable Antimony	mg/kg dry wt	-	-	16.6	-	27
Total Recoverable Arsenic	mg/kg dry wt	-	-	4,700	-	1,450
Total Recoverable Barium	mg/kg dry wt	-	-	158	-	260
Total Recoverable Bismuth	mg/kg dry wt	-	-	< 0.4	-	3.2
Total Recoverable Boron	mg/kg dry wt	-	-	< 20	-	< 20
Total Recoverable Cadmium	mg/kg dry wt	-	-	0.31	-	< 0.10
Total Recoverable Caesium	mg/kg dry wt	-	-	3.8	-	4.4
Total Recoverable Calcium	mg/kg dry wt	-	-	1,240	-	2,100
Total Recoverable Chromium	mg/kg dry wt	-	-	7	-	7
Total Recoverable Cobalt	mg/kg dry wt	-	-	0.5 #1	-	3.3
Total Recoverable Copper	mg/kg dry wt	-	-	42	-	31
Total Recoverable Iron	mg/kg dry wt	-	-	35,000	-	47,000
Total Recoverable Lanthanum	mg/kg dry wt	-	-	6.5	-	3.3
Total Recoverable Lead	mg/kg dry wt	-	-	68	-	250
Total Recoverable Lithium	mg/kg dry wt	-	-	0.4	-	1.8
Total Recoverable Magnesium	mg/kg dry wt	-	-	128	-	570
Total Recoverable Manganese	mg/kg dry wt	-	-	22	-	104
Total Recoverable Mercury	mg/kg dry wt	-	-	43	-	29
Total Recoverable Molybdenum	mg/kg dry wt	-	-	4.9	-	9.4
Total Recoverable Nickel	mg/kg dry wt	-	-	< 2	-	3
Total Recoverable Phosphorus	mg/kg dry wt	-	-	153	-	410
Total Recoverable Potassium*	mg/kg dry wt	-	-	1,190	-	870
Total Recoverable Rubidium	mg/kg dry wt	-	-	5.5	-	5.9
Total Recoverable Selenium	mg/kg dry wt	-	-	< 20	-	< 20
Total Recoverable Sodium	mg/kg dry wt	-	-	199 #1	-	210
Total Recoverable Strontium	mg/kg dry wt	-	-	13.2	-	31
Total Recoverable Thallium	mg/kg dry wt	-	-	5.0	-	5.0
Total Recoverable Tin	mg/kg dry wt	-	-	1.5	-	9.1
Total Recoverable Uranium	mg/kg dry wt	-	-	< 0.10	-	< 0.10
Total Recoverable Vanadium	mg/kg dry wt	-	-	< 100	-	< 100
Total Recoverable Zinc	mg/kg dry wt	-	-	83	-	62

	Sample Name:	MOA020 1.0	MOA024 0.1	MOA024 0.5	MOA024 1.0	MOA016 0.1 (duplicate)
	Lab Number:	947769.20	947769.21	947769.22	947769.23	947769.25
Individual Tests						
Total Recoverable Antimony	mg/kg dry wt	7.0	4.8	0.5	23	-
Total Recoverable Arsenic	mg/kg dry wt	550	46	18	500	-
Total Recoverable Cadmium	mg/kg dry wt	0.16	0.18	< 0.10	0.16	-
Total Recoverable Chromium	mg/kg dry wt	12	12	10	7	-
Total Recoverable Copper	mg/kg dry wt	51	37	43	41	-
Total Recoverable Lead	mg/kg dry wt	42	129	11.6	157	-
Total Recoverable Mercury	mg/kg dry wt	8.4	1.98	0.11	132	-
Total Recoverable Thallium	mg/kg dry wt	2.0	-	-	2.8	-
Total Recoverable Zinc	mg/kg dry wt	155	102	27	57	-
Metals extensive suite, screen level (33 metals)						
Total Recoverable Aluminium	mg/kg dry wt	-	-	-	-	12,300
Total Recoverable Antimony	mg/kg dry wt	-	-	-	-	5.2
Total Recoverable Arsenic	mg/kg dry wt	-	-	-	-	191

Sample Type: Soil						
Sample Name:		MOA020 1.0	MOA024 0.1	MOA024 0.5	MOA024 1.0	MOA016 0.1 (duplicate)
Lab Number:		947769.20	947769.21	947769.22	947769.23	947769.25
Metals extensive suite, screen level (33 metals)						
Total Recoverable Barium	mg/kg dry wt	-	-	-	-	82
Total Recoverable Bismuth	mg/kg dry wt	-	-	-	-	< 0.4
Total Recoverable Boron	mg/kg dry wt	-	-	-	-	< 20
Total Recoverable Cadmium	mg/kg dry wt	-	-	-	-	0.30
Total Recoverable Caesium	mg/kg dry wt	-	-	-	-	2.3
Total Recoverable Calcium	mg/kg dry wt	-	-	-	-	5,700
Total Recoverable Chromium	mg/kg dry wt	-	-	-	-	14
Total Recoverable Cobalt	mg/kg dry wt	-	-	-	-	9.6
Total Recoverable Copper	mg/kg dry wt	-	-	-	-	52
Total Recoverable Iron	mg/kg dry wt	-	-	-	-	42,000
Total Recoverable Lanthanum	mg/kg dry wt	-	-	-	-	9.1
Total Recoverable Lead	mg/kg dry wt	-	-	-	-	78
Total Recoverable Lithium	mg/kg dry wt	-	-	-	-	7.3
Total Recoverable Magnesium	mg/kg dry wt	-	-	-	-	1,800
Total Recoverable Manganese	mg/kg dry wt	-	-	-	-	540
Total Recoverable Mercury	mg/kg dry wt	-	-	-	-	3.9
Total Recoverable Molybdenum	mg/kg dry wt	-	-	-	-	1.1
Total Recoverable Nickel	mg/kg dry wt	-	-	-	-	7
Total Recoverable Phosphorus	mg/kg dry wt	-	-	-	-	440
Total Recoverable Potassium*	mg/kg dry wt	-	-	-	-	1,140
Total Recoverable Rubidium	mg/kg dry wt	-	-	-	-	8.9
Total Recoverable Selenium	mg/kg dry wt	-	-	-	-	< 20
Total Recoverable Sodium	mg/kg dry wt	-	-	-	-	470
Total Recoverable Strontium	mg/kg dry wt	-	-	-	-	38
Total Recoverable Thallium	mg/kg dry wt	-	-	-	-	1.1
Total Recoverable Tin	mg/kg dry wt	-	-	-	-	1.2
Total Recoverable Uranium	mg/kg dry wt	-	-	-	-	0.29
Total Recoverable Vanadium	mg/kg dry wt	-	-	-	-	< 100
Total Recoverable Zinc	mg/kg dry wt	-	-	-	-	168

Sample Name:		MOA018 0.1 (duplicate)	MOA020 0.1 (duplicate)	MOA019 0.1 (duplicate)		
Lab Number:		947769.26	947769.27	947769.28		
Metals extensive suite, screen level (33 metals)						
Total Recoverable Aluminium	mg/kg dry wt	16,300	6,700	13,600	-	-
Total Recoverable Antimony	mg/kg dry wt	14.4	23	10.9	-	-
Total Recoverable Arsenic	mg/kg dry wt	220	380	230	-	-
Total Recoverable Barium	mg/kg dry wt	220	149	191	-	-
Total Recoverable Bismuth	mg/kg dry wt	< 0.4	1.0	< 0.4	-	-
Total Recoverable Boron	mg/kg dry wt	< 20	< 20	< 20	-	-
Total Recoverable Cadmium	mg/kg dry wt	0.49	0.20	0.64	-	-
Total Recoverable Caesium	mg/kg dry wt	1.9	3.0	1.6	-	-
Total Recoverable Calcium	mg/kg dry wt	4,300	2,700	6,000	-	-
Total Recoverable Chromium	mg/kg dry wt	14	12	13	-	-
Total Recoverable Cobalt	mg/kg dry wt	10.0	5.9	9.8	-	-
Total Recoverable Copper	mg/kg dry wt	78	32	73	-	-
Total Recoverable Iron	mg/kg dry wt	35,000	31,000	32,000	-	-
Total Recoverable Lanthanum	mg/kg dry wt	16.3	5.1	7.4	-	-
Total Recoverable Lead	mg/kg dry wt	156	131	240	-	-
Total Recoverable Lithium	mg/kg dry wt	6.8	3.1	5.0	-	-
Total Recoverable Magnesium	mg/kg dry wt	1,550	1,230	2,300	-	-
Total Recoverable Manganese	mg/kg dry wt	1,160	310	620	-	-
Total Recoverable Mercury	mg/kg dry wt	10.6	15.0	12.3	-	-
Total Recoverable Molybdenum	mg/kg dry wt	2.6	6.2	2.3	-	-
Total Recoverable Nickel	mg/kg dry wt	7	5	6	-	-
Total Recoverable Phosphorus	mg/kg dry wt	1,000	490	530	-	-

