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Your Report

Arsenic Bioavailability Assessment

Former Pipfruit Orchards on Mapua and Ranzau Soils, Tasman District

Massey University and Tasman District Council

THE CONTAMINATED SITE CONSULTANCY

Certification and record of review

Roles	***Person Responsible***	***Position***	***Relevant Experience***	***Signature***	***Contaminated Land Specialist Accreditation***
Report Preparation	Dr. Dave Bull	Director	12 years		
Report Review	William Lines	Director	25 years		

Report checklist

Summary contaminated sites report checklist					
Report contained in this document	☐	☑	☑	☐	☑
Report sections and information to be presented	PSI	**SIR**	RAP	SVR	MMP
Executive summary	R☐	**R☑**	R☐	R☐	R☐
Scope of work	R☐	**R☑**	R☐	R☐	R☐
Site identification	R☐	**R☑**	R☐	R☐	R☐
Site history	R☐	**S**	S	S	S
Site condition and surrounding environment	R☐	**S**	S	S	S
Geology and hydrology	A	**R☑**	S	S	S
Sampling and analysis plan and sampling methodology	A	**R☑**	X	R☐	R☐
Field quality assurance and quality control (QA/QC)	N	**R☑**	X	R☐	S
Laboratory QA/QC	N	**R☑**	X	R☐	X
QA/QC data evaluation	N	**R☑**	X	R☐	X
Basis for guideline values	R☐	**R☑**	R☐	R☐	R☐
Results	A	**R☑**	R☐	R☐	S
Site characterisation	R☐	**R☑**	R☐	R☐	R☐
Remedial actions	X	**X**	R☐	S	S
Validation	X	**X**	X	R☐	S
Site management plan	X	**X**	R☐	S	S
Ongoing site monitoring	X	**X**	X	N	R☐
Conclusions and recommendations	R☐	**R☑**	R☐	R☐	R☐

Key:

R - the corresponding heading and details are required

A - readily available information should be included

S - a summary of this section's details will be adequate if detailed information has been included in an available referenced report

N - include only if no further site investigation is to be undertaken

X - not applicable and may be omitted.

Checklist Ref: MfE 2011a

Summary

Tasman District Council (TDC) commissioned Massey University (Massey) to investigate oral bioavailability of arsenic at former orchard sites selected by TDC, and prepare a 'Tier II' health risk assessment for sampled soil types. Massey, in turn, commissioned HAIL Environmental Ltd (HAIL Environmental) to assist with this work as a specialist contaminated land subcontractor with experience in bioavailability assessment. HAIL Environmental undertook additional soil sampling at the direct instruction of TDC. This report presents HAIL Environmental's results and conclusions.

The actual bioavailability of arsenic (and lead) in former orchard soils is likely to be a function of the soil type. Therefore, any general assessment of arsenic bioavailability must take soil type into account. TDC selected two soil types as being of particular interest:

- Ranzau soils, the dominant soil type across the eastern Waimea Plains, in the northeast of Tasman District. This area is under significant residential and lifestyle development pressure from the expanding township of Richmond.
- Mapua soils, a dominant soil type across the Moutere Depression, west of the Waimea Plains, in the north of Tasman District. This area produced much of the district's apple crop from the 1910s onward (Gaw 2001) but is now under significant development pressure from conversion to lifestyle blocks.

A number of historic orchard sites on both Ranzau and Mapua soils were inspected, and six of the Mapua sites were sampled. However, only one historic orchard on Ranzau soils was confirmed to exceed soil contamination standards (SCS), at Paton Road. This orchard has been subdivided into two sites, one of which has been converted to market gardening, while the other is used for growing berryfruit.

Soil samples were analysed for arsenic bioaccessibility using the SBRC gastric protocol. Supporting chemical analysis included other heavy elements associated with different sources of arsenic, elements associated with key binding phases, and phosphorus, which can compete with arsenic for binding sites. Supporting mineralogical analysis included particle size analysis and scanning electron microscopy with energy-dispersive X-ray spectroscopy analysis (SEM-EDAX).

Arsenic oral bioavailability at the Paton Road sites is estimated to be tightly clustered at around 14 %. This is a particularly low result, consistent with the moderately high iron content of the Ranzau soils, which have a distinct ultramafic character. It is substantially less than the 100 % assumed within national SCS. Incorporating this estimated bioavailability value into the soil ingestion pathway of the MfE model, and into the 'soil entrained on vegetables' element of the home-grown produce pathway, generates site-specific soil guideline values significantly greater than the generic SCS. The Paton Road sites may be fit for residential purposes if arsenic bioavailability is taken into account.

At the Mapua sites, results depend on the choice of bioavailability estimate, which could be either an upper bound to the mean of 38 %, or the maximum calculated value of 47 %. In either case, the result is significant, as the study sites may be fit for residential purposes if arsenic bioavailability is taken into account. The results are consistent with supporting analyses and with reported results from orchard soils in the USA and Australia.

Whichever statistic is used, given that similar results were obtained from six different orchards, HAIL Environmental considers that the bioavailability estimate could be applied to any other former pipfruit orchard on the Mapua soil type, providing there is no other arsenic source; that is to say, it can be used to generate a soil-specific guideline value.

More generally, the results are consistent with USEPA's view that arsenic bioavailability rarely exceeds 60 %.

Based on the findings of systematic sampling, and of quality assurance and quality control procedures including replicate analysis at an academic laboratory specialising in bioaccessibility, the underlying bioaccessibility dataset is considered accurate and repeatable. For the Mapua soils, the dataset is considered likely to be representative of former pipfruit orchards on that soil type in general. For the Ranzau soils, because the two sites that were investigated were part of a single historic orchard, the dataset is considered limited and may not be representative of that soil type in general. Reproducibility is unproven because replicate gastric extraction is still to be undertaken: when results are available they will be issued as a supplement to this report.

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1. Introduction

1.1 Background

Apples and pears ('pipfruit') have been grown in New Zealand since Europeans first settled in the country, being exported as early as the late 19th century (Te Ara 2008).

One major pest affecting pipfruit production in New Zealand was codling moth, an introduced species native to Europe. Until the 1950s – anecdotally, as late as the 1980s in some locations – codling moth was controlled by spraying orchards with lead arsenate.

Lead arsenate is toxic to humans and a wide variety of environmental receptors, and its elemental constituents – lead and arsenic – do not break down in the environment. Consequently, historic pipfruit orchards are now deemed potentially contaminated land (MfE 2011b). Investigations in Tasman District have often found that such orchard land often exceeds national soil contaminant standards (SCS) for arsenic in residential use scenarios (e.g. Gaw 2003, Gaw et al. 2008).

On first principles, it is likely that the SCS is overprotective of future residents' health. The SCS is derived via 'Tier I' generic health risk assessment and must be protective in the majority of situations. Therefore, it necessarily contains conservative assumptions about contaminant properties and receptor behaviour. One assumption is that the arsenic has 100 % oral bioavailability – that is, if a person ingests soil or soil-derived dust, all the arsenic it contains will be taken up into the body. In the specific case of lead arsenate in pipfruit orchard soils, this assumption is likely to be significantly conservative; this point is discussed further in Section 3.2.

The actual bioavailability of arsenic (and lead) in former orchard soils is likely to be a function of the soil type. This point is discussed further in Section 3.2. Therefore, any general assessment of arsenic bioavailability must take soil type into account.

Accordingly, Tasman District Council (TDC) commissioned Massey University (Massey) to investigate oral bioavailability of arsenic at former orchard sites selected by TDC, and prepare a 'Tier II' health risk assessment for sampled soil types. Massey, in turn, commissioned HAIL Environmental Ltd (HAIL Environmental) to assist with this work as a specialist contaminated land subcontractor with experience in bioavailability assessment. HAIL Environmental undertook additional soil sampling at the direct instruction of TDC. This report presents HAIL Environmental's results and conclusions.

1.2 Scope of work

HAIL Environmental's scope of work comprised:

- Preparing a soil sample collection and laboratory analysis plan
- Interpreting chemical and mineralogical data
- Obtaining academic review of the analysis and interpretation
- Revising the conceptual site model
- Undertaking Tier II health risk assessment
- Preparing a report (this report).

This report is not in itself a DSI for the purposes of the Resource Management (National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health) Regulations 2011 ('the NES:CS').

1.3 Site identification

TDC selected two soil types as being of particular interest:

- Ranzau soils, the dominant soil type across the eastern Waimea Plains, in the northeast of Tasman District. This area is under significant residential and lifestyle development pressure from the expanding township of Richmond.
- Mapua soils, a dominant soil type across the Moutere Depression, west of the Waimea Plains, in the north of Tasman District. This area produced much of the district's apple crop from the 1910s onward (Gaw 2001) but is now under significant development pressure from conversion to lifestyle blocks.

A number of historic orchard sites on both Ranzau and Mapua soils were inspected. Several of these sites proved to be unsuitable, for a variety of reasons (refer Sections 3.1 and 4.1), but soil sampling proceeded at sites on:

- Paton Road, near Hope (Ranzau soil type)
- Land principally owned by Harakeke 2015 Limited near Mapua, around the intersections of Aporo, Horton, Mamaku and Permins Roads (Mapua soil type)

The general locations of the sampling sites are shown in Figure 1.

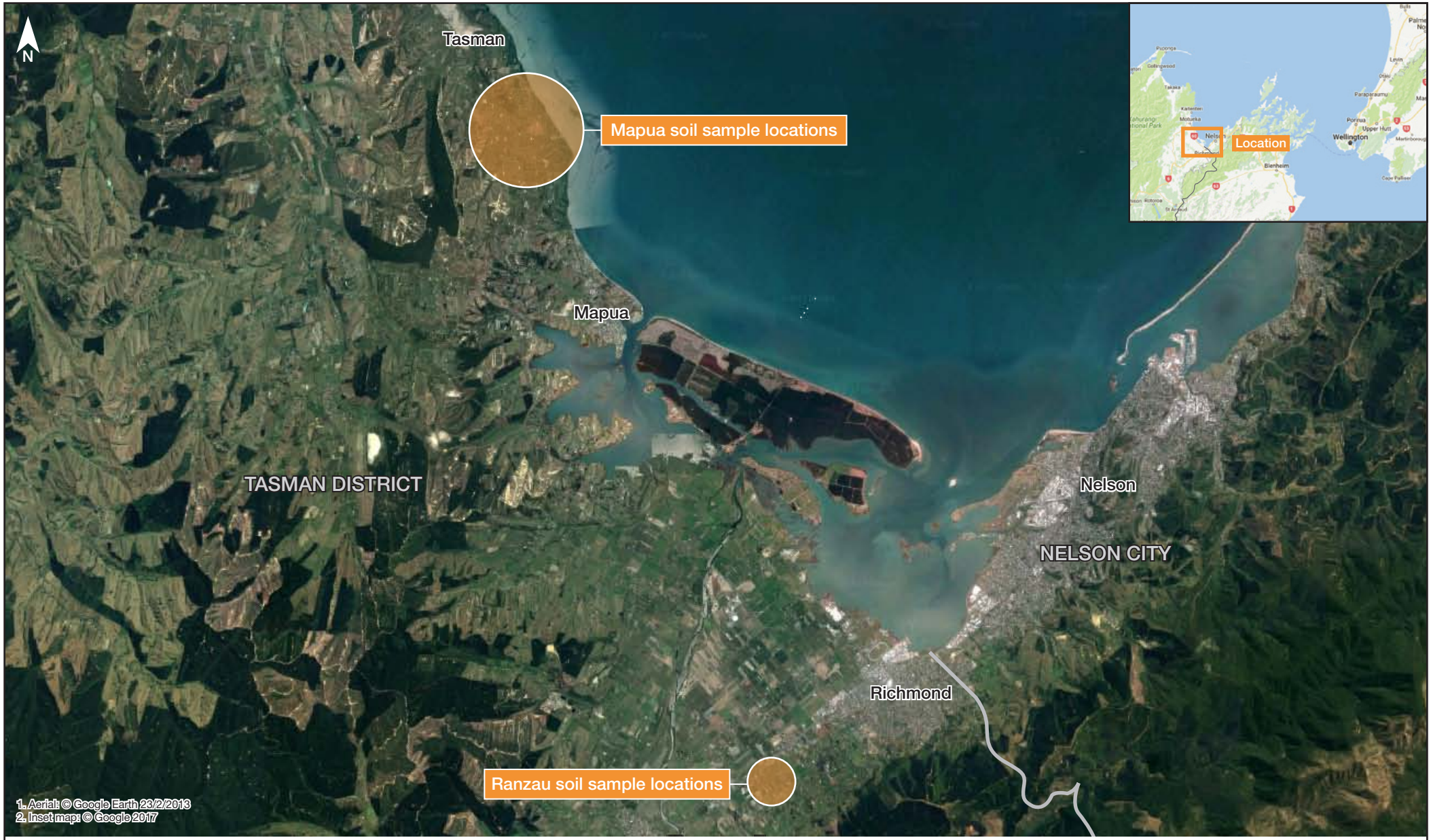

Figure 1: Soil Sampling Site Locations

Arsenic Bioavailability Assessment: Former Pipfruit Orchards on Mapua and Ranzau Soils, Tasman District

Drawn by Simon Garner, www.simonsaysdesign.co.nz | June 2017

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2. Arsenic, Bioavailability, and Risk Assessment

2.1 The environmental chemistry of arsenic

Synthesis

There are many reviews of arsenic sources, fate and transport in the environment. Three sources - Smith *et al.* (1998), Mahimairaja *et al.* (2005), and Kabata-Pendias (2011) – were particularly useful for the purposes of this study. Smith is also an author of a number of papers on arsenic bioavailability and bioaccessibility, and Mahimairaja *et al.* (2005) has particular relevance to New Zealand.

These reviews emphasise that arsenic typically enters soils from two classes of source with very different characteristics. Anthropogenic sources involve arsenical pesticides that are sprayed or deposited onto soil surfaces, or irrigation with arsenic-enriched water. Geogenic sources occur when arsenic-containing minerals are mined, smelted or weathered.

Environmental sources of arsenic

There are many man-made sources of arsenic. The use of lead arsenate in pipfruit orchards to control insect pests is the central focus of this study. Most timber in ground contact is treated with chromated copper arsenate (CCA) preservative, which is released gradually into water runoff through leaching and as the wood matrix breaks down. Arsenic-laced pellets have been used to control pest animals such as possums and rabbits. Sheep in New Zealand were regularly dipped for ectoparasite control, and arsenic was the insecticide of choice beginning in the mid-19th century. Poultry were often treated with the arsenic-based feed additive roxarsone (4-hydroxy-3-nitrobenzenearsonic acid). Most of these uses of arsenic were discontinued by the 1980s, apart from use of CCA in timber treatment which continues in New Zealand to this day.

Many arsenic minerals are known to occur naturally. The most common is arsenopyrite, a highly 'reduced' insoluble form where arsenic is bound to iron and sulphur. Related minerals include the arsenic sulphides – orpiment and realgar. Like any sulphur mineral, these forms slowly oxidise when exposed to air, forming iron arsenates such as scorodite and pharmacosiderite, and arsenic oxides. Some oxidised forms are sparingly soluble, especially in highly acidic conditions, and when they dissolve, arsenic is released into the surrounding environment.

Soil interactions

Regardless of source, once arsenic has been released into the environment, it begins to interact with soils. The interactions are complex and depend on the redox state of the soils, their acidity, and the presence or absence of certain other elements. They include chemical transformations like oxidation and reduction, precipitation and dissolution; and physico-chemical interactions such as adsorption and desorption on and off solid surfaces.

For arsenic in contaminated soils, the core focus is its two dominant chemical forms, referred to as 'arsenate' and 'arsenite', and discussed further below. These are referred to as the 'inorganic' forms of arsenic.

The dominant inorganic form of arsenic in soils is the 'fully oxidised' form called arsenate, which has chemical formula $As^{V}O_4^{3-}$. This form is most likely to dominate in oxic soils. Arsenate has a high affinity for the surfaces of certain common oxic soil constituents including iron, aluminum, and manganese oxyhydroxides, and to some extent to soil organic matter too. This affinity diminishes in soils that are particularly acidic.

Chemically, arsenate is very similar to phosphate (PO_4^{3-}), a nutrient that is essential to all life, and generally much more abundant than arsenate. If surface binding sites are in short supply, an excess of phosphate competes with arsenate, displacing it into solution and thus making it more soluble.

In anoxic, basic conditions, or in soil microenvironments that are anoxic, arsenates transform into arsenite ($As^{III}O_2^{-}$), which is less able to bind to particle surfaces. Moreover, iron and manganese oxides are also reductively dissolved in such conditions, releasing any arsenic bound to their surfaces. Thus, these conditions tend to mobilise arsenic. With further reduction, to sulfidic conditions, mobility will decrease again, as insoluble arsenic-sulphur minerals reform. This is particularly common in marine sediments.

To complicate matters, almost all these processes are mediated by biological action, as well as standard abiotic (non-biological) processes.

Arsenic toxicity

The toxicity of arsenate stems from its chemical similarity to phosphate, coupled with its equally definite refusal to fully perform the same biochemical roles. For example, arsenate is drawn into the ATP cycle as if it is phosphate, but then fails to carry out the same chemistry as phosphate at a critical step, stopping the cycle in its tracks.

Arsenite is even more toxic than arsenate – by perhaps 25 times. So the net effect of anoxic, basic conditions is to increase arsenic mobility and toxicity. But precipitation of arsenic minerals in sulfidic conditions greatly reduces mobility and therefore toxicity.

Inorganic arsenic can also be transformed by living organisms into 'organic' forms, a term which refers to the arsenic becoming incorporated into a larger carbon-based molecule. With some exceptions, organic forms of arsenic are relatively non-toxic. As two examples, marine fish convert inorganic arsenic to organic forms of arsenic as a detoxification mechanism, and various organic forms of arsenic have been detected in different plant species.

2.2 Arsenic bioavailability and bioaccessibility

Since the early 1990s it has been clear that, if laboratory animals are fed arsenic-containing soils, only a fraction of the arsenic is absorbed into the animals' bodies, while the remainder is excreted in the faeces (e.g. Freeman *et al.* 1993). The absorbed fraction is termed the arsenic oral bioavailability.

Given the range of chemical forms that arsenic can take in the environment, it is unsurprising that arsenic bioavailability can vary considerably from site to site. The warm, acidic stomach environment is well suited to liberating arsenic from mineral surfaces, and to some extent, to dissolving oxidised arsenic minerals. Consequently, at one extreme, readily dissolved forms of arsenic, such as sodium arsenate, are completely soluble, and apparently 100 % bioavailable.

In contrast, arsenic that is strongly adsorbed to iron oxyhydroxides and clay appears to have only moderate bioavailability. In USEPA studies of a wide range of soils, arsenic bioavailability rarely exceeded 60 % (USEPA 2012) and findings were similar in Australia (Smith *et al.* 2009). Mixed arsenic metal oxides such as scorodite and lead arsenate, and reduced forms such as arsenopyrite, realgar, and arsenic trioxide generally appear to have relatively low bioavailability, often less than 30 % (Griffin and Lowney 2013).

Overall, bioavailability appears to be greater when arsenic is from an anthropogenic source, compared to geogenic sources, and greater in finer-grained soils than coarser-grained soils (Smith *et al.* 2009, Ollson *et al.* 2016). Intuitively, these findings make sense, as arsenic adsorbed on a small particle with high surface area to volume ratio ought to be quick to dissolve in the digestive system, compared to arsenic occluded deep within a large mineral particle.

It is assumed that people, like animals, absorb only a fraction of ingested soil arsenic. This is difficult to prove since bioavailability is not determined directly from measurements in human body tissues: there are practical collection difficulties, it is hard to attribute findings to a specific source, and there can be ethical issues. Moreover, some animals have rather different digestive systems and metabolic pathways from humans.

Consequently, bioavailability is typically assessed using (*in vivo*) tests with animals that are physiologically similar to people. Piglets ("juvenile swine") are considered a particularly good surrogate for small children. However, conducting live animal bioassays on a site-by-site basis is time-intensive, costly, and still poses ethical issues (Griffin and Lowney 2013, refer Golder 2016).

Accordingly, laboratory-based (*in vitro*) tests have been developed by researchers to mimic biological 'extraction' using simulated digestive fluids. Dissolved trace elements in the simulated biological fluid are then measured by standard analytical techniques. The result is an experimental measurement of the 'bioaccessible' fraction – the fraction that is 'accessible' for absorption into the bloodstream if ingested.

2.3 Determining arsenic bioavailability via the SBRC test

One leading arsenic bioaccessibility test is the Solubility and Bioaccessibility Research Consortium test (SBRC), also known as the Simplified Bioaccessibility Extraction Test or Relative Bioaccessibility Leaching Protocol. The SBRC was developed by commercial researchers in the US, working with regional USEPA staff. Much development work has also been done by staff of the University of South Australia and partner organisations. The SBRC test has been used previously in New Zealand (Golder 2012a, Gaw *et al.* 2008) and is available commercially both here and in Australia.

In its simplest form, the SBRC test is a 'gastric phase' extraction, in which the soil of interest is sieved to <250 μm (the size fraction deemed likely to be incidentally ingested) and shaken for one hour in a glycine hydrochloride buffer, pH 1.5, at 37 °C, approximating conditions in the human stomach. The SBRC test standard operating protocol (SOP) is attached as Appendix A.

The SBRC test has USEPA approval for determining bioaccessibility of lead in soils (USEPA 2009). It has not been formally approved for arsenic in the US or here in New Zealand, although extensive validation has been carried out. It has been shown to correlate with *in vivo* test results by at least ten peer-reviewed studies (Juhasz *et al.* 2007a,b, Juhasz *et al.* 2009, Bradham *et al.* 2011, Brattin *et al.* 2013, Hawkins *et al.* 2013, Juhasz *et al.* 2014a,b, Bradham *et al.* 2015, Li *et al.* 2015). Golder (2016) reviewed these studies, and concluded that:

- The SBRC test correlates with *in vivo* test results for arsenic from different sources, including herbicide / pesticide application, mining and smelting waste, and natural (geogenic) sources.
- The SBRC test correlates with *in vivo* test results for arsenic in a range of different binding phases, and in different land uses including residential environments and some agricultural environments. Although a wide range of soils has been used for validation assessments, no formal descriptions of soil types that the test can or cannot accurately assess have been developed. The correlations hold for a wide range of soil arsenic concentrations (tens to thousands of mg/kg), and a wide range of bioavailability values (<1 % to 80 %).
- Griffin and Lowney (2013) consider that soil lead exceeding 50,000 mg/kg is likely to be a negative interferent, but this is not a significant drawback as such high soil lead concentrations would certainly be inappropriate for sensitive end uses.
- SBRC test results for arsenic closely reflect oral bioavailability, are consistent with animal testing, and broadly consistent with soil chemical and physical characteristics where these have been determined.
- SBRC test results are repeatable within-laboratory, but the test has never been subjected to an inter-laboratory study with five or more participants, so has not had the opportunity to meet USEPA standards for inter-laboratory reproducibility. (HAIL Environmental has been unable to establish why the USEPA considers five laboratories a minimum.)
- SBRC test laboratory quality assurance checks, such as blanks and spikes, have been undertaken throughout validation, and were reported to be satisfactory throughout. Data quality objectives have been achieved for a wide range of samples. Results have been obtained for standard ASTM reference soils NIST 2710, 2710A and 2711.
- The SBRC test is moderately stable to changes in operating parameters (Griffin and Lowney 2013). Large changes in extraction pH, temperature, duration, or buffer strength all had some effect on test results for at least some soils, as did changing the soil:solution ratio. Changing buffer strength, adding hydroxylamine or redox agents (at the usual pH) and changing filter pore sizes had little or no effect. However, the effect of adding phosphate does not appear to have been studied.
- The SBRC test is comparable to common commercial laboratory procedures, and does not require special laboratory equipment or safety precautions.
- The SBRC test poses no ethical, social, or Te Tiriti o Waitangi / Treaty of Waitangi issues.

Diamond *et al.* (2016) carried out a meta-analysis of 83 SBRC bioavailability-bioaccessibility validation data pairs, from Bradham *et al.* 2011,2015 (n = 40), Brattin *et al.* 2013 (n = 19), and Juhasz *et al.* 2009,2014b (n = 24). The sample set included soils affected by mining, smelting, pesticide and herbicide application, with arsenic concentrations ranging from 42 mg/kg to 6,899 mg/kg. One outlier, for which the test substantially overpredicted bioavailability, was identified and excluded from calculations.

Diamond *et al.* were able to derive a general linear regression model for predicting oral bioavailability relative to sodium arsenate standard (*RBA*), from SBRC *in vitro* bioaccessibility (*IVBA*), shown in Equation 1:

Equation 1: $RBA(\%) = 0.79 \times IVBA(\%) + 3$

Similar conclusions have been reached in relation to lead (OSWER 2009).

This model explains approximately 87 % of the variance in oral bioavailability. Coefficients of variation for SBRC test results within each laboratory were less than 5 %.

Diamond *et al.* attempted to include the testing laboratory as a parameter in the linear regression model. However, even though these studies were carried out in different laboratories, on different soils, and used different *in vivo* animal bioassays for validation, only 3 % of variance in bioavailability could be attributed to the laboratory, and therefore the linear regression model was considered to be stable to these variations.

2.4 Regulatory drivers

Arsenic in the Resource Management Act

Contaminated sites are typically regulated under the NES:CS, by territorial authorities and unitary authorities such as TDC. If:

- It is more likely than not that an activity on the Hazardous Activities and Industries List (MfE 2011b) has occurred at a site, and
- The site will not remain in productive use, and
- Contaminant concentrations exceed applicable standards,

Then subdivision, change of use, and significant soil disturbance are 'restricted discretionary' activities under the NES:CS, subject to adequate management or remediation.

For human health 'priority contaminants' such as arsenic, the 'applicable standards' under the NES:CS default to the generic Soil Contaminant Standards (SCS: MfE 2011c), but site-specific guideline values derived in accordance with the prescribed methodology (MfE 2011c) can be used instead. If contaminant concentrations are within site-specific guideline values, then subdivision and change of use are controlled activities, subject only to the adequacy of the assessment; and management or remediation is no longer required. Taking bioavailability into account is currently discouraged (MfE 2011c) but has precedent (Golder 2012a,b), and the Ministry for the Environment (MfE) is currently consulting on measures to enable its use more widely (refer Golder 2016).

If contaminated sites are discharging contaminants directly to air, to water, or to land where they may enter water, that is a matter for regional councils and unitary authorities such as TDC. Bioavailability assessment is not relevant to assessing environmental discharges, and hence they will not be dealt with further here. However, TDC should bear in mind that some sites meeting SCS may still pose environmental issues.

Arsenic in the Building Act

The Building Act 2004 would require dwellings on the site to comply with Clause F1 of the Building Code, *Hazardous agents on site.* The functional requirement of Clause F1 is that "buildings shall be constructed to avoid the likelihood of people within the building being adversely affected by hazardous agents or contaminants on the site." The definition of 'likely effect' explicitly includes 'the nature, potency or toxicity of the hazardous agent or contaminant,' which seems no hindrance to site-specific assessment.

The compliance document (DBH 2006) is currently at variance with the NES:CS. It does not refer to any of the considerable body of contaminated land guidance developed in New Zealand. Instead it requires contaminant toxicity to be assessed with reference to intake values developed by the United States of America's (US) Department of Health and Human Services' Agency for Toxic Substances and Disease Registry (ATSDR), using methods developed by the US Environmental Protection Agency's (USEPA) Office of Emergency and Remedial Response.

This guidance is now poorly aligned with resource management regulations and guidance, and with current contaminated land practice. Most seriously, ATSDR toxicological intake values for arsenic pose substantial practical problems as they are within New Zealand background exposure levels, suggesting that they are set considerably too low. A New Zealand toxicological review (MfE 2011d) prefers a higher value derived in Canada, on both policy and modelling grounds. The USEPA guidance uses equations similar to those of the New Zealand methodology, but with parameters estimated for the US context. Site-specific modelling is permitted, suggesting that the USEPA methodology could be modified to use New Zealand settings. In practice, this would seem to simply mean reverting to the New Zealand methodology.

Moreover, if compliance with the Building Act cannot be achieved through the contaminated land assessment methodology underlying the NES:CS, that would create a regulatory minefield. Land could potentially be deemed fit for residential purposes – so long as no dwellings were built on it. It seems most unlikely that this was the intent of legislators.

Approach in this assessment

Accordingly, the approach taken here is to assess the sites as if the NES:CS applies. This approach is fit for purpose if and when they are subdivided for residential purposes, or if the Building Code is interpreted in such a way that applicable standards for current use are the same as under the NES:CS. Site-specific risk assessment is taken to be acceptable in principle.

2.5 Site-specific risk assessment

In 2011, New Zealand established a methodology for generating and applying SCS for arsenic and several other 'priority' contaminants (MfE 2011c). For arsenic in the residential scenario, modelling predicts that small children are the critical receptors, and that:

- The **dominant** exposure pathway is incidentally **ingesting contaminated soil** and soil-derived dust
- A secondary pathway is **consuming home-grown vegetables**, which have taken up arsenic from the soil, and also have entrained soil on their skins
- Skin contact is a minor contributor
- Dust inhalation is modelled as negligible.

Section 9 of the methodology allows for limited site-specific risk assessment, in which parameters are varied from the generic values, and exposure pathways are added or removed, as dictated by a conceptual site model, to generate a site-specific soil guideline value (SGV). No scope is given to adopt a more sophisticated model, such as a biokinetic uptake model.

Mathematically, it is straightforward to account for oral bioavailability within the SCS methodology, by multiplying the soil ingestion rate and the soil loading on home-grown vegetables by the percentage bioavailability as determined from SBRC testing.

One point of uncertainty is that there is currently no MfE policy position as to whether that percentage bioavailability should be a central tendency (such as 'on average') or an upper bound estimate (for example, 'worst case'). HAIL Environmental suggests a compromise position would be to use a central tendency when bioavailability data for a site are tightly grouped, but to use an upper bound when data are more widely spread.

The MfE guidance stresses the importance of a multiple-lines-of-evidence approach. Despite substantial advances in the understanding of arsenic bioavailability, site-specific risk assessment cannot robustly rely on SBRC testing alone. The bioavailability estimate must be consistent with soil chemistry, mineralogy and the conceptual site model.

Because an oral bioavailability assessment provides no evidence for altering vegetable uptake or dermal absorption parameters, those elements of the generic exposure model remain unchanged. Consequently, even if SBRC bioaccessibility was close to zero, the 20 mg/kg SCS for residential use would increase to at most 100 mg/kg.

The MfE model does not include exposure pathways that are not often present, but may be significant at some sites. Such pathways could include:

- Drinking, cooking with or bathing in contaminated water
- Consumption of home-grown fruit
- Consuming home-grown animal produce such as meat, milk or eggs
- Consuming wild foods such as game, kaimoana, eels or puha taken from the same 'piece of land'

Any site-specific risk assessment must consider whether or not it is necessary to add pathways of these kinds into the model.

For carcinogens such as arsenic, New Zealand policy is to treat exposure to contaminants in soil separately from other sources such as general diet, the domestic environment, occupational exposure or smoking. Those sources are managed separately and not taken into account in contaminated land risk assessment.

3. Selected Orchards of Tasman District

3.1 Site locations, descriptions, histories and settings

Ranzau soils

TDC recently completed a soil mapping exercise for the Waimea Plains, identifying some eighteen soil types; the most extensive, comprising approximately the eastern quarter of the plains, is the Ranzau soil type. Ranzau soils are dark brown stony to very stony silt loams.