Sample Type: Soil							
	Sample Name:	MOA018 0.1 (duplicate)	MOA020 0.1 (duplicate)	MOA019 0.1 (duplicate)		
	Lab Number:	947769.26	947769.27	947769.28		
Metals extensive suite, screen level (33 metals)						
Total Recoverable Potassium*	mg/kg dry wt	850	1,080	820	-	-
Total Recoverable Rubidium	mg/kg dry wt	7.2	6.6	7.6	-	-
Total Recoverable Selenium	mg/kg dry wt	< 20	< 20	< 20	-	-
Total Recoverable Sodium	mg/kg dry wt	260	260	360	-	-
Total Recoverable Strontium	mg/kg dry wt	31	21	40	-	-
Total Recoverable Thallium	mg/kg dry wt	1.9	2.4	1.8	-	-
Total Recoverable Tin	mg/kg dry wt	4.2	3.5	6.6	-	-
Total Recoverable Uranium	mg/kg dry wt	0.69	0.14	0.33	-	-
Total Recoverable Vanadium	mg/kg dry wt	< 100	< 100	< 100	-	-
Total Recoverable Zinc	mg/kg dry wt	173	94	260	-	-

Analyst's Comments

#1 It should be noted that the replicate analyses performed on this sample as part of our in-house Quality Assurance procedures showed greater variation than would normally be expected. This may reflect the heterogeneity of the sample.

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: Soil			
Test	**Method Description**	**Default Detection Limit**	**Samples**
Environmental Solids Sample Preparation	Air dried at 35°C and sieved, <2mm fraction. Used for sample preparation. May contain a residual moisture content of 2-5%.	-	1-3, 5-8, 11-16, 18-23, 25-28
Metals extensive suite, screen level (33 metals)*	Dried sample, <2mm fraction. Nitric/Hydrochloric acid digestion, ICP-MS, screen level.	-	16, 19, 25-28
Total Petroleum Hydrocarbons in Soil	Sonication extraction in DCM, Silica cleanup, GC-FID analysis US EPA 8015B/MfE Petroleum Industry Guidelines. Tested on as received sample	-	1-3, 5-6
Dry Matter (Env)	Dried at 103°C for 4-22hr (removes 3-5% more water than air dry) , gravimetry. US EPA 3550.	0.10 g/100g as rcvd	1-3, 5-6
Total Recoverable digestion	Nitric / hydrochloric acid digestion. US EPA 200.2.	-	1-3, 5-8, 11-16, 18-23, 25-28
Total Recoverable Antimony	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.4 mg/kg dry wt	1-3, 5-8, 11-15, 18, 20-23
Total Recoverable Arsenic	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	2 mg/kg dry wt	1-3, 5-8, 11-15, 18, 20-23
Total Recoverable Cadmium	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.10 mg/kg dry wt	1-3, 5-8, 11-15, 18, 20-23
Total Recoverable Chromium	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	2 mg/kg dry wt	1-3, 5-8, 11-15, 18, 20-23
Total Recoverable Copper	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	2 mg/kg dry wt	1-3, 5-8, 11-15, 18, 20-23
Total Recoverable Lead	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.4 mg/kg dry wt	1-3, 5-8, 11-15, 18, 20-23
Total Recoverable Mercury	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.10 mg/kg dry wt	1-3, 5-8, 11-15, 18, 20-23
Total Recoverable Thallium	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.2 mg/kg dry wt	5, 11-15, 18, 20, 23
Total Recoverable Zinc	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	4 mg/kg dry wt	1-3, 5-8, 11-15, 18, 20-23

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.

Ara Heron BSc (Tech)
Client Services Manager - Environmental Division

pdp solutions for your environment

ATTLE DELAMORE PARTNERS LTD

Job No: **947769**

No of Samples 24 No of Fractions 24

NOTE: P. of these sam., form and emailing

From: Pattle Delamore Partners Ltd

Address (Refer to base of sheet): ☑ PDP Auckland urch

Submitted by: Chris Foote Ph No.: 09 5236900

To: Hills Lab

Quote No.: 4645)

PDP Job No.: AO2469100

Chain of Custody Record

Sent:
Name: Chris Foote
Signature: CFoote
Date and time: 28-10-11 8:30am

Received: ☐ Room temp. ☑ Chilled Temp.: 20.5°C
Name: Paeard
Signature:
Date and time:

Notes:
OCT 28 PM 1:36

Results by: ☑ Email submitter: Chris.Foote @pdp.co.nz ☑ Mail (address below)
☑ Email other: Natalie.Webster @pdp.co.nz ☐ Fax (number below)

Priority: ☐ Normal ☑ High ☐ Urgent
Results required by: ___ / ___ / ___

Invoice to: ☑ PDP ☐ Other:

Sample ID	Sample type	No. bottles	Analyses requested	Notes
MOA014 0.1	S	1	HOLD COLD	
MOA014 0.5	S	1	" "	
MOA014 1.0	S	1	" "	
MOA014 1.5	S	1	" "	
MOA016 0.1	S	1	" "	
MOA016 0.5	S	1	" "	
MOA017 0.1	S	1	" "	
MOA017 0.5	S	1	" "	
MOA017 1.0	S	1	" "	
MOA017 1.5	S	1	" "	
MOA018 0.1	S	1	" "	
MOA018 0.5	S	1	" "	
MOA018 1.0	S	1	" "	
MOA019 0.1	S	1	" "	
MOA019 0.5	S	1	" "	
MOA019 1.0	S	1	" "	
MOA019 1.5	S	1	" "	
MOA020 0.1	S	1	" "	
MOA020 0.5	S	1	" "	
MOA020 1.0	S	1	" "	
MOA020 1.5	S	1	" "	
MOA024 04	S	1	" "	

Sample type: S Soil GW Groundwater SAL Seawater/saline FW Freshwater LEACH Leachate GEO Geothermal
SED Sediment BIO Biota TW Tradewaste WW Wastewater P Potable Other:

Note: Samples may contain dangerous or hazardous substances

PDP Auckland
PDP House, 235 Broadway, Newmarket, Auckland
PO Box 9528, Newmarket, Auckland 1149

PDP Wellington
ISOFT House, Level 1, 111 Customhouse Quay, Wellington
PO Box 6136, Wellington 6141

PDP Christchurch
Radio NZ House, 51 Chester St West, Christchurch
PO Box 389, Christchurch 8140

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PATTLE DELAMORE PARTNERS LTD

Request for Analyses

NOTE: Please acknowledge receipt of these samples by signing this form and emailing to submitter.

From: Pattle Delamore Partners Ltd

Address (Refer to base of sheet): ☑ PDP Auckland ☐ PDP Wellington ☐ PDP Christchurch

Submitted by: Chris Foote Ph No.:

To: Hills Lab

Quote No.: 46451

PDP Job No.: A02469100

Chain of Custody Record

Sent:

Name: Chris Foote

Signature: CFoote

Date and time: 28-10-11 8:30am

Received: ☑ Room temp. ☐ Chilled Temp.: 20.5°C

Name:

Signature:

Date and time:

Notes:

OCT 28 PM1:36

Results by: ☑ Email submitter: Chris.Foote @pdp.co.nz ☑ Mail (address below)

☑ Email other: Natalie.Webster @pdp.co.nz ☐ Fax (number below)

Priority: ☐ Normal ☑ High ☐ Urgent

Results required by: ___ / ___ / ___

Invoice to: ☑ PDP ☐ Other:

Sample ID	Sample type	No. bottles	Analyses requested	Notes
MOA02405	S	1	HOLD COLD	
MOA02410	S	1	"	
MOA02415	S	1	"	

Sample type: S Soil GW Groundwater SAL Seawater/saline FW Freshwater LEACH Leachate GEO Geothermal

SED Sediment BIO Biota TW Tradewaste WW Wastewater P Potable Other:

Note: Samples may contain dangerous or hazardous substances

PDP Auckland
PDP House, 235 Broadway, Newmarket, Auckland
PO Box 9528, Newmarket, Auckland 1149

PDP Wellington
iSOFT House, Level 1, 111 Customhouse Quay, Wellington
PO Box 6136, Wellington 6141

PDP Christchurch
Radio NZ House, 51 Chester St West, Christchurch
PO Box 389, Christchurch 8140

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Hamilton 3240, New Zealand

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Fax +64 7 858 2001
Email mail@hill-labs.co.nz
Web www.hill-labs.co.nz

ANALYSIS REPORT

Client:	Pattle Delamore Partners Ltd	**Lab No:**	947724	SUPv2
Contact:	Natalie Webster	**Date Registered:**	28-Oct-2011	
	C/- Pattle Delamore Partners Ltd	**Date Reported:**	18-Nov-2011	
	PO Box 9528	**Quote No:**	46451	
	Newmarket	**Order No:**		
	AUCKLAND 1149	**Client Reference:**	AO2469100	
		Submitted By:	Chris Foote	

Amended Report

This report replaces an earlier report issued on the 17 Nov 2011 at 10:29 am
At the client's request, a thallium result has been added to sample 947724.15.

Sample Type: Soil

	Sample Name:	MOA001 0.1 27-Oct-2011	MOA001 0.5 27-Oct-2011	MOA001 1.0 27-Oct-2011	MOA002 0.1 27-Oct-2011
	Lab Number:	947724.1	947724.2	947724.3	947724.5
Individual Tests					
Dry Matter	g/100g as rcvd	-	-	-	68
Total Recoverable Antimony	mg/kg dry wt	0.70 ± 0.29	1.72 ± 0.41	6.7 ± 1.3	7.5 ± 1.4
Total Recoverable Arsenic	mg/kg dry wt	24.1 ± 2.8	95.6 ± 9.7	185 ± 19	65.5 ± 6.7
Total Recoverable Cadmium	mg/kg dry wt	0.185 ± 0.073	< 0.10 ± 0.067	< 0.10 ± 0.067	0.122 ± 0.068
Total Recoverable Chromium	mg/kg dry wt	48.3 ± 5.1	6.8 ± 1.5	8.7 ± 1.6	8.3 ± 1.6
Total Recoverable Copper	mg/kg dry wt	31.8 ± 4.7	35.4 ± 5.2	48.4 ± 6.9	21.6 ± 3.3
Total Recoverable Lead	mg/kg dry wt	33.4 ± 4.7	9.9 ± 1.5	6.9 ± 1.0	31.7 ± 4.5
Total Recoverable Mercury	mg/kg dry wt	0.334 ± 0.077	0.488 ± 0.088	2.24 ± 0.28	0.394 ± 0.081
Total Recoverable Zinc	mg/kg dry wt	83.6 ± 8.8	24.8 ± 3.7	27.2 ± 3.8	52.8 ± 5.9
Total Petroleum Hydrocarbons in Soil					
C7 - C9	mg/kg dry wt	-	-	-	< 10 ± 5.5
C10 - C14	mg/kg dry wt	-	-	-	< 20 ± 7.8
C15 - C36	mg/kg dry wt	-	-	-	< 40 ± 9.5
Total hydrocarbons (C7 - C36)	mg/kg dry wt	-	-	-	< 70 ± 14

	Sample Name:	MOA002 0.5 27-Oct-2011	MOA006 0.1 27-Oct-2011	MOA006 0.5 27-Oct-2011	MOA006 1.0 27-Oct-2011
	Lab Number:	947724.6	947724.8	947724.9	947724.10
Individual Tests					
Dry Matter	g/100g as rcvd	78	-	-	-
Total Recoverable Antimony	mg/kg dry wt	1.68 ± 0.40	3.31 ± 0.65	2.14 ± 0.47	1.66 ± 0.40
Total Recoverable Arsenic	mg/kg dry wt	54.1 ± 5.6	39.4 ± 4.2	57.6 ± 6.0	36.9 ± 4.0
Total Recoverable Cadmium	mg/kg dry wt	< 0.10 ± 0.067	0.364 ± 0.092	< 0.10 ± 0.067	< 0.10 ± 0.067
Total Recoverable Chromium	mg/kg dry wt	7.7 ± 1.6	12.0 ± 1.8	9.0 ± 1.6	5.8 ± 1.5
Total Recoverable Copper	mg/kg dry wt	26.4 ± 4.0	30.1 ± 4.5	23.8 ± 3.6	15.6 ± 2.6
Total Recoverable Lead	mg/kg dry wt	13.8 ± 2.0	35.2 ± 5.0	7.0 ± 1.1	5.16 ± 0.77
Total Recoverable Mercury	mg/kg dry wt	0.360 ± 0.079	0.63 ± 0.11	0.514 ± 0.091	0.82 ± 0.12
Total Recoverable Zinc	mg/kg dry wt	46.0 ± 5.4	99 ± 11	14.7 ± 3.1	6.8 ± 2.8
Total Petroleum Hydrocarbons in Soil					
C7 - C9	mg/kg dry wt	< 9 ± 5.4	-	-	-
C10 - C14	mg/kg dry wt	< 20 ± 7.7	-	-	-
C15 - C36	mg/kg dry wt	< 40 ± 9.4	-	-	-
Total hydrocarbons (C7 - C36)	mg/kg dry wt	< 70 ± 14	-	-	-

Sample Type: Soil					
	Sample Name:	MOA011 0.1 27-Oct-2011	MOA011 0.5 27-Oct-2011	MOA021 0.1 27-Oct-2011	MOA021 0.5 27-Oct-2011
	Lab Number:	947724.11	947724.12	947724.13	947724.14
Individual Tests					
Dry Matter	g/100g as rcvd	-	84	85	85
Total Recoverable Antimony	mg/kg dry wt	1.20 ± 0.34	1.18 ± 0.34	5.4 ± 1.1	7.2 ± 1.4
Total Recoverable Arsenic	mg/kg dry wt	25.2 ± 2.9	31.0 ± 3.4	87.0 ± 8.8	206 ± 21
Total Recoverable Cadmium	mg/kg dry wt	0.336 ± 0.089	0.306 ± 0.085	0.172 ± 0.072	< 0.10 ± 0.067
Total Recoverable Chromium	mg/kg dry wt	15.4 ± 2.1	15.0 ± 2.0	19.7 ± 2.4	9.7 ± 1.7
Total Recoverable Copper	mg/kg dry wt	35.6 ± 5.2	132 ± 19	62.4 ± 8.9	152 ± 22
Total Recoverable Lead	mg/kg dry wt	41.9 ± 5.9	29.5 ± 4.2	81 ± 12	67.8 ± 9.5
Total Recoverable Mercury	mg/kg dry wt	0.64 ± 0.11	0.257 ± 0.073	0.92 ± 0.13	1.39 ± 0.18
Total Recoverable Zinc	mg/kg dry wt	99 ± 11	69.8 ± 7.5	138 ± 15	59.3 ± 6.5
Polycyclic Aromatic Hydrocarbons Screening in Soil					
Acenaphthene	mg/kg dry wt	-	-	< 0.03 ± 0.0099	< 0.03 ± 0.0097
Acenaphthylene	mg/kg dry wt	-	-	0.0311 ± 0.0072	0.0494 ± 0.0080
Anthracene	mg/kg dry wt	-	-	0.052 ± 0.017	0.084 ± 0.026
Benzo[a]anthracene	mg/kg dry wt	-	-	0.245 ± 0.064	0.50 ± 0.13
Benzo[a]pyrene (BAP)	mg/kg dry wt	-	-	0.312 ± 0.025	0.513 ± 0.040
Benzo[b]fluoranthene + Benzo[j] fluoranthene	mg/kg dry wt	-	-	0.54 ± 0.12	1.03 ± 0.21
Benzo[g,h,i]perylene	mg/kg dry wt	-	-	0.353 ± 0.062	0.434 ± 0.075
Benzo[k]fluoranthene	mg/kg dry wt	-	-	0.204 ± 0.027	0.402 ± 0.052
Chrysene	mg/kg dry wt	-	-	0.237 ± 0.036	0.527 ± 0.079
Dibenzo[a,h]anthracene	mg/kg dry wt	-	-	0.072 ± 0.012	0.100 ± 0.015
Fluoranthene	mg/kg dry wt	-	-	0.592 ± 0.060	1.08 ± 0.11
Fluorene	mg/kg dry wt	-	-	< 0.03 ± 0.0074	< 0.03 ± 0.0073
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	-	-	0.302 ± 0.029	0.423 ± 0.040
Naphthalene	mg/kg dry wt	-	-	< 0.14 ± 0.046	< 0.14 ± 0.045
Phenanthrene	mg/kg dry wt	-	-	0.258 ± 0.037	0.505 ± 0.071
Pyrene	mg/kg dry wt	-	-	0.694 ± 0.090	1.00 ± 0.13
Total Petroleum Hydrocarbons in Soil					
C7 - C9	mg/kg dry wt	-	< 8 ± 5.4	< 9 ± 5.4	-
C10 - C14	mg/kg dry wt	-	< 20 ± 7.6	< 20 ± 7.6	-
C15 - C36	mg/kg dry wt	-	< 40 ± 9.3	67.9 ± 9.4	-
Total hydrocarbons (C7 - C36)	mg/kg dry wt	-	< 70 ± 14	< 70 ± 14	-