TDC had already identified some historic orchards on the Ranzau soil area, via historic aerial photographs from the late 1940s and 1960s, and occasionally via existing site investigation reports. Site owners were not prepared to grant access to some of these sites, and at least one had been so modified that finding original orchard soils was likely to be difficult. However, TDC were able to obtain access for HAIL Environmental to a promising pair of sites at 266 and 286 Paton Road.

The Paton Road sites are shown on Figure 2.

HAIL Environmental inspected a further six historic orchard sites within the mapped Ranzau soil area, recently identified by TDC based on the later aerial photography. Field measurements of near-surface soil lead using an Olympic Vanta C-Series X-ray fluorescence spectrometer (XRF) did not identify significantly elevated lead or arsenic concentrations at any of these six sites. Accordingly, no soil sampling was undertaken, and no detailed description of them is given here.

Mapua soils

Expert evidence presented by Harakeke 2015 Ltd to TDC (Campbell 2015) describes soils across a 169 ha area in the vicinity of Horton Rd, Marriages Rd and Aporo Rd. This area is characterised as:

> "…part of… the Moutere Depression, a lowland area that extends from the Nelson Lakes to Tasman Bay and comprises a thick deposit of outwash gravels, the Moutere Gravel Formation, which dates from Late Tertiary time. Subsequent land forming processes have resulted in an intensively dissected landscape dominated by ridges and gullies, with deep weathering into the underlying gravels."

Two main soil types in this area are identified, Mapua and Braeburn, along with an important subtype, Mapua X:

> "The veneer of surface soil on the Moutere Gravel Formation in the northern part of the region comprises the Mapua soil type… valley floors have been infilled with alluvium that is derived from erosion of Moutere Gravel materials and the overlying Mapua soils, and… identified as the Braeburn soil type."
>
> "The Mapua soils… occur on the flat to gently undulating, undulating and rolling land of the dissected Moutere Gravel Formation landscape. The predominant aspect for Mapua soils is between northeast to northwest…"
>
> "Mapua soils in the Harakeke 2015 Ltd property are typical of the Mapua soils found elsewhere in the region. Topsoils are weakly structured and moderately deep (average 18 cm) while textures range from sandy loam to clay loam… The soil drainage class is moderately well drained."

> "Mapua X soils were identified as the soils on toe slopes and gully bottoms… the soils on these surfaces have a significant soil drainage impediment and probably remain wet throughout the winter months… Mapua X soils resemble Mapua soils but differ in that they commonly have a weakly developed brownish sandy loam topsoil of variable thickness (range 15-60 cm) overlying a blackish buried former topsoil. The upper brownish soil horizon represents sediments that have accumulated on the lower lying surfaces, being derived from erosion of the soils on the slopes above… and thus gives an indication of the widespread extent of past soil erosion and movement of sediment from the higher to the lower surfaces under early land use management." (Campbell 2015).

Small areas of Skeletal and Anthropogenic soils were also identified on the Harakeke 2015 Ltd land (Campbell 2015).

An earlier mapping, 'Soils of NZ: by region' (WRC undated), adds that Mapua fine sandy loam is: "…a strongly weathered soil formed in ancient weathered gravels. It has low pH and very low nutrient levels." Te Ara (2008) also states that "Nelson soils – especially on the Moutere gravels – are generally [less fertile]." Anecdotal accounts put it more bluntly, "The only thing that could be said for the Moutere clay was that it was good for holding up trees" (Eyebright 2016).

However, despite these comments, nutrient levels in former orchard soils are not necessarily low now. In order to replace nutrients lost in each apple crop, "each hectare needs 50 kg of nitrogen, 13 kg of phosphorus and 70 kg of potassium added annually… nutrient deficiencies, particularly of [calcium,] magnesium, manganese, boron and zinc… are normally addressed by leaf sprays." (Te Ara 2008).

In addition to nutrients, these soils are expected to contain lead arsenate and other pesticides. Copper compounds have long been applied as fungicides in New Zealand orchards. Phenylmercury chloride was used to control black spot in apples until the 1970s (Gaw 2001), and the mercury component may remain in soils to this day. Over the decades, dozens of organic fungicides and insecticides have been available for use in apple orchards; some of these, especially organochlorine compounds such as DDT, are highly persistent, so residues may still be present (PCE 2008, MfE 2011b).

From inspection of historic aerial photography, TDC had previously identified five distinct orchards within the Harakeke 2015 Ltd property ('Orchards One through Five'). These five orchards appear to comprise young trees in the 1948 aerial photograph, and were therefore deemed highly likely to have been sprayed with lead arsenate. Moreover, all five were predominantly mapped as Mapua or Mapua X soils, though low-lying areas were often Braeburn soils, and the coastal northeastern side of Orchard Five was mapped as Skeletal soil (Campbell 2015). TDC was able to arrange access for HAIL Environmental to the whole Harakeke 2015 Ltd property, and hence to these five historic orchard sites.

These Mapua sites and soils are shown on Figure 3.

3.2 Field observations

Ranzau soil sites

On inspection by HAIL Environmental staff on 19 April 2017:

- Originally the two halves of a former orchard block, 266 Paton Road is currently being used to produce boysenberries, while 286 Paton Road is currently a market garden.
- The berryfruit site appeared relatively undisturbed; soils were compact and the posts and wires had clearly been in place for several years at least. Access was not granted to the areas between the boysenberry rows, which were covered with growing vines.
- The market garden soils had clearly been extensively tilled and fertilised on many occasions. A small fraction of the site was planted and therefore not sampled.

Mapua soil sites

On inspection by HAIL Environmental staff on 12 May 2017:

- **Orchard One**, a small, gently sloping, northeast-facing block, was within a larger area of unfenced, ungrazed pasture with much young blackberry and other weeds. It was evidently also in pastoral use in 1978 and 1989, per aerial photography from those years. However, Google Earth satellite imagery from August 2003 and 2006 shows rows of plantings across the Orchard One area and surroundings – possibly espaliered apples, berryfruit or vines – before reverting to pasture as of the April 2011 image. The approximate location of the former Orchard One was deduced relative to a nearby irrigation pond, and XRF measurements were used to identify probable lead arsenate-impacted soils, which were then sampled.
- **Orchard Two**, an undulating northwest-facing block, was also in ungrazed pasture. Unlike Orchard One, it was readily identifiable as former orchard, from the presence of young self-seeded apple trees. Historic imagery indicates that it had remained orchard until shortly before August 2003. XRF measurements indicated elevated lead, so soil sampling proceeded.
- **Orchard Three**, a large, undulating to rolling block that may in fact have been two separate orchards, was partly in ungrazed pasture, with one remnant of old and apparently abandoned pear orchard at the western end. XRF measurements did not provide firm evidence for lead arsenate use within the remnant pears, or elsewhere within the western half of the orchard, but lead concentrations appeared elevated in the eastern half. Based on historic imagery, orchard activities terminated at different dates for different sections of this orchard; much of the western half reverted to pastoral use between 1989 and 2003, but the last trees were removed from the eastern half during 2013. Only the eastern half of the site ('Orchard 3A') was sampled.
- **Orchard Four**, gently sloping and northwest-facing, was found to be in improved pasture recently grazed by cattle. XRF measurements did not provide firm evidence of significantly elevated lead over upper parts of the site, so samples were collected from toe end slopes only.

- Much of **Orchard Five** was extensively reworked. The site manager advised that the bulk of the site had been disced five times in the past eight years to physically control weeds. Heavy earthmoving equipment was present on site, evidently preparing landscaped house platforms by scraping back to subsoil. These modified areas were dropped from the sampling programme; only the grassed, northern-facing, northern end ('Orchard 5A') was sampled. Satellite imagery shows that, like Orchard Three, the trees were removed from this sampled area during 2013.

Outside Harakeke 2015 Ltd land, several other orchards were visible in the same 1948 aerial photograph, and TDC was also able to arrange access to two of these ('Orchards Six and Seven'), further along Aporo Road and closer to Mapua village:

- On inspection **Orchard Six** had been extensively reprofiled to create landscaped residential sections, making it difficult to identify the original topsoils. No sampling was undertaken.
- **Orchard Seven** had been replanted some decades previously, partly in more modern varieties of apple and partly as a eucalypt woodlot. However, with the help of the original orchardist – still living on part of the site – it was possible to confirm that lead arsenate had been applied in the 1950s, and to sample within known sprayed and relatively undisturbed areas. Like Orchard Five, Orchard Seven was mapped on Skeletal soils along the northeastern boundary; again these soils were avoided during sampling.

Finally, TDC staff collected samples from one more orchard further along Aporo Road, **Orchard Eight**. This sampling was done without benefit of XRF.

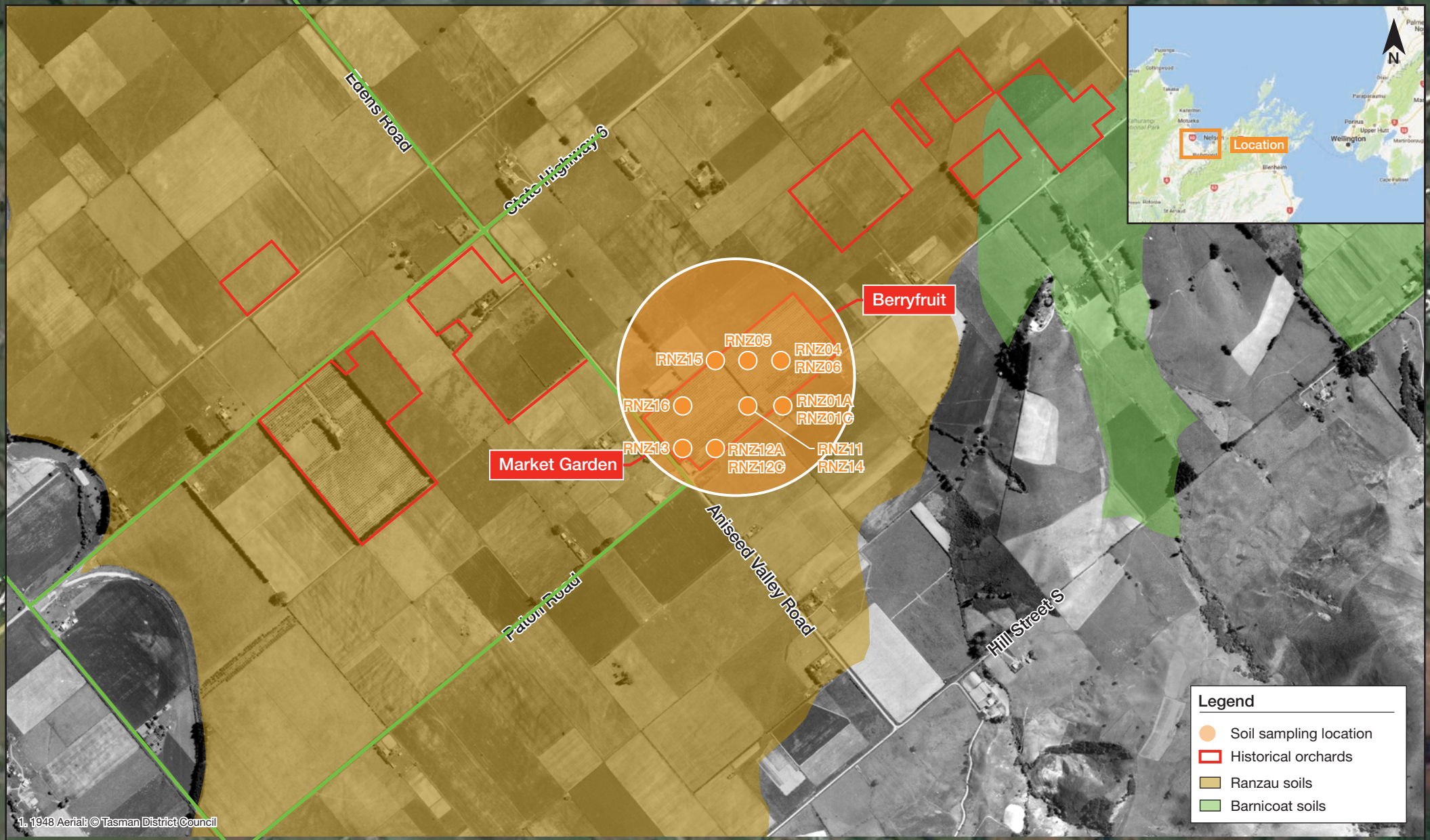

Figure 3: Ranzau Soil Sampling Locations

Arsenic Bioavailability Assessment: Former Pipfruit Orchards on Mapua and Ranzau Soils, Tasman District

Drawn by Simon Garner, www.simonsa[illegible].co.nz | June 2017

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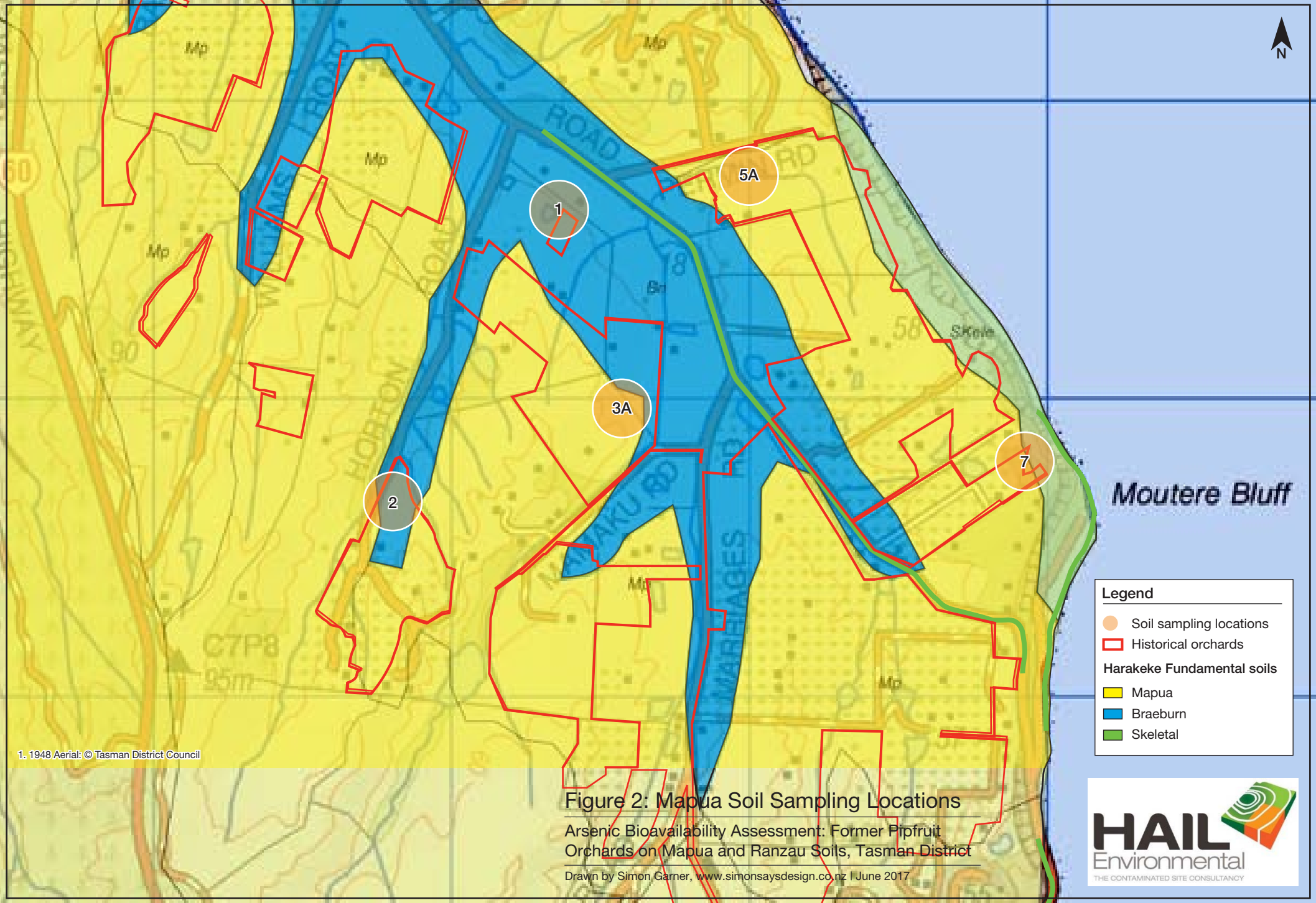

Figure 2: Mapua Soil Sampling Locations

Arsenic Bioavailability Assessment: Former Pipfruit Orchards on Mapua and Ranzau Soils, Tasman District

Drawn by Simon Garner, www.simonsaysdesign.co.nz | June 2017

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3.3 Conceptual site model

Sources and contaminants

Based on field XRF measurements and 1948 historic aerial photographs, sampling sites in Orchards One through Five, and Seven, are expected to be impacted by lead arsenate pesticide, arising from historic use between circa 1920 and perhaps circa 1950. While applied as a foliar spray, the pesticide was typically distributed through the orchard by in-ground reticulation (Gaw 2003).