	Sample Name:	MOA021 1.0 27-Oct-2011	MOA012 0.5 27-Oct-2011	MOA012 0.1 27-Oct-2011	
	Lab Number:	947724.15	947724.16	947724.17	
Individual Tests					
Dry Matter	g/100g as rcvd	78	80	-	-
Total Recoverable Antimony	mg/kg dry wt	9.4 ± 1.8	2.67 ± 0.55	1.60 ± 0.39	-
Total Recoverable Arsenic	mg/kg dry wt	270 ± 28	86.3 ± 8.8	34.9 ± 3.8	-
Total Recoverable Cadmium	mg/kg dry wt	< 0.10 ± 0.067	0.247 ± 0.079	< 0.10 ± 0.067	-
Total Recoverable Chromium	mg/kg dry wt	7.2 ± 1.6	12.3 ± 1.9	13.6 ± 1.9	-
Total Recoverable Copper	mg/kg dry wt	59.0 ± 8.4	92 ± 13	38.2 ± 5.6	-
Total Recoverable Lead	mg/kg dry wt	83 ± 12	119 ± 17	34.7 ± 4.9	-
Total Recoverable Mercury	mg/kg dry wt	6.27 ± 0.76	3.75 ± 0.46	0.570 ± 0.095	-
Total Recoverable Thallium	mg/kg dry wt	1.89 ± 0.27	-	-	-
Total Recoverable Zinc	mg/kg dry wt	37.4 ± 4.6	161 ± 17	90.0 ± 9.4	-
Polycyclic Aromatic Hydrocarbons Screening in Soil					
Acenaphthene	mg/kg dry wt	0.070 ± 0.021	-	-	-
Acenaphthylene	mg/kg dry wt	0.545 ± 0.050	-	-	-
Anthracene	mg/kg dry wt	1.58 ± 0.48	-	-	-
Benzo[a]anthracene	mg/kg dry wt	3.9 ± 1.1	-	-	-
Benzo[a]pyrene (BAP)	mg/kg dry wt	3.57 ± 0.28	-	-	-
Benzo[b]fluoranthene + Benzo[j] fluoranthene	mg/kg dry wt	3.93 ± 0.81	-	-	-
Benzo[g,h,i]perylene	mg/kg dry wt	1.95 ± 0.34	-	-	-

Sample Type: Soil					
Sample Name:		MOA021 1.0 27-Oct-2011	MOA012 0.5 27-Oct-2011	MOA012 0.1 27-Oct-2011	
Lab Number:		947724.15	947724.16	947724.17	
Polycyclic Aromatic Hydrocarbons Screening in Soil					
Benzo[k]fluoranthene	mg/kg dry wt	1.71 ± 0.22	-	-	-
Chrysene	mg/kg dry wt	2.72 ± 0.41	-	-	-
Dibenzo[a,h]anthracene	mg/kg dry wt	0.412 ± 0.054	-	-	-
Fluoranthene	mg/kg dry wt	11.1 ± 1.2	-	-	-
Fluorene	mg/kg dry wt	0.306 ± 0.037	-	-	-
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	1.87 ± 0.18	-	-	-
Naphthalene	mg/kg dry wt	0.139 ± 0.046	-	-	-
Phenanthrene	mg/kg dry wt	9.3 ± 1.3	-	-	-
Pyrene	mg/kg dry wt	9.3 ± 1.2	-	-	-
Total Petroleum Hydrocarbons in Soil					
C7 - C9	mg/kg dry wt	< 9 ± 5.4	< 9 ± 5.4	-	-
C10 - C14	mg/kg dry wt	< 20 ± 7.6	< 20 ± 7.7	-	-
C15 - C36	mg/kg dry wt	115 ± 16	< 40 ± 9.4	-	-
Total hydrocarbons (C7 - C36)	mg/kg dry wt	115 ± 18	< 70 ± 14	-	-

The reported uncertainty is an expanded uncertainty with a level of confidence of approximately 95 percent (i.e. two standard deviations, calculated using a coverage factor of 2). Reported uncertainties are calculated from the performance of typical matrices, and do not include variation due to sampling.

For further information on uncertainty of measurement at Hill Laboratories, refer to the technical note on our website: www.hill-laboratories.com/files/Intro_To_UOM.pdf, or contact the laboratory.

Analyst's Comments

Appendix No.1 - Total Petroleum Hydrocarbon Chromatograms

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: Soil			
Test	**Method Description**	**Default Detection Limit**	**Samples**
Environmental Solids Sample Preparation	Air dried at 35°C and sieved, <2mm fraction. Used for sample preparation. May contain a residual moisture content of 2-5%.	-	1-3, 5-6, 8-17
Polycyclic Aromatic Hydrocarbons Screening in Soil	Sonication extraction, Dilution or SPE cleanup (if required), GC-MS SIM analysis (modified US EPA 8270). Tested on as received sample.	-	13-15
Total Petroleum Hydrocarbons in Soil	Sonication extraction in DCM, Silica cleanup, GC-FID analysis US EPA 8015B/MfE Petroleum Industry Guidelines. Tested on as received sample	-	5-6, 12-13, 15-16
Dry Matter (Env)	Dried at 103°C for 4-22hr (removes 3-5% more water than air dry) , gravimetry. US EPA 3550.	0.10 g/100g as rcvd	5-6, 12-16
Total Recoverable digestion	Nitric / hydrochloric acid digestion. US EPA 200.2.	-	1-3, 5-6, 8-17
Total Recoverable Antimony	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.4 mg/kg dry wt	1-3, 5-6, 8-17
Total Recoverable Arsenic	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	2 mg/kg dry wt	1-3, 5-6, 8-17
Total Recoverable Cadmium	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.10 mg/kg dry wt	1-3, 5-6, 8-17
Total Recoverable Chromium	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	2 mg/kg dry wt	1-3, 5-6, 8-17
Total Recoverable Copper	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	2 mg/kg dry wt	1-3, 5-6, 8-17
Total Recoverable Lead	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.4 mg/kg dry wt	1-3, 5-6, 8-17