Previous published data (e.g. Gaw 2003, Gaw *et al.* 2008) reported arsenic concentrations in the range 3-48 mg/kg in Tasman District orchards, accompanied by 15-243 mg/kg lead. *In vivo* bioavailability studies from apple orchards in North Carolina (Casteel *et al.* 2009) and Pennsylvania (PADoH 2013) have reported the oral bioavailability of arsenic to juvenile swine from lead arsenate application to pipfruit orchard soils to be 31-53 % and 53 % respectively. *In vitro* bioavailability studies from ten apple orchards around New Zealand (Gaw *et al.* 2008) and from USA orchard sites (Bradham *et al.* 2015) have estimated the oral bioavailability of arsenic to be 12-45 % and 16-48 % respectively.

These previous studies occasionally provide some information on soil parameters. The USA orchard soils studied by Bradham *et al.* (2015) were reported to have total arsenic in the 320-460 mg/kg range, pH 5.6 to 6.2, iron 1.3-6.7 %, phosphorus 1,200-1,800 mg/kg. Arsenic was predominantly present as arsenate adsorbed to oxides in the soil. The New Zealand orchard soils of Gaw *et al.* (2008) contained 16-116 mg/kg arsenic, 0.7-3.0 % iron. In both studies, arsenic bioaccessibility generally decreased as iron content increased.

Considering these findings together with chemical expectations about arsenic binding, and considering that arsenic is applied to these soils in dissolved form rather than arising from minerals within it, it is hypothesized that arsenic in these orchard soils is predominantly bound to iron oxides. Accordingly, the more iron binding sites available, the lower the bioavailability. Phosphate, a comparatively abundant analogue of arsenate, would be expected to compete for binding sites and therefore increase arsenic bioavailability.

Based on these previous results, arsenic in the Ranzau and Mapua soils is provisionally anticipated to reach concentrations of up to approximately 50 mg/kg, predominantly bound to iron oxides, with a bioavailability of up to approximately 50 %.

Soils that have been extensively modified after orchard activities ceased, such as the tilled, fertilised soils of the 286 Paton Road market garden, are considered likely to exhibit lower arsenic concentrations due to mixing with underlying clean soils and to removal of arsenic in crops. However, by the same token, extensively modified soils may have a higher arsenic bioavailability, due to weathering processes and to higher phosphate content.

Aside from lead arsenate sprays, other possible sources of arsenic on site include:

- Chromated copper arsenic timber preservative from support posts, fence posts and so on
- Arsenic-rich fertilisers, potentially including chicken manure
- Geogenic background, which is expected to be generally less than 8.6 mg/kg in Tasman and Nelson Districts (Landcare 2015).

No sheepdips were observed on site, either in aerial imagery or during the site visit.

Potential exposure pathways

In future residential use, the most important soil arsenic exposure pathway is expected to be incidentally ingesting contaminated soil and soil-derived dust. Following closely behind is consuming home-grown vegetables, which have taken up arsenic from the soil, and also have entrained soil on their skins. The generic residential exposure scenario assumes 10 % of vegetable consumption is home-grown; this may be an underestimate in the warm, sunny Tasman region. However these soil types are not particularly good for horticulture and hence there is considered to be insufficient evidence to raise the consumption rate for this assessment. Skin contact is a very minor contributor and dust inhalation is modelled as negligible.

It is probable that fruit trees would be planted again after residential development, and home-grown fruit consumed. Fruit are generally assumed not to take up arsenic, owing to the biological barriers between root, shoot and fruit (MfE 2011c, PADoH 2013). Despite extensive historic use of lead arsenate pesticide in pipfruit orchards, the latest New Zealand Total Diet Survey (MAF 2011) does not report significantly elevated arsenic in limited sampling of apples or pears. Based on these considerations, consuming fruit from the site is not considered to be a significant arsenic exposure pathway.

Consuming home-grown animal produce such as eggs would be a potential exposure pathway if free-range chickens were kept on site in future. Insufficient information is available to model these pathways, so they have not been considered at this stage, but this caveat may need to be investigated in future. Milk and meat consumption can be largely ruled out in residential end use due to insufficient land area per property for grazing.

Considering potential exposures through drinking water, Paton Road, and the mapped Ranzau soil area generally, are on reticulated supply derived from deep groundwater. Some of the area around Mapua village is also on reticulated supply. The Harakeke 2015 Ltd land will have a deep groundwater supply when developed. Generally, in the absence of reticulated supply, Tasman District residents may rely either on shallow groundwater abstraction, or on rainwater storage. There does not seem to be any information about arsenic content of shallow groundwater under former orchard land, so this pathway is not well understood, and should be considered provisionally open.

Sensitive receptors

At present, the sites are generally still in productive agricultural or orchard use, though there are a small number of existing houses. Following national policy for contaminated land risk assessment, neither agricultural workers nor produce itself are taken to be sensitive receptors.

In current or future residential use, the sensitive receptors will be residents, especially any children that may be present. The corresponding SCS for residential use is 20 mg/kg arsenic – the lead SCS of 210 mg/kg could possibly also be exceeded, but probably only if arsenic levels were well above SCS, so lead concentrations are unlikely to be the primary risk driver. For lifestyle use, where there is more opportunity for uptake via produce, the SCS are 17 mg/kg arsenic and 160 mg/kg lead. Both lifestyle and ordinary residential activities are possible in both the Waimea Plains and Moutere areas.

Waimea Plains groundwater is a recognised local resource, albeit significantly impacted by nitrate contamination in some areas and therefore unlikely to meet potable standards. Tasman Resource Management Plan maps identify much of the Moutere area, including the Mapua soil sampling sites, as a Confined Aquifer Zone and Wastewater Management Zone. The area drains northwest into the Moutere Inlet via the Tasman Valley Stream; neither of these water bodies appears to have any ecological designation.

There is one highly significant cultural receptor close to the Mapua study area, the former Te Papa Pa on the Kina Cliffs near Orchard Five, but it is not within orchard land and does not appear to require specific consideration as regards sampling or interpretation.

Potentially complete contaminant linkages

Based on the above sources, pathways and receptors, HAIL Environmental considers that the key potentially complete contaminant linkages for the former orchard sites involve future child resident exposure to soil arsenic from lead arsenate pesticide, both via incidental ingestion of soil and dust, and via consumption of home-grown vegetables. It is likely that many historic orchard sites will exceed the residential SCS for arsenic.

Arsenic oral bioavailability is likely to be moderate, suggesting that the generic SCS substantially overestimates the risk to residents via incidental ingestion. It is very likely that some orchard land will exceed the SCS, but will not exceed a SGV taking expected bioavailability into account.

Depending on the circumstances of individual sites, it may not be possible to rule out exposure through drinking shallow groundwater.

4. Sampling and Analysis

4.1 Data quality objectives

Based on the objectives of the investigation and the conceptual site model, data quality objectives (DQOs) comprised:

- Assessing Ranzau and Mapua soil types only, specifically not Braeburn or Skeletal soils.
- Accessing at least six representative former orchards per soil type.
- Collecting at least six well-dispersed soil samples per orchard.
- Targeting soils with a range of arsenic levels, generally exceeding lifestyle SCS of 17 mg/kg.
- Targeting soils with lead levels indicating historic lead arsenate application, while avoiding soils with locally elevated chromium, which might indicate a treated timber contribution.
- Estimating arsenic oral bioavailability by a robust laboratory method, namely the SBRC gastric protocol.
- Analysing key binding phases for arsenic and lead, including organic material, iron, manganese and sulphur compounds; and for a key competitor, phosphate.
- Determining particle size distributions to assess clay content – another potential binding phase – and to help assess potential availability of binding phases.
- Obtaining accurate, repeatable laboratory data, specifically analysing at least 10 % of samples in duplicate, with replicate error generally < 30 %.
- Ensuring that bioaccessibility analysis is reproducible, specifically analysing at least 10 % of samples at a second laboratory, with replicate error generally < 30 %.

The mass ratio of lead to arsenic in $Pb_3(AsO_4)_2$ is approximately 5:1. Therefore, allowing for background and assuming no differential leaching or plant uptake, arsenic at the DQO of 17 mg/kg ought to be accompanied by approximately 100 mg/kg lead.

Note that, because the sampling spacing and sample location were not driven by possible future residential use patterns, and soils with low levels of lead were generally not sampled, the results of this assessment are not suitable for assessing whether investigated orchard soils would be fit for residential purposes. Sampling was strictly directed at obtaining soils relevant to arsenic bioavailability assessment.

4.2 Soil sampling

Ranzau soils were sampled on 19 April 2017. Mapua Orchards One through Five were sampled on 12 May 2017, Orchard Seven the following day, and Orchard Eight (by TDC staff) on 22 May 2017. Conditions on all three sampling occasions were wintry; fine and cool with heavy dew, following days of moderate rain. The sample locations are indicated on Figure 3.

All soil samples were collected from surface soils 0-0.1 m below ground level, at locations well dispersed across the subject orchard. The target was six samples per site. As the size of orchard areas varied, sample spacing varied correspondingly. At 266 Paton Road, the berry farm, there was no access between the rows, in order to avoid damaging growing canes, and hence all samples were around the perimeter of the current growing area. Mapua Orchards One and Seven (at least the accessible part of the historic Orchard Seven) were significantly smaller and so only three samples were taken rather than the target six. The northern end of Orchard Seven visibly comprised thin, sandy Skeletal soils, which were not sampled.

A stainless steel spade was used to dig up an undisturbed core and remove grass, after which samples were collected directly into sampling containers. Two replicates were collected at every location, an A sample and a B sample; at one location per site, C and D samples were collected as well.

Sampled soils matched expected descriptions. Mapua soils were:

- Moist to wet brown silts, sometimes sandy,
- Generally with a good growth of shallow rooted grasses and weed species such as blackberry and gorse,
- Often with infauna including worms and grass grubs.

Samples of these hill soils were principally taken on local crests or slopes since gully soils were generally quite distinct, being dark and mottled – the Braeburn soil type.

Ranzau soils were dark greyish brown very gravelly silts, gravel being grey and mostly subangular; the tilled soils at 286 Paton Road (the market garden site) were loose while the untilled soils at 266 Paton Road (the berry farm) were firm. These were flat sites with very little local topography, sample locations were essentially random.

Sampling was guided by an Olympus Vanta™ handheld X-ray fluorescence spectrometer (except at Orchard Eight). 30-second XRF measurements were taken from the sides of the core, pressing the instrument window against the smooth face left by the spade. Occasionally measurements were also made on exposed soil surfaces when trying to locate a suitable location for sampling (data not included).

The XRF's field reporting limit for arsenic was considerably higher than the manufacturer's suggestion of 5 mg/kg. At times it was not clear that the instrument was able to confidently detect the DQO, 17 mg/kg (see also Section 4.5.3). Accordingly the secondary DQO of 100 mg/kg lead became the field screening criterion.

At Orchards Two and Four, and across large parts of Orchards Three and Five, it was difficult to find Mapua soils with elevated lead. Therefore Orchard Four was discarded, and sampling at Orchards Three and Five was restricted to specific (albeit large) parts of the historic orchard.

Sampled Mapua soils were considered **representative** of relatively undisturbed former apple orchards on that soil type. However, it may not be the case that the Paton Road soils were necessarily representative of Ranzau soils generally. HAIL Environmental observed the same physical and chemical characteristics – dark greyish brown stony soils with elevated chromium and nickel – at other former orchards in the mapped area of Ranzau soils, but the current uses of the sites varied widely, and the extent of tilling and fertilising appeared to have varied correspondingly.

4.3 Analytical suite

The samples were analysed as follows:

- Air-drying A- and C-sample replicates, sieving to 2 mm, analysing for pH in slurry by potentiometric determination; and total recoverable arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc by USEPA Method 200.2.
- Particle size analysis of B- and D-sample replicates by laser diffraction.
- Wet sieving A- and C-sample replicates to < 250 μm; analysing for total recoverable arsenic, calcium, iron, lead, manganese and phosphorus by USEPA Method 200.2; total organic carbon by acid pretreatment and catalytic combustion; and total sulphur by ASTM 4239.
- Gastric extraction of < 250 μm fractions in accordance with the SBRC standard operating protocol, and analysing for extractable arsenic (and lead).

Additionally, < 2 mm fractions of samples RNZ01A, RNZ12A, MA11A, MA21A, MA3A1A, MA5A1A and MA5A1C were analysed for acid-soluble and acid-insoluble sulphide by USEPA Methods 9030B and 9034. Sulphides are potential arsenic binding phases. This was one sample for each site (except Orchards Seven and Eight), including one pair of replicates. Only limited sulphide analysis was undertaken because the analysis is only accredited for use on 'as received' sample as opposed to a wet sieved replicate, and the sulphide content may not be the same in the < 250 μm fraction of the soil upon which most of the analyses were performed, so results would be indicative only.

The lead laboratory was RJ Hill Laboratories Ltd. of Hamilton ('Hill Labs'). Hill Labs is an IANZ accredited laboratory, and was the analytical laboratory for previous uses of SBRC in New Zealand (Golder 2012a and a confidential study by HAIL Environmental). Hill Labs subcontracted particle sizing to University of Waikato.

Samples RNZ01, RNZ12, MA11, MA21, MA3A1, and MA5A1 were selected for further analysis. The A-sample replicates were sent to the University of South Australia for replicate gastric extraction using the same SBRC protocol. Arsenic analysis of these soils and extracts was undertaken at ALS Environmental Laboratories Ltd, Melbourne.

The C-sample replicates were sent to Massey University for mineralogical analyses. This comprised scanning electron microscopy with energy-dispersive X-ray spectroscopy analysis (SEM-EDAX) of < 250 μm fractions. SEM-EDAX was performed on a FEI Quanta 200 SEM (FEI, Eindhoven, The Netherlands) equipped with a silicon EDAX unit (NJ, USA). Samples were carbon-coated, then a backscattered electron detector (BSED) was used to target heavier elements. An electron dispersion spectrum was obtained for selected grains or part-grains that were strongly scattering. Samples were then gold-coated and the grains from which spectra were taken were imaged.

The following analytical approaches were considered but not undertaken:

- X-ray diffraction (XRD). This technique is useful for identifying bulk mineral phases. However, since arsenic in these soils was expected to be present at no more than moderate levels, arising from anthropogenic sources, it was considered unlikely that XRD would be able to identify any arsenic-containing minerals.
- X-ray fine structure analysis (EXAFS) or X-ray near edge spectroscopy (XANES), which could reveal the principal chemical bonding modes of arsenic in these soils. These techniques are not available in New Zealand, as they require a synchrotron radiation source.

- Sequential extraction schemes intended to chemically identify arsenic binding phases. HAIL Environmental could identify no schemes that have shown a reliable relationship with arsenic bioavailability.