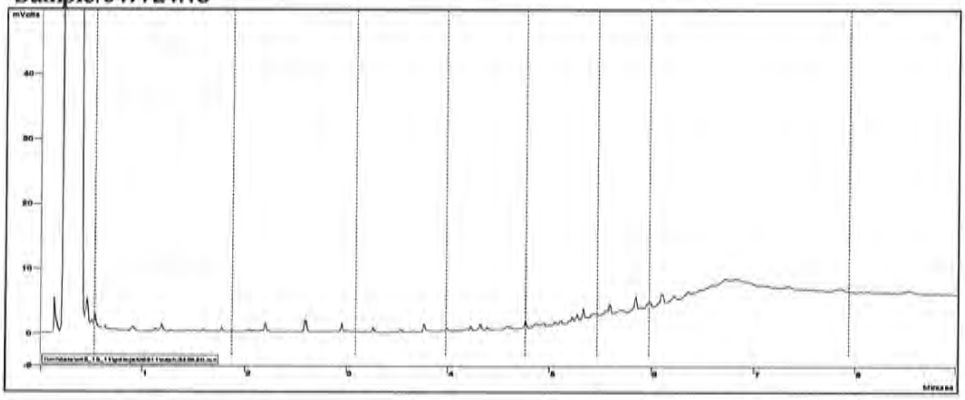
Sample Type: Soil			
Test	**Method Description**	**Default Detection Limit**	**Samples**
Total Recoverable Mercury	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.10 mg/kg dry wt	1-3, 5-6, 8-17
Total Recoverable Thallium	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.2 mg/kg dry wt	15
Total Recoverable Zinc	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	4 mg/kg dry wt	1-3, 5-6, 8-17

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

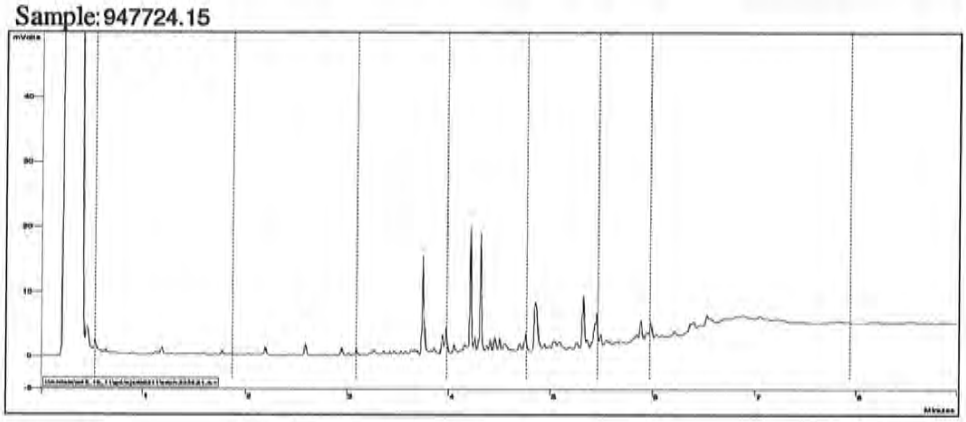
Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.

Ara Heron BSc (Tech)
Client Services Manager - Environmental Division

Sample: 947724.13



Sample: 947724.15



Appendix E
Acute Arsenic Report

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15 November 2011

Nick Kim
Waikato Regional Council
Private Bag 3038
Waikato Mail Centre
HAMILTON 3240

Dear Nick

Calculation of Acceptable Soil Concentrations for Acute Exposure to Arsenic in Soil

Summary

Elevated concentrations of arsenic have been found in surface soil within the residential neighbourhood of Moanataiari, Thames. The concentrations are sufficiently high to raise the possibility that ingestion of a relatively large amount of soil by a small child could cause acute health effects. This report calculates soil concentration values at which the onset of health effects might occur and at which a lethal dose might be obtained, for various short-term (acute) soil ingestion rates. The focus of this study is small children as the most vulnerable group. Acute effects are much less likely in adults, because they are less likely to ingest large amounts of soil and have greater body weights.

Review of the scientific literature suggests that a reasonable reference dose for acute toxicity, at which the onset of health effects in people might be observed, is 0.015 mg/kg-bw. Similarly, a lethal dose has been assessed as being about 1 mg/kg-bw. A high, but reasonable, rate of daily soil ingestion for a child with pica behaviour is recommended as 5000 mg (close to a teaspoon-full). The average rate of soil ingestion for a normal child is much smaller at about 50 mg/day with an upper-bound rate for a normal child of the order of 200 mg/day.

At an ingestion rate of 5000 mg/day and a reference dose of 0.015 mg/kg-bw, the calculated acceptable soil concentration threshold, assuming 100% bioavailability, is 39 mg/kg. This is lower than some of the concentrations measured within surface soil at Moanataiari, indicating a potential acute risk.

At an ingestion rate of 5000 mg/day and the potentially lethal dose of 1 mg/kg-bw, the potentially lethal soil concentration is 2,600 mg/kg. This is much higher than any surface soil concentration measured at Moanataiari to date indicating minimal risk of a lethal dose, but lower than concentrations measured at 1 m below the ground.

Arsenic in soil is not 100% bioavailable. The calculated acceptable and potentially lethal soil concentrations will therefore be conservative (low) by a factor of somewhere between about 1.4 and about 25. The actual bioavailability of the arsenic in the Moanataiari soil is not known and quite probably varies from place to place.

Population statistics and the prevalence of the soil pica in children suggests that very few if any children at Moanataiari will actually ingest dangerous amounts of soil, but the risk cannot be dismissed. As the measured concentrations exceed the Soil Concentration Standard for arsenic developed for the new soil contamination National Environmental Standard, a risk requiring management is indicated for long-term exposure. Further sampling is required.

1.0 Introduction

Waikato Regional Council is undertaking a sampling programme to ascertain soil concentration of various contaminants in soil within the residential area of Moanataiari, Thames, which has been built on reclaimed land. The reclamation included the deposition of mining waste.

Preliminary soil sampling has found elevated concentrations of arsenic, ranging from 5000 mg/kg within waste at about 1 m depth to 21 – 350 mg/kg in surface samples. All of the surface concentrations and deeper samples exceed the Soil Concentration Standard[1] (SCS) of 20 mg/kg for the residential use scenario (MfE, 2011). The exceedances for surface soil indicate a risk to human health for at least young children for the chronic (long-term) exposure assumed for the SCS. The elevated concentrations raise the possibility of there also being an acute risk for residents accidentally or deliberately ingesting larger amounts of soil than assumed for the SCS derivation, as a one-off or short term exposure. This would include soil-pica[2] behaviour of some children.

The Waikato Regional Council has engaged Pattle Delamore Partners Limited to consider whether the detected concentrations at Moanataiari could pose an acute risk. This report presents the result of the study. The study is intended to contribute to decisions made by various regulatory authorities regarding further investigations and the public health advice provided to residents.

Given the shortness of time in preparing this report, the views expressed are preliminary.

2.0 Study Approach

The basic approach to the study is to calculate allowable soil concentrations that result in a daily intake (expressed as mg/kg-bw/day) equivalent to a safe or reference dose derived for acute exposure. The equation used for these calculations is:

Estimated exposure dose = (arsenic concentration in soil) x (intake rate of soil) x (bioavailability factor) / body weight

An acute reference dose is required. The relatively limited literature is reviewed in the next section. The approach taken for this was to consider a number of review studies and also a number of studies similar to this one, in which a reference dose was required to calculate potentially acutely toxic soil concentrations. In some instances the original papers referenced by these studies were consulted, but time constraints generally did not permit this.

An intake rate is also required. Both intake rate (mg/day) and body weight (kg) are dependent on the particular exposed person. The choice of intake rate must be made hand-in-hand with the choice of body weight, or in other words a critical receptor must be determined. Typically, a small child is more likely to ingest relatively large amounts of soil (grams per day) than an adult and with a lower body weight, the normalised dose is larger. The small child is therefore most likely the critical receptor. For consistency with MfE (2011) a 13 kg toddler has been chosen as the critical receptor. Likely soil ingestion rates for a small child are explored in Section 4.

The equation above also includes a bioavailability factor. It is typical in contaminated land practice to assume 100% bioavailability for the contaminant in soil. In other words, 100% of the contaminant measured in the soil (using total recoverable analysis) passes through the gastro-intestinal tract into the blood stream, where the contaminant is then available to cause various adverse effects on the health of the person. This is the approach adopted by MfE (2011) in deriving chronic SCSs and is also the approach adopted by many overseas jurisdictions. However, it is well-known that

[1] Developed for the National Environmental Standard (NES) for Assessing and Managing Contaminants in Soil to Protect Human Health (MfE, 2011).

[2] Pica is a condition where individuals, typically children, ingest non-food items. Soil-pica is specifically related to ingestion of soil.

arsenic in soil is not 100% bioavailable (Juhasz *et al*, 2003) and some studies attempt to account for reduced bioavailability.

The calculations in this study (section 5) have assumed 100% bioavailability (bioavailability factor = 1), but a discussion on the range of possible bioavailability factors is included in Section 6.