4.4 Analytical results

The two soil types gave quite distinct results. Accordingly, results are analysed separately. Tables 1 and 2 present descriptive statistics for the soil analytical suite described above, for the Ranzau and Mapua soils respectively. Laboratory reports are attached in Appendix B. SEM-EDAX data is presented in Appendix E: images have been omitted due to the very large file size, but can be provided under separate cover if required.

Tables 1 and 2 also present calculated bioaccessibility, i.e. SBRC gastric extractable arsenic divided by total recoverable arsenic; and estimated bioavailability, based on the bioaccessibility results, Equation 1 and OSWER 2009.

Ranzau soils

The Ranzau soils at 266 and 286 Paton Road appear physically and chemically quite uniform in most respects; sandy SILT (the gravel component is not evident in the laser particle size analysis), circumneutral pH, moderate fine organic content, low in sulfur. Samples differ principally in contaminant content – arsenic, copper, lead and to a lesser extent cadmium. Comparing the two sites, the market garden soils of 286 Paton Road are slightly more acidic and contain approximately 50 % more phosphorus and cadmium.

These soils are notably high in chromium and nickel, moderately high in iron, and XRF data suggest elevated magnesium as well (refer Appendix C). Comparing < 2 mm and < 250 μm data, nickel concentrations are almost identical, whereas arsenic, chromium, copper and lead are enriched in the smaller size fraction.

Gastric extractable arsenic is remarkably low in the Paton Road soils. Calculated upper bound to the mean arsenic bioaccessibility, with 95th % confidence (UCL_{95} statistic), is just 14 %. Lead bioaccessibility is also moderate, with UCL_{95} of 56 %.

The descriptive statistics include linear regression correlation coefficients for each analyte with two key parameters; total recoverable arsenic in the < 2 mm particle size fraction, and arsenic bioavailability:

- Total recoverable arsenic in these soils is very strongly positively correlated with total recoverable lead (Pearson R = 0.991) with a lead:arsenic ratio consistently averaging 3.5. But it is negatively correlated with pH (R = -0.78), total recoverable nickel (R = -0.78) and to a lesser extent chromium and copper.
- Arsenic bioavailability is not well correlated to any other measured parameter, the strongest relationship being with lead bioavailability (R = 0.79).

Fifteen selected grains from RNZ01C and sixteen grains from RNZ12C were examined using SEM-EDAX:

- In RNZ01C, eight grains contained lead, usually with iron, calcium, silicon, aluminum and oxygen, occasionally with antimony (two samples), phosphorus, magnesium, potassium and/or sodium. One of these grains contained lead, oxygen and carbon with minor palladium, tin and iron. No grains in RNZ12C contained lead.
- Four grains in each sample contained iron, chromium, titanium, calcium, silicon, aluminum, magnesium, and oxygen, with or without nickel, or minor manganese, chlorine, phosphorus, or carbon.

- Two grains in RNZ01C, and five grains in RNZ12C, contained iron, titanium, chlorine, silicon, aluminum, magnesium, and oxygen, with or without minor manganese, calcium, and potassium.
- One grain in each sample contained phosphorus, silicon, aluminum, oxygen, and minor iron, with or without other lighter elements.
- In RNZ12C, two grains contained silver, copper, iron, calcium, silicon, aluminum, magnesium, oxygen, and carbon. Three grains contained gold, silicon, aluminum and oxygen, in one case with manganese, and other lighter elements.
- No grains contained detectable arsenic.

Mapua soils

Despite originating from six different orchards, the Mapua soil samples are fairly uniform in respect of bulk parameters. These soils are found to be sandy SILTS. The < 250 μm fraction is moderately low in organic carbon; low in sulphur and phosphorus, iron and manganese, chromium and nickel. Soil acidity is somewhat higher in Orchards Two and Eight than at the other sites. There are moderate correlations between organic carbon, sulfur, phosphorus and cadmium concentrations (data not shown). Samples differ most in contaminant content; Orchard Five samples have conspicuously higher levels of arsenic, lead and mercury, Orchard Three is higher in cadmium, copper and zinc. There is no consistent sign of contaminant enrichment in smaller size fraction – arsenic levels are if anything lower in the < 250 μm ingestible fraction, than in the < 2 mm.

Arsenic and lead bioavailability in the Mapua soils is substantially higher than in the Ranzau soils, with UCL_{95}s of 38 % and 67 % respectively. At Moanataiari, the P:Fe ratio had been moderately predictive of arsenic bioavailability, but here the relationship is moderately weak (R = 0.57).

The descriptive statistics include linear regression correlation coefficients for each analyte with two key parameters; total recoverable arsenic in the < 2 mm particle size fraction, and arsenic bioavailability:

- Total recoverable arsenic in these soils is positively correlated with total recoverable lead and mercury (Pearson R = 0.75, 0.70) though lead:arsenic ratio varies substantially, ranging from 3.6 to 12.2.
- Arsenic bioavailability is not well correlated to any other measured parameter.

Fifteen selected grains from each of MA21C, MA3A1C, MA5A1C, and MA71C, for a total of 60, were examined using SEM-EDAX:

- One grain in MA5A1C contained lead, arsenic, iron, potassium, silicon, aluminum, oxygen, carbon and minor calcium.
- One grain in MA3A1C contained minor arsenic with zinc, manganese, calcium, potassium, sulphur, silicon, aluminum, sodium, oxygen and carbon.
- The above two grains were the only ones observed to contain arsenic, while none contained lead and only two contained minor copper.
- One common assemblage, seen in between four and eight grains in each sample, involved iron, titanium, silicon, aluminum, and oxygen, with or without manganese, calcium, potassium, chlorine, magnesium, or carbon, usually as minor contributions.
- Nine grains, including all four sites, contained cerium, lanthanum, silicon, aluminum, oxygen and carbon, with or without thorium, silver, nickel, calcium, phosphorus or magnesium, or minor copper, iron or chlorine.

- A further nine grains, including all four sites, contained phosphorus, silicon, aluminum, oxygen, and carbon, with or without iron, titanium, calcium, potassium, sulfur, magnesium, or sodium, usually as minor contributions.
- Three grains, from two sites, contained silver, potassium, silicon, aluminum, magnesium, oxygen, carbon and minor calcium.
- Two grains from MA21C were reported to contain iridium, dysprosium, silicon, aluminum, oxygen, carbon and minor potassium.
- Two grains from MA21C contained nickel, iron, chromium, sulfur, silicon, aluminum, oxygen and carbon.
- One grain from MA3A1C contained iron, silicon, carbon, minor aluminum and chlorine.
- Two grains from MA5A1C contained iron, manganese, titanium, silicon, aluminum, oxygen, carbon and minor chlorine.
- One grain from MA5A1C contained gold, potassium, silicon, oxygen, carbon, minor iron and magnesium.

Table 1 Ranzau soil samples – descriptive statistics

Analyte	***Units***	***Number of results***	***Minimum*** *(% ND)*	***Maximum***	***Mean***	***Standard deviation***	***UCL_{95}***	***$R(As_{<2mm})$***	***$R(As_{BA})$***
				Whole soil as received					
Sand	%	14	20.3	40.5	32.3	5.7	35	0.01	-0.01
Silt	%	14	48.5	59.2	53.4	3.3	55	0.03	-0.17
Clay	%	14	8.6	19.1	13.5	3.0	15	-0.06	0.19
Acid Soluble Sulphide	mg/kg	2	< 3 (50 %)	8					
Acid Insoluble Sulphide	mg/kg	2	11	16	13.5	4	29		
				Less than 2 mm fraction (dry weights)					
Total Recoverable Arsenic	mg/kg	14	15	49	28	10	33	(≡ 1)	0.56
Total Recoverable Cadmium	mg/kg	14	0.24	0.49	0.34	0.08	0.38	0.25	0.35
Total Recoverable Chromium	mg/kg	14	142	186	162	11	167	-0.57	-0.33
Total Recoverable Copper	mg/kg	14	38	185	114	48	137	-0.61	-0.18
Total Recoverable Lead	mg/kg	14	49	177	101	38	119	0.991	0.61
Total Recoverable Mercury	mg/kg	14	< 0.10 (93 %)	0.12					
Total Recoverable Nickel	mg/kg	14	151	210	179	16	187	-0.78	-0.48
Total Recoverable Zinc	mg/kg	14	78	92	85	5	88	0.49	0.37
pH		14	6.3	7.2	6.9	0.3	7.0	-0.78	-0.42

Analyte	***Units***	***Number of results***	***Minimum*** *(% ND)*	***Maximum***	***Mean***	***Standard deviation***	***UCL_{95}***	***$R(As_{<2mm})$***	***$R(As_{BA})$***
				Less than 250 µm fraction (dry weights)					
Total Recoverable Arsenic	mg/kg	14	18	63	33	12	39	0.983	0.54
Gastric Extractable Arsenic	mg/kg	14	1.8	8.7	4.4	2.0	5.4	0.961	0.70
Total Recoverable Calcium	mg/kg	14	11100	13600	12779	668	13095	0.14	0.04
Total Recoverable Chromium	mg/kg	14	175	210	191	9	196	-0.39	-0.32
Total Recoverable Copper	mg/kg	14	43	230	135	62	164	-0.58	-0.13
Total Recoverable Iron	mg/kg	14	41000	46000	43857	1292	44469	-0.08	-0.07
Total Recoverable Lead	mg/kg	14	54	200	118	46	140	0.65	0.65
Gastric Extractable Lead	mg/kg	14	24	117	65	30	79	0.63	0.65
Total Recoverable Manganese	mg/kg	14	860	1080	953	59	981	0.73	0.55
Total Recoverable Nickel	mg/kg	14	166	200	185	12	190	-0.68	-0.36
Total Recoverable Phosphorus	mg/kg	14	1500	2900	2151	498	2387	0.35	0.42
Total Organic Carbon	g/100g	14	3.2	4.5	3.9	0.3	4.0	0.46	0.11
Total Sulfur	g/100g	14	0.03	0.04	0.04	0.00	0.04	-0.01	-0.20
				Calculated parameters					
Lead:Arsenic Ratio (< 2 mm)		14	3.2	3.9	3.5	0.2	3.6	0.22	0.54
Arsenic Bioaccessibility	%	14	9%	16%	13%	2%	14%	0.56	(≡ 1)
Arsenic Bioavailability	%	14	10%	16%	13%	1%	14%	0.56	(≡ 1)
Lead Bioaccessibility	%	14	44%	60%	53%	5%	56%	0.60	0.79
Lead Bioavailability	%	14	36%	50%	44%	4%	46%	0.60	0.79

All concentrations dry weight. Bioavailability calculated from bioaccessibility using Equation 1 for arsenic, OSWER 2009 for lead.

Table 2 Mapua soil samples – descriptive statistics

Analyte	***Units***	***Number of results***	***Minimum*** *(% ND)*	***Maximum***	***Mean***	***Standard deviation***	***UCL_{95}***	***$R(As_{<2mm})$***	***$R(As_{BA})$***
				Whole soil as received					
Sand	%	31*	29.2	40.4	34.2	2.9	35	0.57	0.41
Silt	%	31	53.2	63.1	58.9	2.5	59	-0.59	-0.26
Clay	%	31	4.8	8.4	6.4	1.0	7	-0.19	-0.52
Acid Soluble Sulphide	mg/kg	5	3	11	7	3.6	10	-0.42	0.00
Acid Insoluble Sulphide	mg/kg	5	4	16	8	4.5	14	0.62	0.13
				Less than 2 mm fraction (dry weights)					
Total Recoverable Arsenic	mg/kg	34	11	89	23	15	30	(≡ 1)	0.24
Total Recoverable Cadmium	mg/kg	34	0.17	0.62	0.36	0.13	0.39	-0.19	0.41
Total Recoverable Chromium	mg/kg	34	5.0	13.0	8.1	2.1	8.7	0.18	0.09
Total Recoverable Copper	mg/kg	34	6	51	26	13	30	0.19	0.53
Total Recoverable Lead	mg/kg	34	73	350	157	71	188	0.75	0.49
Total Recoverable Mercury	mg/kg	34	< 0.10 (29 %)	1.00	0.36	0.24	0.48	0.70	0.36
Total Recoverable Nickel	mg/kg	34	< 2 (6 %)	10	5	2	6	0.22	0.23
Total Recoverable Zinc	mg/kg	34	11	94	44	21	48	-0.30	-0.08
pH		34	5.4	7.4	6.4	0.6	6.5	-0.40	0.01

Analyte	Units	Number of results	Minimum (% ND)	Maximum	Mean	Standard deviation	UCL_{95}	$R(As_{<2mm})$	$R(As_{BA})$
				Less than 250 µm fraction (dry weights)					
Total Recoverable Arsenic	mg/kg	14	9	47	19	9	23	0.93	0.29
Gastric Extractable Arsenic	mg/kg	14	2.8	21.0	7.8	4.7	9.9	0.85	0.61
Total Recoverable Calcium	mg/kg	14	1,570	5,700	3,477	1,222	3,703	-0.44	0.22
Total Recoverable Chromium	mg/kg	14	5.0	11.0	7.5	1.8	8.1	0.01	-0.05
Total Recoverable Copper	mg/kg	14	6	48	25	12	29	0.21	0.53
Total Recoverable Iron	mg/kg	14	3,200	11,600	6,788	1,893	7,305	-0.07	-0.19
Total Recoverable Lead	mg/kg	14	70	340	151	68	180	0.71	0.51
Gastric Extractable Lead	mg/kg	14	50	270	119	56	142	0.64	0.55
Total Recoverable Manganese	mg/kg	14	35	470	102	71	112	0.02	-0.03
Total Recoverable Nickel	mg/kg	14	2.0	8.0	4.9	1.7	5.6	0.14	0.14
Total Recoverable Phosphorus	mg/kg	14	420	1,490	965	299	1,035	-0.28	0.43
Total Organic Carbon	g/100g	14	1.7	4.8	3.1	0.8	3.2	-0.23	0.32
Total Sulphur	g/100g	14	0.02	0.05	0.03	0.01	0.03	-0.28	0.26
				Calculated parameters					
Lead:Arsenic Ratio (< 2 mm)		14	3.6	12.2	7.2	1.9	7.5	-0.32	0.37
P:Fe Ratio (< 250 µm)		14	5%	26%	15%	5%	16%	-0.26	0.57
Arsenic Bioaccessibility	%	14	15%	55%	41%	9%	44%	0.24	(≡ 1)
Arsenic Bioavailability	%	14	15%	47%	35%	7%	38%	0.24	(≡ 1)
Lead Bioaccessibility	%	14	64%	93%	78%	6%	80%	0.01	0.53
Lead Bioavailability	%	14	53%	79%	66%	5%	67%	0.01	0.53

All concentrations dry weight. Bioavailability calculated from bioaccessibility using Equation 1 for arsenic, OSWER 2009 for lead. * See Section 4.4.2, Accuracy

4.5 Quality assurance and quality control

4.5.1 Field

Hill Labs advised that they had received one unlabelled sample, and that sample MA73 appeared on the chain of custody but could not be located. Accordingly the unlabelled sample was identified as MA73. Parameters are sufficiently similar to MA71 and MA72 to give confidence that this was correct.

4.5.2 Analytical laboratories

Laboratory quality analysis and quality control is considered generally satisfactory. The Hill Labs quality assurance report, and the University of South Australia SBRC test report, are included in Appendix B.

Laboratory blanks

Hill Labs ran two laboratory blanks for each total recoverable extraction batch and each SBRC extraction batch, and one blank for each total organic carbon batch. Almost all results were within control limits, except for:

- One instance of elevated mercury (0.11 mg/kg). This was ascribed to carryover from a calibrating standard, and was not used in final calculations.
- One instance of elevated total organic carbon. The corresponding data was accepted as blank levels were less than 10 % of sample levels.
- Two instances of elevated SBRC extractable lead. The corresponding data was accepted as blank levels were less than 10 % of sample levels.

Laboratory spikes

Hill Labs also carried out a total of six spiked and blank spiked SBRC extractions. One arsenic spike recovery was less than control limits allowed. As the corresponding blank spike was acceptable, the laboratory ascribed the poor spike recovery to a matrix effect, although HAIL Environmental has identified no mechanism for this.

Laboratory standards

During the analytical programme, Hill Labs ran six internal standards for soil pH measurements, eight for total organic carbon, and approximately 40 for total recoverable extractions; all were within control limits.

For SBRC extractions, 17 extractions of internal standards were reported. Two materials identified as QCA3 and QCA5 were used. Three extractions of QCA3 were outside control limits; one was above limits for arsenic and two were below for lead, with no evident explanation. Although QCA5 had no set control limits, results were at least consistent.

Laboratory replicates

Hill Labs ran a total of six samples in duplicate for total recoverable heavy elements. The elements being analysed varied from batch to batch, but included arsenic, chromium, copper, lead, mercury, or nickel, and in one duplicate calcium, iron, manganese, and phosphorus. Replicates were within error estimates of each other on all occasions.

Detection limits

The only analyte significantly affected by detection limits is mercury; almost all Ranzau samples and a third of Mapua samples were below limits of quantitation.

Normality and outliers

The Mapua dataset for total recoverable arsenic in < 250 μm fraction fails the Shapiro-Wilk test for normality (CIEH 2008). This lack of normality is to be expected, indeed desirable, given the investigation's intent to avoid sampling soils with low arsenic. Consequently, the distribution is artificially curtailed below approximately 15 mg/kg, while there are some samples with considerably higher levels, up to 47 mg/kg (MA5A1A).

However the Mapua dataset for bioavailable arsenic passes the Shapiro-Wilk test. So do both corresponding Ranzau datasets. Moreover, for the Ranzau dataset, calculated bioavailability values are tightly grouped, meaning that the result will be very similar whatever descriptive statistic is used as a measure of bioavailability.

While elements found in orchard pesticides – arsenic, lead, copper and mercury – are quite variable from sample to sample, and from site to site, for other parameters data is relatively tightly grouped. Exceptions include:

- Manganese in MA81A, at 470 mg/kg in the < 250 μm fraction; this is three times higher than in any of the other Mapua samples, and is not accompanied by a correspondingly high level of iron, with which manganese is usually associated. HAIL Environmental has no explanation for this result.
- Coarse sand in RNZ14A, which was recorded to contain very few particles > 250 μm diameter, unlike any of the other samples from that soil type. HAIL Environmental has no explanation for this result; this sample was not recorded as distinctive in the field.

Accuracy

Five SBRC extractions of the certified reference material NIST 2711a Montana II soil averaged 54 mg/kg arsenic with standard deviation less than 4 mg/kg. This is consistent with previous results recorded in-house by Hill Labs. Gastric extractable lead for the same samples, at 1,125 ± 11 mg/kg, was within the control limits set by USEPA for this method (refer Appendix A). These results are considered satisfactory.

One particle size analysis, for sample MA82, has an unusual distribution, with no particles counted in the 149-177 μm size fraction, although a range of smaller and larger sized particles were recorded. Other Orchard Eight samples do have lower counts in this size fraction compared to the adjacent sizes, but not a complete absence. This result is considered anomalous and is not included in the descriptive statistics of Table 2.

Repeatability

Over all laboratory analyses of the duplicate samples RNZ01, RNZ12, MA21, MA3A1, MA5A1 and MA71 (particle size analysis was not repeated for the latter), mean relative error averaged approximately 4 %. Only one paired result had relative error exceeding 30 %, the suggested standard of acceptability (MfE 2011); total recoverable and gastric extractable lead in < 250 μm fraction of RNZ01A and RNZ01C had 48 % and 57 % relative error respectively.

One acceptable, but problematic, replicate result was total recoverable arsenic in < 2 mm fraction of MA5A1, reported as 89 mg/kg in the A sample and 59 mg/kg in the C sample, for a relative error of 20 %. As this sample had the highest arsenic level in this investigation, it had a disproportionate weight on all linear regressions involving this parameter.

Reproducibility

Replicate gastric extraction results were not available at the time of writing.

4.5.3 Field XRF

Field blanks

At the beginning and end of each working day, a manufacturer-prepared sample of a quartz powder standard was analysed using the XRF. On 19 April, all blanks were satisfactory except that traces of iron were measured. However, on 12 May, blanks were poor, with the instrument reporting aluminum, iron and potassium. These results are not significant for this assessment, because evaluation of the role of iron in arsenic bioavailability here relies on laboratory data.

Field spikes

On occasion during the works, an XRF measurement was taken from a treated timber post. These results invariably showed several thousand mg/kg of chromium, copper, arsenic and other elements. Elements not anticipated in wood preservatives, such as vanadium, lead, or bismuth, were not detected. These results indicated that instrument response remained qualitatively satisfactory.

Field standards

At the beginning and end of each working day, manufacturer-prepared samples of the standard reference soils NIST2710a and NIST2711a were analysed using the XRF. On 19 April, results were typically consistent and close to certified element content, with some significant exceptions:

- Phosphorus measurements were excessively variable (coefficient of variance ~30 %)
- Reported calcium in NIST2711a was approximately 40 % below certified content
- Reported arsenic in NIST2710a was approximately 60 % below certified content.

On 12 May, standard results were poor:

- Measurements of aluminum, silicon, phosphorus, sulfur, potassium and calcium were all excessively variable (coefficient of variance 23-45 %)
- Reported calcium in both standards was below certified content, approximately 60 % low for NIST2710a and 30 % low for NIST 2711a
- Reported arsenic in both standards was below certified content, approximately 20 % low for NIST2710a and 70 % low for NIST 2711a.

These measurements were very concerning, and played the major part in the decision to select soils for sampling based on lead content, rather than arsenic. The instrument supplier noted that low arsenic readings for standards had been reported on other projects. Comment was sought from the manufacturer, who suggested that 'something might be wrong with the standard' and noted that arsenic can be difficult to detect by XRF in the presence of lead. These remarks were not reassuring.

Detection limits

The key elements, arsenic and lead, reached limits of quantitation in almost all XRF measurements at sampled locations. The exception was Mapua Orchard Three where no arsenic was reported in three of the six samples, despite lead exceeding 100 mg/kg. Even at sites or areas that were not sampled, arsenic was generally quantified, at concentrations as low as 3 mg/kg.

Cadmium and mercury were never quantified by XRF. As expected, laboratory analysis confirmed they were typically present at sub-mg/kg levels, below the manufacturer's specified limits of detection. Light elements of interest, particularly phosphorus and sulphur, were not always quantifiable. Chromium and nickel were readily quantifiable in Ranzau soils, but rarely reported in Mapua soils.

Accuracy

XRF results for arsenic and lead were similar to laboratory results, per Table 3:

Table 3: Comparing XRF data for arsenic and lead with laboratory data

Soil type	*Element*	*Slope*	*Intercept*	*R^2*
Ranzau	Arsenic	0.945	0	0.90
	Lead	1.17	0	0.96
Mapua	Arsenic	1.53	7	0.72
	Lead	1.30	23	0.88

These findings support instrument performance, despite the concerns raised in 'Standards' above. If elevated lead compromises arsenic analysis by XRF, then it only does so when lead concentrations are much greater than arsenic concentrations.

Despite the evident accuracy of XRF analysis, the 100 mg/kg lead by XRF field screen for Mapua soils was no better than 70% accurate at identifying soils with 20 mg/kg As in the laboratory. This was principally because the lead-arsenic relationship was not as strong as expected in these soils (at least, based on laboratory data). But, even in hindsight, it was a better screen than calibrating using the response to the NIST2711a standard, which would have been only 50 % accurate, or accepting the field XRF response without question (42 % accurate).

Accuracy for other elements was variable when compared to laboratory results; copper was well-behaved for Ranzau soils, and zinc for Mapua soils, but the converse was not remotely true. The XRF-laboratory correlation coefficients were 0.18 for copper in Mapua soils, 0.12 for zinc in Ranzau soils and 0.13 for chromium in Ranzau soils – scarcely better than independent. Surprisingly, chromium concentrations by XRF in Ranzau soils were on the order of four times higher than the laboratory results.

Repeatability

Triplicate XRF measurements were taken from different sides of the core for samples RNZ01, RNZ12, MA11, MA21, MA3A1, MA5A1 and MA7A1. Despite the combination of slightly different depths, slightly different lateral positions and the inherent error of XRF measurements, results were consistently similar. The mean covariance across all triplicate measurements was 12 %, and there were only four instances in which a single element had covariance greater than 30 %.

5. Interpretation

5.1 Arsenic bioavailability

Based on Hill Labs' SBRC test results and the linear regression of Diamond *et al* (2016: Equation 1), the 95th percentile upper confidence bound to the mean (UCL_{95}) arsenic oral bioavailability in 12 samples of Ranzau type soils from a former Paton Road orchard is estimated at 14 %. Across 30 samples of Mapua type soils from six former orchards, the arsenic bioavailability UCL_{95} is estimated at 38 %, with a maximum value of 47 %.

Based on the findings of systematic sampling, and of quality assurance and quality control procedures including replicate analysis at an academic laboratory specialising in bioaccessibility, the underlying bioaccessibility dataset is considered **accurate** and **repeatable.** For the Mapua soils, the dataset is considered likely to be **representative** of former pipfruit orchards on that soil type in general. For the Ranzau soils, because the two sites that were investigated were part of a single historic orchard, the dataset is considered limited and **may not be representative** of that soil type in general. **Reproducibility is unproven** because replicate gastric extraction is still to be undertaken: when results are available they will be issued as a supplement to this report.

The Mapua arsenic bioavailability result is moderate, in the middle to upper end of the range reported in previous studies (50 %) of pipfruit orchard soils (Section 3.2). This is consistent with the geochemical conceptual site model (Section 3.2), for the iron content of the Mapua soils is low, and iron oxides were expected to be the principal binding phase. Sulfide concentrations are so low that iron-arsenic-sulfur compounds are unlikely.

The Ranzau arsenic bioavailability is low, at the bottom end of the range reported in previous studies (Section 3.2). This result is initially surprising given that half the data comes from a tilled, fertilised market garden site, where phosphate – which competes with arsenic for soil binding sites – must have been added, and some degree of physical and biological reworking of soils has obviously occurred. Nonetheless, it is consistent with the moderately high iron content of Ranzau soils (> 4 %).

5.2 Soil chemistry

Ranzau soils

The Ranzau soils appear to have a distinct ultramafic character, with high background chromium, nickel and copper, and relatively high pH for a New Zealand soil. This is plausible given local geology; the Bryant Range some distance to the east of the site includes mafic and ultramafic rocks (hartzburgite, dunite, pyroxenite, gabbro, serpentinite) of the Dun Mountain Ultramafics Group (GNS 1998). The Bryant Range drains via the Roding River to the south of the site, currently a tributary of the Wairoa River that flows north across the Waimea Plains to Tasman Bay (see Figure 1). Evidently the Ranzau soils are at least partly sedimentary deposits left by these rivers. Hartzburgite, dunite and pyroxenite can all contain chromium minerals, which could explain why XRF results for the Ranzau soils show much more chromium than laboratory 'total extractable' results – the chromium may be trapped in minerals resistant even to very strong acid digestion.

Mapua soils

As anticipated, Mapua soils are revealed to be sandy silts with a low nutrient content, albeit with a clear signature of fertiliser addition (elevated potassium, phosphorus, calcium, cadmium) in some samples.

Lead:arsenic ratios are notably higher in the Mapua soils. Ranzau soil samples consistently had Pb:As around 3.5, while Mapua soil samples had Pb:As ranging from 3.6 to more than 12, with an average of 7.2. One possible explanation is that a different formulation of lead arsenate, with a lower lead content, was used by the Paton Road orchardist. Another explanation, perhaps more plausible, is that arsenic in the Mapua soils is not only more bioavailable, but also more phytoavailable and/or more leachable, so that it is selectively removed from topsoils, while the less mobile lead remains in place.

5.3 Mineralogy

SEM-EDAX revealed an astonishing array of mineral particles. Elements detected included thorium, lead, gold, iridium, dysprosium, cerium, lanthanum, antimony, silver, arsenic, and almost all metals lighter than copper.

Most of the heavy elements could not conceivably have been used on site. However, natural sources are not impossible:

- The association cerium and lanthanum ± thorium suggests monazite, which has often been reported in Westland and northwest Nelson (Christie *et al.*).
- The Aorere, Owen and Wangapeka goldfields of south Nelson are known sources of gold and silver (Christie and Brathwaite).
- Iridium is one of the rarest elements in the earth's crust, but iridium and other platinum group metals have been reported in the Dun Mountain area and from other ultramafic rocks around Nelson (Christie and Challis).

Some of the grains examined by SEM-EDAX are more likely to have anthropogenic sources:

- The lead ± antimony particles found only in RNZ01 are most likely fragments of lead shot, which has a small and variable antimony content; lead shot has an obvious application for pest control on a berryfruit orchard.
- Particles dominated by phosphorus are most likely phosphate fertilisers.
- The iron-dominated grain in MA3A1 is probably a metal fragment; the electron micrograph does suggest a cut face.
- Most relevantly to this study, just one of the grains, from MA5A1, was dominated by lead and arsenic, suggesting lead arsenate. Whether this grain came from undissolved pesticide, or precipitated from pesticide solution, or re-formed in the soil, is a matter for speculation.

A single manganese-dominated grain contained arsenic. We tend to think that this mineral may also be natural in origin. If it had formed from pesticide interacting with a manganese mineral, lead ought to have been present, since lead is known to bind strongly to manganese oxides.

The absence of lead, arsenic, and more than minor copper in the EDS spectra suggests that orchard spray residues are not present in mineralised forms. Instead, consistent with the CSM, they must be present in thin layers, adsorbed onto amorphous minerals such as iron oxides.

5.4 Particle size

Consistent differences in reported recoverable arsenic concentrations between the < 2 mm and < 250 μm particle size fractions may suggest that arsenic, lead, chromium and copper are enriched in large particles of the Mapua soils (diameters between 250 μm and 2 mm) but depleted in large particles of the Ranzau soils. However, because the magnitudes of the differences are small, batch-to-batch variation in the laboratory cannot completely be ruled out.

The correlation between bioavailable arsenic and clay content is poor for both soil types, confirming that aluminosilicate clays are not important binding phases for arsenic.

6. Arsenic Bioavailability Assessment

6.1 Site-specific soil guideline values

Because the arsenic oral bioavailability dataset for the Paton Road sites is tightly clustered, it is largely academic whether the mean, upper bound to the mean, or an upper bound to the distribution is used in calculating a site-specific soil guideline value. For consistency with general contaminated land practice, and with the previous arsenic bioavailability risk assessment (Golder 2012b), this assessment uses the UCL_{95} statistic of 14 % (refer Section 5). While it is likely that arsenic has a similar bioavailability in other historic orchard sites on Ranzau soils, there is no data from which to prove this conjecture.

Incorporating this estimated oral bioavailability value into the soil ingestion pathway of the MfE model, and into the 'soil entrained on vegetables' element of the home-grown produce pathway, generates a site-specific soil guideline value for residential use (SGV_{res}) of 68 mg/kg for 266 and 286 Paton Road (Appendix C), or 27 mg/kg for lifestyle use (SGV_{life}).

These SGVs are significantly different from the generic SCS, which are 20 and 17 mg/kg respectively. The Paton Road sites may be fit for residential purposes if arsenic bioavailability is taken into account.

It is surprising that arsenic bioavailability at Paton Road has remained low when the land has been used for market gardening. Nonetheless, this finding is very encouraging in that it implies bioavailability assessment may be robust with respect to subsequent changes in land use patterns.

For the Mapua soils, the choice of bioavailability estimate is more important. Using the UCL_{95} statistic of 38 % would give SGV_{res} of 40 mg/kg and SGV_{life} of 20 mg/kg. Using the maximum calculated value of 47 % would give SGV_{res} 35 mg/kg, SGV_{life} 18 mg/kg. In either case, the result is significant, as the study sites may be fit for residential purposes if arsenic bioavailability is taken into account. Note that some individual samples from Orchard Five exceed these SGV_{res}.