3.0 Review of Acute Toxicity of Arsenic

3.1 Symptoms of Acute Arsenic Toxicity

There is very little information on acute toxicity of arsenic published in the scientific literature. Most of the cases of acute arsenic toxicity reported are from accidental ingestion of high concentrations of arsenic in insecticides or pesticides and, less commonly, suicide attempts.

Small amounts of arsenic (<5 mg) result in vomiting and diarrhoea but this usually resolves within 12 hours (Kingston *et al*, 1993). Other clinical manifestations of low-dose acute arsenic toxicity include nausea, vomiting, colicky abdominal pain, profuse watery diarrhoea and excessive salivation (Ratnaike, 2003).

Ingestion of large doses of arsenic may lead to acute symptoms within 30 – 60 minutes, but the effects may be delayed when the arsenic is taken with food. Acute gastrointestinal syndrome is the most common presentation of acute arsenic poisoning. This syndrome starts with a metallic or garlic-like taste associated with dry mouth, burning lips and dysphagia (difficulty in swallowing) (WHO, 2001). At higher doses symptoms may also include acute psychosis, skin rashes, peripheral neuropathy (with symptoms ranging from pin and needles sensations in hands and feet to loss of fine motor control), cardiomyopathy (heart muscle weakness), pulmonary oedema and seizures (Ratnaike, 2003). Other consequences of acute arsenic poisoning can include bone-marrow depression, haemolysis (breaking open of the red blood cells), hepatomegaly (abnormal enlargement of the liver), melanosis (abnormally dark pigmentation of the skin) and encephalopathy (ATSDR, 2007; WHO, 2001).

The extent of arsenic poisoning depends on various factors such as dose, individual susceptibility (there is some evidence that Asian populations are less susceptible to some of the effects of arsenic poisoning) and the age of the affected individuals (due to differences in body weight) (Schuhmacher-Wolz *et al*, 2009).

For arsenic, the United States Agency for Toxic Substances and Disease Registry (ATSDR) consider oral exposure (e.g. ingestion of contaminated soil) to be the most important route for acute toxicity and contaminated soils pose a particular risk to children due to soil-pica and hand-to-mouth activities (ATSDR, 2007).

3.2 Acute Oral Reference Dose (Non-Lethal Health Effects)

A review of the literature found three sub-lethal reference doses reported in literature (ATSDR, 2007; US EPA, 2001 and Tsuji *et al*, 2004). International agencies such as the World Health Organization (WHO) do not appear to have derived an acute reference dose. Most attention has been paid to the long-term chronic effects, particularly carcinogenicity.

ATSDR derived a minimal risk level (MRL) for acute exposure (1 to 14 days) to arsenic of 0.005 mg/kg-bw/day. This value was derived from the findings of a poisoning case in Japan of 220 people ingesting contaminated soy sauce (ATSDR, 2007). In this study the arsenic intake was estimated to be 3 mg/day (or 0.05 mg/kg-bw/day assuming an average Asian body weight of 55 kg). An uncertainty factor of 10 was then applied to derive a short term (exposure of less than 14 days) MRL for arsenic of 0.005 mg/kg-bw/day. Facial oedema and gastrointestinal symptoms (nausea, vomiting and diarrhoea) were considered by ATSDR to be the critical effects for which the acute MRL was derived to protect against.

An MRL is a screening level defined as an estimate of daily human exposure to a substance that is likely to be without an appreciable risk of adverse effects (ATSDR, 2007). Exposure to a level above the MRL does not mean that adverse health effects will occur. ATSDR also notes that MRL can be viewed as a mechanism to identify those hazardous waste sites that are not expected to cause adverse health effects.

Region 8 of the US EPA (US EPA, 2001) (not seen but cited in a variety of US EPA risk assessment documents) published a study of acute and chronic reference doses intended to apply to exposures of one to 14 days and 15 days to seven years. The report concludes that a NOAEL (no observed adverse effect level) value of 0.015 mg/kg-bw/day from a study by Mazumder *et al* (1998) can be used for acute and sub-chronic reference dose values, with an uncertainty factor of 1. Alternately, the LOAEL (lowest observed adverse effect level) of 0.05 mg/kg-bw/day and an uncertainty factor of 3 (for extrapolation from the LOAEL to the NOAEL) could be selected from this same study. A full factor of 10 was not employed in US EPA (2001) because the NOAEL "is likely at an exposure only slightly below the effect level".

Tsuji *et al* (2004) recommended an acute reference dose for children of 0.015 mg/kg-bw/day. Although this study was published before the final ATSDR was released it contains a wider range of studies and more recent data than that considered by ATSDR[3] (seven studies including the soy sauce incident in Japan, ingestion of contaminated groundwater in the US, ingestion of Fowler's Solution (1% As_2O_3) and recent data from the use of arsenic-containing drugs used to treat leukaemia (IV infusion)). An uncertainty factor of 3 was used to derive the acute reference dose. Tsuji *et al* notes that the database for acute or relatively short-term effects is less robust than that for sub-chronic and chronic exposures. Their rationale for using an uncertainty factor of 3 instead of 10 was that:

- the NOAEL appears to be within an order of magnitude or less of the LOAEL data;
- prevalence of effects is based on study populations that are generally 0-9 years old who have had cumulative exposure (i.e. higher prevalence of effects) and possibly a lower calculated dose-per-body-weight than an average dose for younger ages;
- exposed populations include malnourished children and other sensitive individuals, which may increase susceptibility to arsenic;
- populations evaluated for sub-chronic effects often had *in utero* exposure via drinking water. In a risk assessment application for arsenic in soil, *in utero* exposure would be low because of the lower soil ingestion rates of adults/pregnant women compared to children;
- doses for water exposure in some studies do not account for additional exposure from inorganic arsenic in foods or drinking water; and
- many of the studies include broad categories of exposure in which misclassification (e.g. use of an average or median dose for a group with a range of exposure) has likely led to underestimation of exposure in subjects exhibiting effects, and thereby potential downward bias in the LOAEL.

We consider the acute reference dose derived by Tsuji *et al* (2004) to be more robust than ATSDR (2007) due to the wider range of studies used to derive the value and better consideration of biases in the original data.

3.3 Acute Oral Reference Dose (Lethal)

There is a large number of studies in humans on the lethal effects of ingestion of inorganic arsenic compounds and in most cases toxicity has occurred from accidental, suicidal, homicidal, by medical ingestion of arsenic powders or

[3] ATSDR (2007) contains the same discussion for the acute MRL as the 2001 version of the same document. The authors of ATSDR (2007) do not appear to be aware of Tsuji *et al* (2004).

solutions, or by consumption of contaminated food or drinking water (ATSDR, 2007). However, in most cases reliable estimates of the ingested dose are not available, meaning quantitative information on lethal dose in humans is sparse (ATSDR, 2007). A literature review conducted by ATSDR found that the lethal dose of arsenic was probably between 1 and 3 mg/kg-bw of arsenic.

Washington State Office of Environmental Health concluded that the lethal dose of arsenic in humans was between 0.32 and 2.37 mg /kg-bw, with the best estimate of 1 mg /kg-bw (White, 1999). Another study has concluded that the lethal dose of inorganic arsenic in acute poisoning ranged from 100 mg to 300 mg, with the estimated acute lethal dose in humans being about 0.6 mg/kg-bw/day (Ratnaike, 2003).

Based on these studies, we have adopted an acute lethal oral reference dose for arsenic of 1 mg/kg-bw.

3.4 Limitations in Acute Oral Reference Doses

There are a number of uncertainties associated with the estimates of the acute oral reference doses. The data used to derive these reference doses is limited (for the non-lethal acute toxicity reference dose only seven case studies were used to derive this value). In most of these studies (the two leukaemia-treatment studies may be the exception) the doses involved have been estimated. None of these studies involved exposure to arsenic in soil. In most cases the chemical ingested was in soluble form which is likely to be more bio-accessible than the forms of arsenic found in the soil. Therefore, the dose from ingesting arsenic contaminated soil required to produce the same toxicological effect may be significantly different (higher).

A further limitation of the data used in these studies is that the dose estimates are not minimum doses required to produce the specific toxicological endpoint; rather they are the doses that were observed to result in a specific toxicological endpoint. Therefore the actual minimum dose to produce the specific toxicological endpoint could be lower.