Whichever statistic is used, given that similar results were obtained from six different orchards, HAIL Environmental considers that the bioavailability estimate could be applied to any other former pipfruit orchard on this soil type, providing there is no other arsenic source. That is, these SGVs appear fit to be used as soil-specific guideline values providing that:

- Any such risk assessment is based on a robust conceptual site model incorporating typical residential or lifestyle use (or some less sensitive use),
- These SGVs are applied to Mapua type soils only,
- The soils have been impacted by lead arsenate application, and not by any other source of arsenic,
- The soils have not subsequently been substantially modified, and
- Hot spots such as spray sheds are not included in the results.

More generally, the results are consistent with USEPA's view that arsenic bioavailability rarely exceeds 60 % (USEPA 2012).

6.2 Other considerations

The following exposure pathways have not been evaluated, and would have to be considered or controlled before applying a bioavailability adjustment to a specific site:

- Drinking, cooking with or bathing in contaminated water
- Consuming wild foods
- Consuming home-grown meat, milk or eggs.

The results from the Paton Road sites indicate that tilling and fertilising had little or no effect on arsenic bioavailability in a historic orchard on Ranzau soil. Nonetheless, there is insufficient information to conclude that this is a general principle. Because phosphate and arsenate, the oxidised inorganic form of arsenic, are chemically very similar, it is conceivable that substantial increases in phosphate concentration could affect arsenic oral bioavailability. Accordingly, this assessment should be revisited if undertaking large scale phosphate fertiliser application.

6.3 Potential for further assessment

This assessment has shown that arsenic bioavailability in former pipfruit orchards on Mapua soils is consistently moderate, pending replicate gastric extraction by a second laboratory. It therefore provides a foundation to carry out similar assessments for other soil types in Tasman District or elsewhere in New Zealand.

This assessment has shown that arsenic bioavailability at a single former pipfruit orchard on Ranzau soils is consistently low, pending replicate gastric extraction by a second laboratory. Some other former orchards on Ranzau soils were visited, but there was no field evidence of substantial lead arsenate contamination, and hence no opportunity to determine whether this finding holds for Ranzau soils generally. In order to maximise future utility of Ranzau soils, and to provide further evidence as to whether lead arsenate bioavailability is principally dependent on soil type, there may be considerable value in screening more of these sites.

Because this assessment was not intended to be a DSI for any of the study sites, in the event of subdivision or change of use, further investigation may be required to confirm whether or not specific sites are fit for proposed uses. Further investigation would certainly be required for sites where there are other complete exposure pathways besides soil ingestion and vegetable consumption.

According to the human health contaminant risk assessment model used in this assessment, the risk driver for lifestyle use is consumption of home-grown vegetables. If arsenic phytoavailability were assessed and found to be less than assumed, or if gardening were undertaken only in clean imported soil, it is possible that the soil-specific soil guideline value could be raised further.

7. Limitations

This assessment has been prepared for Massey University by HAIL Environmental in accordance with the purpose and scope set out above, and the usual care and thoroughness of the consulting profession. It is solely for use by Massey University, its client Tasman District Council, and such other persons as may be agreed in writing by HAIL Environmental. For the avoidance of doubt, this limitation does not preclude use in resource consent decisions made by Tasman District Council.

As a site will change over time, this assessment is only accurate at the time of preparation and in respect of the proposed development as it has been explained to HAIL Environmental. Information from cited sources has not been independently verified unless specifically stated, and HAIL Environmental assumes no responsibility for any inaccuracy or omission therein.

This document does not purport to give legal or financial advice.

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Appendix A: SBRC Standard Operating Protocol

Solubility/Bioavailability Research Consortium

Standard Operating Procedure:

In Vitro Method for Determination of Lead and Arsenic Bioaccessibility

Doc. No.: 8601102.001 0601 1099 RN01

Contents

1. Introduction

1.1 Synopsis

This SOP describes an *in vitro* laboratory procedure to determine a bioaccessibility value for lead or arsenic (i.e., the fraction that would be soluble in the gastrointestinal tract) for soils and solid waste materials. A recommended quality assurance program to be followed when performing this extraction procedure is also provided.

1.2 Purpose

An increasingly important property of materials/soils found at contaminated sites is the bioavailability of individual contaminants. Bioavailability is the fraction of a contaminant in a particular environmental matrix that is absorbed by an organism via a specific exposure route. Many animal studies have been conducted to experimentally determine the oral bioavailability of individual metals, particularly lead and arsenic. During the period 1989–1997, a juvenile swine model developed by EPA Region VIII was used to predict the relative bioavailability of lead and arsenic in approximately 20 soils/solid materials (Weis and LaVelle 1991; Weis et al. 1994; Casteel et al. 1997a,b). The bioavailability determined was relative to that of a soluble salt (i.e., lead acetate trihydrate or sodium arsenate). The tested materials had a wide range of mineralogy, and produced a range of lead and arsenic bioavailability values. In addition to the swine studies, other animal models (e.g., rats and monkeys) have been used to measure the bioavailability of lead and arsenic from soil.

Several researchers have developed *in vitro* tests to measure the fraction of a chemical solubilized from a soil sample under simulated gastrointestinal conditions. This measurement is referred to as "bioaccessibility" (Ruby et al. 1993). Bioaccessibility is thought to be an important determinant of bioavailability, and several groups have sought

to compare bioaccessibility determined in the laboratory to bioavailability determined in animal studies (Imber 1993; Ruby et al. 1996; Medlin 1997; Rodriguez et al. 1999). The *in vitro* tests consist of an aqueous fluid, into which soils containing lead and arsenic are introduced. The solution then solubilizes the soil under simulated gastric conditions. Once this procedure is complete, the solution is analyzed for lead and/or arsenic concentration. The mass of lead and/or arsenic found in the aqueous phase, as defined by filtration at the 0.45-μm pore size, is compared to the mass introduced into the test. The fraction liberated into the aqueous phase is defined as the bioaccessible fraction of lead or arsenic in that soil. To date, for lead-bearing soils tested in the EPA swine studies, this *in vitro* method has correlated well with relative bioavailability values.

2. Procedure

2.1 Sample Preparation

All soil/material samples should be prepared for testing by oven drying (<40 °C) and sieving to <250 μm. The <250-μm size fraction is used because this particle size is representative of that which adheres to children's hands. Subsamples for testing in this procedure should be obtained using a sample splitter.

2.2 Apparatus and Materials

2.2.1 Equipment

The main piece of equipment required for this procedure consists of a Toxicity Characteristic Leaching Procedure (TCLP) extractor motor that has been modified to drive a flywheel. This flywheel in turn drives a Plexiglass block situated inside a temperature-controlled water bath. The Plexiglass block contains ten 5-cm holes with stainless steel screw clamps, each of which is designed to hold a 125-mL wide-mouth high-density polyethylene (HDPE) bottle (see Figure 1). The water bath must be filled such that the extraction bottles are immersed. Temperature in the water bath is maintained at 37±2 °C using an immersion circulator heater (for example, Fisher Scientific Model 730). Additional equipment for this method includes typical laboratory supplies and reagents, as described in the following sections.

The 125-mL HDPE bottles must have an air-tight screw-cap seal (for example, Fisher Scientific 125-mL wide-mouth HDPE Cat. No. 02-893-5C), and care must be taken to ensure that the bottles do not leak during the extraction procedure.

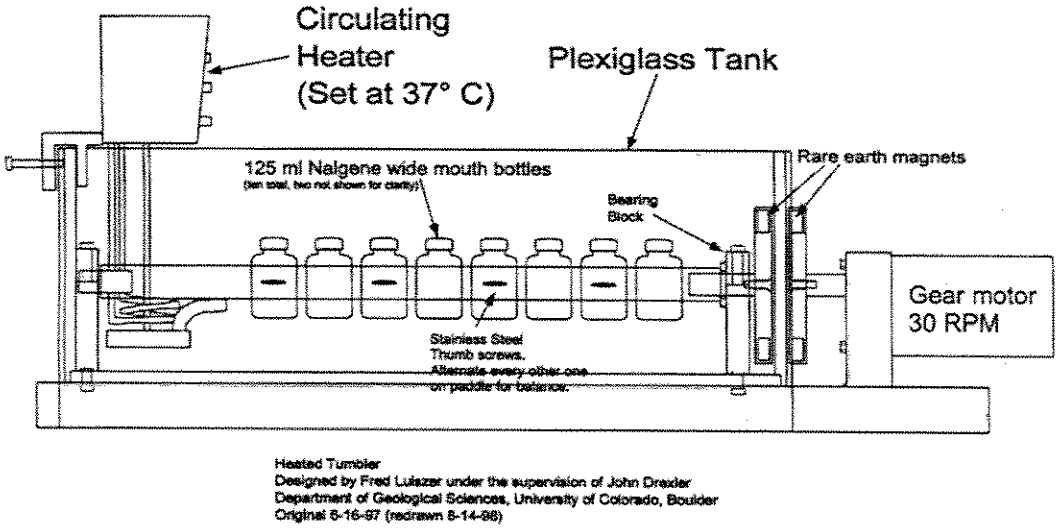

Figure 1. Extraction device for performing the SBRC *in vitro* extraction

2.2.2 Standards and Reagents

The leaching procedure for this method uses a buffered extraction fluid at a pH of 1.5. The extraction fluid is prepared as described below.

The extraction fluid should be prepared using ASTM Type II deionized (DI) water. To 1.9 L of DI water, add 60.06 g glycine (free base, Sigma Ultra or equivalent). Place the mixture in a water bath at 37 °C until the extraction fluid reaches 37 °C. Standardize the pH meter using temperature compensation at 37 °C or buffers maintained at 37 °C in the water bath. Add concentrated hydrochloric acid (12.1 N, Trace Metal grade) until the solution pH reaches a value of 1.50 ±0.05 (approximately 120 mL). Bring the solution to a final volume of 2 L (0.4 M glycine).

Cleanliness of all reagents and equipment used to prepare and/or store the extraction fluid is essential. All glassware and equipment used to prepare standards and reagents must be properly cleaned, acid washed, and finally, rinsed with DI water prior to use. All

reagents must be free of lead and arsenic, and the final fluid should be tested to confirm that lead and arsenic concentrations are less than 25 and 5 μg/L, respectively.

2.3 Leaching Procedure

Measure 100 ±0.5 mL of the extraction fluid, using a graduated cylinder, and transfer to a 125-mL wide-mouth HDPE bottle. Add 1.00 ±0.05 g of test substrate (<250 μm) to the bottle, ensuring that static electricity does not cause soil particles to adhere to the lip or outside threads of the bottle. If necessary, use an antistatic brush to eliminate static electricity prior to adding the soil. Record the volume of solution and mass of soil added to the bottle on the extraction test checklist (see Attachment A for example checklists). Hand-tighten each bottle top, and shake/invert to ensure that no leakage occurs, and that no soil is caked on the bottom of the bottle.

Place the bottle into the modified TCLP extractor, making sure each bottle is secure and the lid(s) are tightly fastened. Fill the extractor with 125-mL bottles containing test materials or Quality Control samples.

The temperature of the water bath must be 37±2 °C. Record the temperature of the water bath at the beginning and end of each extraction batch on the appropriate extraction test checklist sheet (see Attachment A).

Rotate the extractor end over end at 30±2 rpm for 1 hour. Record start time of rotation.

When extraction (rotation) is complete, immediately remove bottles, wipe them dry, and place them upright on the bench top.

Draw extract directly from reaction vessel into a disposable 20-cc syringe with a Luer-Lok attachment. Attach a 0.45-μm cellulose acetate disk filter (25 mm diameter) to the syringe, and filter the extract into a clean 15-mL polypropylene centrifuge tube or other

appropriate sample vial for analysis. Store filtered sample(s) in a refrigerator at 4 °C until they are analyzed.

Record the time that the extract is filtered (i.e., extraction is stopped). If the total elapsed time is greater than 1 hour 30 minutes, the test must be repeated.

Measure and record the pH of fluid remaining in the extraction bottle. If the fluid pH is not within ±0.5 pH units of the starting pH, the test must be discarded and the sample reanalyzed as follows.

If the pH has dropped by 0.5 or more pH units, the test will be re-run in an identical fashion. If the second test also results in a decrease in pH of greater than 0.5 s.u., the pH will be recorded, and the extract filtered for analysis. If the pH has increased by 0.5 or more units, the test must be repeated, but the extractor must be stopped at specific intervals and the pH manually adjusted down to pH 1.5 with dropwise addition of HCl (adjustments at 5, 10, 15, and 30 minutes into the extraction, and upon final removal from the water bath [60 minutes]). Samples with rising pH values must be run in a separate extraction, and must not be combined with samples being extracted by the standard method (continuous extraction).

Extracts are to be analyzed for lead and arsenic concentration using analytical procedures taken from the U.S. EPA publication, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods. SW-846.* (current revisions). Inductively coupled plasma (ICP) analysis, method 6010B (December 1996 revision) will be the method of choice. This method should be adequate for determination of lead concentrations in sample extracts, at a project-required detection limit (PRDL) of 100 μg/L. The PRDL of 20 μg/L for arsenic may be too low for ICP analysis for some samples. For extracts that have arsenic concentrations less than five times the PRDL (e.g., <100 μg/L arsenic), analysis by ICP-hydride generation (method 7061A, July 1992 revision) or ICP-MS (method 6020, September 1994 revision) will be required.

2.4 Calculation of the Bioaccessibility Value

A split of each solid material (<250 μm) that has been subjected to this extraction procedure should be analyzed for total lead and/or arsenic concentration using analytical procedures taken from the U.S. EPA publication, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods. SW-846.* (current revisions). The solid material should be acid digested according to method 3050A (July 1992 revision) or method 3051 (microwave-assisted digestion, September 1994 revision), and the digestate analyzed for lead and/or arsenic concentration by ICP analysis (method 6010B). For samples that have arsenic concentrations below ICP detection limits, analysis by ICP-hydride generation (method 7061A, July 1992 revision) or ICP-MS (method 6020, September 1994 revision) will be required.

The bioaccessibility of lead or arsenic is calculated in the following manner:

$$Bioaccessibility\ value = \frac{(concentration\ in\ in\ vitro\ extract,\ mg/L)\ (0.1L)}{(concentration\ in\ solid,\ mg/kg)\ (0.001\ kg)} \times 100$$

2.5 Chain-of-Custody/Good Laboratory Practices

All laboratories that use this SOP should receive test materials with chain-of-custody documentation. When materials are received, each laboratory will maintain and record custody of samples at all times. All laboratories that perform this procedure should follow good laboratory practices as defined in 40 CFR Part 792 to the extent practical and possible.

2.6 Data Handling and Verification

All sample and fluid preparation calculations and operations should be recorded in bound and numbered laboratory notebooks, and on extraction test checklist sheets. Each page must be dated and initialed by the person who performs any operations. Extraction and filtration times must be recorded, along with pH measurements, adjustments, and buffer preparation. Copies of the extraction test checklist sheets should accompany the data package.

3. Quality Control Procedures

3.1 Elements of Quality Assurance and Quality Control (QA/QC)

A standard method for the *in vitro* extraction of soils/solid materials, and the calculation of an associated bioaccessibility value, are specified above. Associated QC procedures to ensure production of high-quality data are as follows (see Table 1 for summary of QC procedures, frequency, and control limits):

- Reagent blank—Extraction fluid analyzed once per batch.
- Bottle blank—Extraction fluid only run through the complete extraction procedure at a frequency of no less than 1 per 20 samples or one per extraction batch, whichever is more frequent.
- Blank spikes—Extraction fluid spiked at 10 mg/L lead and/or 1 mg/L arsenic and run through the extraction procedure at a frequency of no less than every 20 samples or one per extraction batch, whichever is more frequent. Blank spikes should be prepared using traceable 1,000-mg/L lead and arsenic standards in 2 percent nitric acid.
- Duplicate—duplicate extractions are required at a frequency of 1 for every 10 samples. At least one duplicate must be performed on each day that extractions are conducted.
- Standard Reference Material (SRM)—National Institute of Standards and Technology (NIST) material 2711 (Montana Soil) should be used as a laboratory control sample (LCS).