Also, the chemical form (or speciation) of arsenic is uncertain in some of the studies. There are two main chemical forms which commonly occur; Arsenic (III) and Arsenic (V). Arsenic (III) is regarded as being much more toxic than Arsenic (V), however Arsenic (V) is the predominate form found in the environment (Wilson *et al*, 2010). In some studies used to derive the acute reference doses the arsenic ingested has been the more toxic Arsenic (III). This may mean the calculated soil concentrations based on these reference doses overestimate the risk.

As noted above, ATSDR notes that exposure to a level of arsenic above the MRL does not mean that adverse health effects will occur; rather they are screening values which, when exceeded, are intended to alert the public health professionals to examine the situation more closely. This advice is pertinent to both of the derived acute reference doses used in this study. More reliable indictors of arsenic toxicity are the biological exposure indices recommended by the Department of Labour (2010) and the WHO recommended action level for intervention of 100 μg/L in urine (ATSDR, 2007).

4.0 Soil Ingestion Rates

Most children ingest small quantities of soil (e.g. < 50 mg/day), however small children (1-6 years old) can occasionally ingest much greater rates of soil (referred to as soil-pica). Children of less than 6 years of age have a tendency to place their hands and other objects in their mouths more frequently than do older children or adults (Paustenbach, *et al*, 2006). For the purposes of deriving an acute soil guideline value for short term exposure to arsenic an upper bound estimate of soil ingestion rate is required, rather than the average soil ingestion rate used to derive the SCSs for the contaminated soil NES (MfE, 2011).

The amount of soil ingested varies greatly from child to child and also from day to day for each child, and very few reliable studies of maximum children soil ingestion rates are available. Children of 18-24 months of age are generally

believed to ingest the most soil per kilogram of body weight (White, 1999; Calabrese *et al*, 1997a), based on the frequency of observed hand-to-mouth activities.

Studies cited in US EPA (2008) suggest that the upper 95th percentile for soil ingestion for children is approximately 208 mg/day with a maximum soil ingestion rate of 7,703 mg/day (US EPA, 2008). However, a recent meta-analysis of the same four mass-balance tracer studies cited in US EPA (2008) found the 95th percentile for normal children to be 79.4 mg/day (Stanek *et al*, 2011). This study excluded clear soil-pica children.

In one of the soil tracer studies cited by Stanek *et al*, (2011) a 2½ year-old girl was found to have ingested 20,000 to 22,000 mg on two of four days. During the same study a young girl was observed to have ingested between 1,000 and 2,000 mg of soil in a seven-day period (Calabrese & Staneck, 1998). Another study of pre-school children who lived near the Anaconda metal smelter in the US state of Montana found one soil-pica child with an estimated soil ingestion rate of between 719 and 2,828 mg/day depending on the soil tracer used (Stanek & Calabrese, 2000). A soil-tracer study undertaken in Jamaica of institutionalised children found that the soil-pica ingestion rate varied from 898 to 10,343 mg/day with an average soil ingestion rate of 5,000 mg (Wong, M.S. , 1988, in Calabrese & Stanek, 1993).

It is not clear how many children may display soil-pica behaviour and how frequently they may be engaged in ingesting large amounts of soils. In a number of different studies soil-pica behaviour has been estimated as occurring in between 4% to 21% of children evaluated (Barltrop, 1966; Robischon, 1971; Shellshear, 1975 and Vermeer & Frate, 1979). However, some of these estimates are based on observations of mouthing behaviour, rather than actual measurements of ingested soil. As pointed out by Calabrese *et al* (1997b), parental reports of high soil ingestion in their children was not borne out by soil tracer measurements of the same children.

Calabrese and Stanek (1998) used statistical techniques to estimate that 42% of preschool children will ingest more than 5,000 mg of soil once or twice during their preschool years, however the authors of this report admit that they may have overestimated the percentage of children who are engaged in soil-pica behaviour. They note:

> *While it is true that some children will ingest large amounts of soil, it is far from certain whether soil pica is behavior that only a small subgroup displays over a limited number of years (e.g., one to six) or whether most children, on occasion, display this behavior or some combination of both behavioural patterns.*

In its *Child-Specific Exposure Factors Handbook* (US EPA, 2008), the US EPA estimates that the amount of soil ingested by a pica child is greater than 1g of soil per day, citing typical rates between 1,000 to 5,000 mg/day with a maximum reported soil-pica ingestion rate of 41,000 mg/day. The US EPA recommends a soil-pica ingestion rate of 1,000 mg/day for use in risk assessments (US EPA, 2008)[4]. The Washington Department of Health states that the range of commonly occurring short-term soil ingestion rates for children is 1,000 to 2,000 mg/day, with the upper 95th percentile of 1751 mg/day being the best estimate (White, 1999). These figures appear to be limited to only one study and therefore may not encompass the full range of soil ingestion rates displayed by pica children.

ATSDR recommends that in the absence of any reliable estimate of short term soil ingestion rates for children that a soil ingestion rate of 5 g/day should be used for deriving acute soil guideline values (ATSDR, 2000). It was noted at the workshop reported in ATSDR (2000) that the few reports of very high soil ingestion were from a few children in only two studies, with the highest rate reported being from a "developmentally disabled" child (the inference being this was not "true" soil-pica). Other criticism by workshop participants was that rates greater than 5000 mg/day were derived by considering only manganese as a tracer (ATSDR, 2000). Other tracers, particularly aluminium and silicon, are generally considered to be more reliable.

[4] Reduced from a recommendation of 10,000 mg/day in 2000 and 2006 external review draft versions of US EPA (2008).

Based on the literature reviewed we believe the ATSDR recommendation of 5 g/day (5000 mg/day) provides a reasonable value for calculating the acute risk for a soil-pica child.

5.0 Calculations

We have carried out calculations using the equation given in Section 2 to derive two soil concentrations; the "Acceptable Acute Soil Concentration", at which the onset of observable health effects in a young child might occur, and a "Potentially Lethal Soil Concentration" at which death might occur, if the amount of soil for which the calculations have been carried out was in fact ingested.

We have carried out the calculations for five soil ingestion rates:

- 50mg/day, being the estimated rate for an average child used to derive the NES SCS (MfE, 2011), to demonstrate what concentrations can be tolerated in the short term for a "normal" child;
- 200 mg/day, being the value recommend by the US EPA (2008) as being an upper bound for a "normal" child (95th percentile, but probably higher than that);
- 1000 mg/day, being a value at the lower end of the soil-pica range;
- 5000 mg/day, being a value recommended as being reasonable for the soil-pica child; and
- 10,000 mg/day being towards the extreme end of the range for a soil-pica child, although not as high as some reported rates.

The calculations are set out in Table 1, below. An alternative set of calculations have been carried out for the lower MRL recommended by ATSDR (2007), as a means of comparison. These calculations are appended as Table 2.

Table 1: Recommended acceptable and potentially lethal soil concentrations at various ingestion rates

	Soil Ingestion rate (mg/day)				
	50	200	1000	**5000** [1]	10,000
Acceptable Acute Soil Concentration[2] (mg/kg)	3,900	975	195	**39**	20
Potentially Lethal Soil Concentration[3] (mg/kg)	260,000	65,000	13,000	**2,600**	1,300

Notes:
1. Bold indicates recommended values
2. Calculated for a reference dose of 0.015 mg/kg bw
3. Calculated for a potentially lethal dose of 1 mg/kg bw

It is beyond the scope of this report to compare the measured concentrations in any detail with the calculated values in Table 1. However, it is immediately apparent that, for the range of measured soil concentrations given in the introduction of this report, even at the upper bound of soil ingestion rates for the "normal" young child, the measured concentrations do not present an acute risk. Even the highest measured concentrations, found for soil below the surface, fall well short of lethal concentrations for the "normal" non-pica child.

However, for a soil-pica child the highest measured concentrations at the surface are above calculated concentrations for the onset of health effects at a soil ingestion rate of 1000 mg/day and, for our recommended pica ingestion rate of

5000 mg/day, many of the measured soil concentrations exceed the calculated concentration for the onset of effects. None of the measured surface concentrations come close to the calculated lethal soil concentration.

6.0 Other Factors

A variety of other factors may come into play in determining the actual likelihood of acute effects from soil ingestion. These include:

- the likelihood of a small child actually living on a property with sufficiently high concentrations **and** having a soil-pica habit;
- whether the arsenic is as bioavailable as the toxicity estimates assume; and
- whether the arsenic is in as toxic a form as the toxicity estimates assume.

There is insufficient sampling data to have any certainty regarding the number of residential properties that might have sufficiently high concentrations to cause health effects from short-term ingestion of arsenic with soil. There are approximately 200 households in the area studied. Census data from 1996, 2001 and 2006[5] show an average of 27 children aged 0 – 4 in the four census "meshblocks" that cover the majority of the study area. If it is assumed that there is an even distribution of ages within this group and that children less than one year old are unlikely to be mobile enough or have the unsupervised opportunity to ingest large quantities of soil, then we are left with perhaps 20 children in the age range that may display pica behaviour.

Twenty six surface soil sample results are currently available over the study area. Of these, approximately 70% exceed the recommended acceptable soil concentration, but as noted above, none exceed the potentially lethal soil concentration. Ignoring any spatial trends that may exist, and assuming the soil samples are representative of the soil in general (a large assumption given the small number of samples), perhaps 140 residential properties have soil concentrations in excess of the acceptable concentration. It is not possible to determine without more detailed examination of the census data how many households the estimated 20 children aged 1 – 4 occupy. At most it will be 20 households, but quite possibly it will be a smaller number. Taking the maximum number, and assuming the children are evenly distributed about the area, then perhaps 70% of 20 children, or 14 children, are exposed to an acute risk if they have a pica habit.

The question then is; how many of those children will, in fact, have a soil-pica habit? As noted earlier, the literature is not very helpful. Estimates range from a small proportion (a few percent) regularly ingesting relatively large amounts of soil up to tens of percent a few times per year. On this basis, there might be less than an average of one child routinely exposing themselves to an acute risk up to perhaps five or six children.

The greatest concentrations exist in the eastern part of the subdivision. All the samples in this area exceeded the acceptable soil concentration for acute exposure at 5000 mg/day ingestion rate (39 mg/kg), with the lowest measured concentration being 46 mg/kg. Most samples in this eastern area were at least three times the acceptable concentration, with a couple in excess of eight times the acceptable concentration. An estimated six children aged 0 – 4 live in this area. This number is too small to assume there are babies, thus six children risk effects from acute exposure if they have a soil-pica habit. It is quite likely that no small children have this habit in the eastern area, but perhaps up to one or two children may ingest sufficient soil for that risk to be realised.

Clearly, as the soil concentrations increase the possibility of effects increases. However, if the current results are representative of the area as a whole, the likelihood of a child with the soil-pica habit actually living on one of the properties with the higher concentrations is small, perhaps negligible.

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[5] http://www.stats.govt.nz/Census/2006CensusHomePage/MeshblockDataset.aspx?tab=Download accessed 10 November 2011

The highest concentrations measured in surface soils over the study area are well short of the estimated potentially lethal concentration of 2,600 mg/kg. Thus symptoms of poisoning that might occur are expected to be at the lower end of the scale, perhaps gastrointestinal upsets, nausea and the like. Against the normal background of such symptoms from other causes, occurrences of poisoning from soil ingestion are less likely to be noticed.

It is well-known that arsenic in soil is not 100% bioavailable. The main studies from which the acute reference dose was derived (Tsuji *et al*, 2004) involved contamination of soy sauce, probably with calcium arsenate, and from intravenous treatment of leukaemia with arsenic-containing drugs. Calcium arsenate is highly soluble and presumably highly bioavailable, as will be the arsenic in the cancer treatment drugs. Bioavailability in soil, relative to soluble salts, measured using animal studies as reported in Juhasz *et al* (2003) and Ng *et al* (2010), ranges from a few percent to about 70%. The bioavailability very much depends on the original source and form of arsenic, the age of the contamination and the mineralogy of the soil. Mining sources of contamination often, but not always, have low bioavailability.

It would be speculative to attempt to assign a bioavailability factor to the Moanataiari soils, however it is a reasonable assumption that the bioavailability is not 100%. Given this, the acceptable concentrations for the soils will be higher by some unknown amount than the calculated values. In other words, the actual risk of acute effects from a pica child ingesting large amounts of soil will be even lower than that suggested above. That is not to say, however, that at the higher surface soil concentrations found mainly on the eastern side of the study area, adverse health effects would not occur should a child ingest excessive quantities of soil.

7.0 Conclusions

The scientific literature has few case studies providing robust assessments of the NOAEL/LOAEL and lethal doses for acute exposure to arsenic. A non-exhaustive review of the literature has found estimates for the reference dose at which no significant health effects are expected in the range 0.005 – 0.015 mg/kg-bw/day. The most robust assessment appears to be that of Tsuji *et al* (2004), who recommend 0.015 mg/kg-bw/day. This value has been chosen for this assessment. A similar review found lethal doses from short-term exposure in the range 0.6 – 3 mg/kg-bw/day. On-balance, a value of 1 mg/kg-bw/day seems reasonable and has been used in this report.

The greatest risk in the community arises from the accidental or deliberate ingestion of unusually high rates of soil by young children who exhibit behaviour known as soil-pica. Few robust studies of the behaviour exist, but the incidence is generally considered to be low, ranging from a very small number of children with a relatively frequent habit, to a larger number of children with a rare habit. Daily soil ingestion estimates range from 1000 mg to tens of thousands of mg. Government authorities in the United States variously recommend ingestion rates of 1000 and 5000 mg/day for risk assessment purposes. We have chosen 5000 mg/day as an appropriate rate for this assessment. This contrasts with the average rate of soil ingestion for a normal child of about 50 mg/day and an upper bound (at least 95th percentile) for a normal child of about 200 mg/day.

We have used the selected reference and lethal doses and soil ingested rates to calculate acceptable acute soil concentrations and potentially lethal soil concentrations. At the selected soil-pica ingestion rate and a reference dose of 0.015 mg/kg-bw/day, the calculated acceptable soil concentration threshold, assuming 100% bioavailability, is 39 mg/kg. At the selected pica ingestion rate and the potentially lethal dose of 1 mg/kg-bw, the potentially lethal soil concentration is 2,600 mg/kg.

The acceptable soil concentration is lower than some of the concentrations measured within surface soil at Moanataiari, indicating a potential acute risk. However, the calculated potentially lethal soil concentration is much higher than any surface soil concentration measured to date at Moanataiari, indicating minimal risk of a lethal dose. Higher concentrations than the potentially lethal concentration have been measured at 1 m below the ground, but contact with this soil is much less likely than surface soil.

The calculated acceptable and potentially lethal soil concentrations assume 100% bioavailability. Arsenic in soil is known to range from a few percent up to about 70% bioavailable relative to ingestion of soluble salts. Unfortunately, the bioavailability of arsenic in the Moanataiari soil is not known and cannot be readily measured with any certainty. The best that can be said on the current information is that the calculated soil concentrations are low (conservative) by a factor of between about 1.4 and 25 times.

Population statistics and the prevalence of soil-pica in children suggests that very few if any children at Moanataiari will actually ingest dangerous amounts of soil, but the risk cannot be dismissed.

As the measured concentrations exceed the Soil Concentration Standard for arsenic developed for the new soil contamination National Environmental Standard (MfE, 2011), a risk requiring management is indicated for long-term exposure. Further sampling is required to better understand the range of arsenic concentrations and spatial distribution over the Moanataiari area in general and within individual properties, and therefore better understand and manage the risk to residents.

We trust this assessment provides the information you were seeking. Should you have any queries please do not hesitate to contact one of the undersigned.

Yours sincerely

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Table 2: Alternative acceptable and potentially lethal soil concentrations at various ingestion rates

	Soil Ingestion rate (mg/day)				
	50	200	1000	**5000** [1]	10,000
Acceptable Acute Soil Concentration[2] (mg/kg)	1,300	325	65	**13**	7
Potentially Lethal Soil Concentration[3] (mg/kg)	260,000	65,000	13,000	**2,600**	1,300

Notes:

1. Bold indicates recommended values
2. Calculated for a reference dose of 0.005 mg/kg bw
3. Calculated for a potentially lethal dose of 1 mg/kg bw