Control limits for these QC samples are delineated in Table 1, and in the following discussion.

Table 1. Summary of QC samples, frequency of analysis, and control limits

QC Sample	Minimum Frequency of Analysis	Control Limits
Reagent Blank	Once per batch (min. 5%)	<25 µg/L lead <5 µg/L arsenic
Bottle Blank	Once per batch (min. 5%)	<50 µg/L lead <10 µg/L arsenic
Blank Spike	Once per batch (min. 5%)	85–115% recovery
Duplicate	10%	±20% RPD
SRM (NIST 2711)	2%	9.22 ±1.50 mg/L Pb 0.59 ±0.09 mg/L As

3.2 QA/QC Procedures

Specific laboratory procedures and QC steps are described in the analytical methods cited in Section 2.3, and should be followed when using this SOP.

3.2.1 Laboratory Control Sample (LCS)

The NIST SRM 2711 should be used as a laboratory control sample for the *in vitro* extraction procedure. Analysis of 18 blind splits of NIST SRM 2711 (105 mg/kg arsenic and 1,162 mg/kg lead) in four independent laboratories resulted in arithmetic means ± standard deviations of 9.22 ±1.50 mg/L lead and 0.59 ±0.09 mg/L arsenic. This SRM is available from the National Institute of Standards and Technology, Standard Reference Materials Program, Room 204, Building 202, Gaithersburg, Maryland 20899 (301/975-6776).

3.2.2 Reagent Blanks/Bottle Blanks/Blank Spikes

Reagent blanks must not contain more than 5 µg/L arsenic or 25 µg/L lead. Bottle blanks must not contain arsenic and/or lead concentrations greater than 10 and 50 µg/L,

respectively. If either the reagent blank or a bottle blank exceeds these values, contamination of reagents, water, or equipment should be suspected. In this case, the laboratory must investigate possible sources of contamination and mitigate the problem before continuing with sample analysis. Blank spikes should be within 15% of their true value. If recovery of any blank spike is outside this range, possible errors in preparation, contamination, or instrument problems should be suspected. In the case of a blank spike outside specified limits, the problems must be investigated and corrected before continuing sample analysis.

4. References

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Attachment A:

Extraction Test Checklist Sheets

Extraction Fluid Preparation

Date of Extraction Fluid Preparation:_____ Prepared by:_____

Extraction Fluid Lot #:_____

Component	Lot Number	Fluid Preparation 1L	Fluid Preparation 2L	Acceptance Range	Actual Quantity	Comments
Deionized Water		0.95 L (approx.)	1.9 L (approx.)	---		
Glycine		30.03±0.05 g	60.06±0.05g	---		
HCl [a]		60 mL (approx.)	120 mL (approx.)	---		
Final Volume	---	1 L (Class A, vol.)	2 L (Class A, vol.)	---		
Extraction Fluid pH value (@ 37°C)	---	1.50±0.05	1.50±0.05	1.45–1.55		

[a] Concentrated hydrochloric acid (12.1 N)

INVITRO PROCEDURE REQUIRED PARAMETERS:

Volume of extraction fluid (V) = 100 ±0.5 mL
Mass of test substrate (M) = 1.00 ±0.05 g
Temperature of water bath = 37 ±2 °C
Extraction time = 60 ±5 min

Extractor rotation speed = 30 ±2 rpm
Maximum elapsed time from extraction to filtration = 90 minutes
Maximum pH difference from start to finish (ΔpH)= 0.5 pH units
Spike solution concentrations: As = 1 mg/L; Pb = 10 mg/L

Date of Extraction:_____
Extraction Fluid Lot #:_____
Extracted by:_____

As Spike Solution Lot #:_____
Pb Spike Solution Lot #:_____

EXTRACTION LOG (Page 1 of 2)
[Complete 1 log for every batch of 20 samples]

	Sample Preparation		Extraction								Filtration	
Sample ID	V (mL)	M (g)	Start Time[a]	End Time[a]	Elapsed Time (min)	Start pH	End pH	ΔpH	Start Temp (°C)	End Temp (°C)	Time[a]	Time Elasped from extraction (min)
Acceptance Range	(95.5–100.5)	(0.95–1.05)	---	---	(55–65 min)	---	---	(≤ 0.5)	(35–39)	(35–39)		(Max = 90 min)

EXTRACTION LOG (Page 2 of 2)
[Complete 1 log for every batch of 20 samples]

	Sample Preparation		Extraction								Filtration	
Sample ID	V (mL)	M (g)	Start Time[a]	End Time[a]	Elapsed Time (min)	Start pH	End pH	ΔpH	Start Temp (°C)	End Temp (°C)	Time[a]	Time Elasped from extraction (min)
Acceptance Range	(95.5–100.5)	(0.95–1.05)	---	---	(55–65 min)	---	---	(≤ 0.5)	(35–39)	(35–39)		(Max = 90 min)

[a] 24-hour time scale

NOTES:

Analytical Procedures

QC Requirements:

QC Sample	Minimum Analysis Frequency	Control Limits	Corrective Action[a]
Reagent blank	once per batch (min. 5%)	< 25 µg/L Pb <5 µg/L As	Investigate possible sources of target analytes. Mitigate contamination problem before continuing analysis.
Bottle blank	once per batch (min. 5%)	< 50 µg/L Pb <10 µg/L As	Investigate possible sources of target analytes. Mitigate contamination problem before continuing analysis.
Blank spike	once per batch (min. 5%)	85–115%	Re-extract and reanalyze sample batch
Duplicate	10% (min. once/day)	±20% RPD	Re-homongenize, re-extract and reanalyze

RPD – Relative percent difference
a – Action required if control limits are not met

Appendix B: Laboratory Reports

Hill Laboratories
TRIED, TESTED AND TRUSTED

R J Hill Laboratories Limited
1 Clyde Street Hamilton 3216
Private Bag 3205
Hamilton 3240 New Zealand

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E mail@hill-labs.co.nz
W www.hill-laboratories.com

ANALYSIS REPORT

Client:	Tasman District Council ENVIRONMENTAL	**Lab No:**	1778626	SPv4
Contact:	Anna MacKenzie	**Date Received:**	19-May-2017	
	C/- Tasman District Council ENVIRONMENTAL	**Date Reported:**	28-Jun-2017	**(Amended)**
	Private Bag 4	**Quote No:**	83731	
	Richmond 7050	**Order No:**	337657	
		Client Reference:		
		Submitted By:	P Sheldon	

Interim Report

This is an interim report, prepared before all test results are completed. As all final Q.C. checks may not have been possible, it is not regarded as an official laboratory report. The final, official report will be issued upon completion of all tests.

Sample Type: Soil

	Sample Name:	RNZ01 A 19-Apr-2017 10:00 am	RNZ01 B 19-Apr-2017 10:00 am	RNZ01 C 19-Apr-2017 10:00 am	RNZ01 D 19-Apr-2017 10:00 am	RNZ02 A 19-Apr-2017
	Lab Number:	1778626.1	1778626.2	1778626.3	1778626.4	1778626.5
Individual Tests						
Dry Matter	g/100g as rcvd	83	-	-	-	-
Particle size analysis		-	See attached report	-	See attached report	-
pH	pH Units	7.1	-	7.2	-	7.0
Acid Soluble Sulphide	mg/kg as rcvd	In Progress	-	-	-	-
Acid Insoluble Sulphide	mg/kg as rcvd	In Progress	-	-	-	-
Heavy Metals with Mercury, Screen Level						
Total Recoverable Arsenic	mg/kg dry wt	18	-	16	-	15
Total Recoverable Cadmium	mg/kg dry wt	0.31	-	0.28	-	0.28
Total Recoverable Chromium	mg/kg dry wt	165	-	161	-	166
Total Recoverable Copper	mg/kg dry wt	143	-	144	-	128
Total Recoverable Lead	mg/kg dry wt	64	-	62	-	49
Total Recoverable Mercury	mg/kg dry wt	< 0.10	-	< 0.10	-	< 0.10
Total Recoverable Nickel	mg/kg dry wt	190	-	200	-	210
Total Recoverable Zinc	mg/kg dry wt	84	-	86	-	81

	Sample Name:	RNZ02 B 19-Apr-2017 10:00 am	RNZ03 A 19-Apr-2017	RNZ03 B 19-Apr-2017	RNZ04 A 19-Apr-2017 10:35 am	RNZ04 B 19-Apr-2017 10:35 am
	Lab Number:	1778626.6	1778626.7	1778626.8	1778626.9	1778626.10
Individual Tests						
Particle size analysis		See attached report	-	See attached report	-	See attached report
pH	pH Units	-	6.4	-	7.2	-
Heavy Metals with Mercury, Screen Level						
Total Recoverable Arsenic	mg/kg dry wt	-	41	-	24	-
Total Recoverable Cadmium	mg/kg dry wt	-	0.31	-	0.25	-
Total Recoverable Chromium	mg/kg dry wt	-	164	-	186	-
Total Recoverable Copper	mg/kg dry wt	-	97	-	87	-
Total Recoverable Lead	mg/kg dry wt	-	148	-	88	-
Total Recoverable Mercury	mg/kg dry wt	-	< 0.10	-	< 0.10	-
Total Recoverable Nickel	mg/kg dry wt	-	173	-	200	-
Total Recoverable Zinc	mg/kg dry wt	-	92	-	79	-

	Sample Name:	RNZ05 A 19-Apr-2017	RNZ05 B 19-Apr-2017	RNZ06 A 19-Apr-2017	RNZ06 B 19-Apr-2017	RNZ11 A 19-Apr-2017 11:30 am
	Lab Number:	1778626.11	1778626.12	1778626.13	1778626.14	1778626.15

Sample Type: Soil						
Sample Name:		RNZ05 A 19-Apr-2017	RNZ05 B 19-Apr-2017	RNZ06 A 19-Apr-2017	RNZ06 B 19-Apr-2017	RNZ11 A 19-Apr-2017 11:30 am
Lab Number:		1778626.11	1778626.12	1778626.13	1778626.14	1778626.15
Individual Tests						
Particle size analysis		-	See attached report	-	See attached report	-
pH	pH Units	7.1	-	7.1	-	7.0
Heavy Metals with Mercury, Screen Level						
Total Recoverable Arsenic	mg/kg dry wt	28	-	31	-	21
Total Recoverable Cadmium	mg/kg dry wt	0.24	-	0.26	-	0.39
Total Recoverable Chromium	mg/kg dry wt	152	-	168	-	167
Total Recoverable Copper	mg/kg dry wt	75	-	64	-	121
Total Recoverable Lead	mg/kg dry wt	94	-	99	-	68
Total Recoverable Mercury	mg/kg dry wt	< 0.10	-	< 0.10	-	< 0.10
Total Recoverable Nickel	mg/kg dry wt	168	-	180	-	175
Total Recoverable Zinc	mg/kg dry wt	78	-	81	-	85

Sample Name:		RNZ11 B 19-Apr-2017	RNZ12 A 19-Apr-2017	RNZ12 B 19-Apr-2017	RNZ12 C 19-Apr-2017 11:55 am	RNZ12 D 19-Apr-2017 11:55 am
Lab Number:		1778626.16	1778626.17	1778626.18	1778626.19	1778626.20
Individual Tests						
Dry Matter	g/100g as rcvd	-	82	-	-	-
Particle size analysis		See attached report	-	See attached report	-	See attached report
pH	pH Units	-	6.8	-	6.8	-
Acid Soluble Sulphide	mg/kg as rcvd	-	In Progress	-	-	-
Acid Insoluble Sulphide	mg/kg as rcvd	-	In Progress	-	-	-
Heavy Metals with Mercury, Screen Level						
Total Recoverable Arsenic	mg/kg dry wt	-	27	-	29	-
Total Recoverable Cadmium	mg/kg dry wt	-	0.42	-	0.49	-
Total Recoverable Chromium	mg/kg dry wt	-	158	-	163	-
Total Recoverable Copper	mg/kg dry wt	-	185	-	181	-
Total Recoverable Lead	mg/kg dry wt	-	97	-	102	-
Total Recoverable Mercury	mg/kg dry wt	-	< 0.10	-	< 0.10	-
Total Recoverable Nickel	mg/kg dry wt	-	172	-	165	-
Total Recoverable Zinc	mg/kg dry wt	-	90	-	88	-

Sample Name:		RNZ13 A 19-Apr-2017	RNZ13 B 19-Apr-2017	RNZ14 A 19-Apr-2017	RNZ14 B 19-Apr-2017	RNZ15 A 19-Apr-2017
Lab Number:		1778626.21	1778626.22	1778626.23	1778626.24	1778626.25
Individual Tests						
Particle size analysis		-	See attached report	-	See attached report	-
pH	pH Units	6.6	-	6.6	-	6.7
Heavy Metals with Mercury, Screen Level						
Total Recoverable Arsenic	mg/kg dry wt	24	-	33	-	41
Total Recoverable Cadmium	mg/kg dry wt	0.43	-	0.38	-	0.34
Total Recoverable Chromium	mg/kg dry wt	168	-	164	-	145
Total Recoverable Copper	mg/kg dry wt	171	-	115	-	45
Total Recoverable Lead	mg/kg dry wt	87	-	121	-	156
Total Recoverable Mercury	mg/kg dry wt	< 0.10	-	< 0.10	-	< 0.10
Total Recoverable Nickel	mg/kg dry wt	175	-	183	-	162
Total Recoverable Zinc	mg/kg dry wt	88	-	81	-	91

Sample Name:		RNZ15 B 19-Apr-2017	RNZ16 A 19-Apr-2017	RNZ16 B 19-Apr-2017	MA5A1 A 12-May-2017 10:20 am	MA5A1 B 12-May-2017 10:20 am
Lab Number:		1778626.26	1778626.27	1778626.28	1778626.29	1778626.30
Individual Tests						
Dry Matter	g/100g as rcvd	-	-	-	80	-

Sample Type: Soil						
Sample Name:		RNZ15 B 19-Apr-2017	RNZ16 A 19-Apr-2017	RNZ16 B 19-Apr-2017	MA5A1 A 12-May-2017 10:20 am	MA5A1 B 12-May-2017 10:20 am
Lab Number:		1778626.26	1778626.27	1778626.28	1778626.29	1778626.30
Individual Tests						
Particle size analysis		See attached report	-	See attached report	-	See attached report
pH	pH Units	-	6.3	-	6.0	-
Acid Soluble Sulphide	mg/kg as rcvd	-	-	-	In Progress	-
Acid Insoluble Sulphide	mg/kg as rcvd	-	-	-	In Progress	-
Heavy Metals with Mercury, Screen Level						
Total Recoverable Arsenic	mg/kg dry wt	-	49	-	89	-
Total Recoverable Cadmium	mg/kg dry wt	-	0.41	-	0.28	-
Total Recoverable Chromium	mg/kg dry wt	-	142	-	12	-
Total Recoverable Copper	mg/kg dry wt	-	38	-	30	-
Total Recoverable Lead	mg/kg dry wt	-	177	-	320	-
Total Recoverable Mercury	mg/kg dry wt	-	0.12	-	0.74	-
Total Recoverable Nickel	mg/kg dry wt	-	151	-	7	-
Total Recoverable Zinc	mg/kg dry wt	-	90	-	27	-

Sample Name:		MA5A1 C 12-May-2017 10:20 am	MA5A1 D 12-May-2017 10:20 am	MA5A2 A 12-May-2017	MA5A2 B 12-May-2017	MA5A3 A
Lab Number:		1778626.31	1778626.32	1778626.33	1778626.34	1778626.35
Individual Tests						
Dry Matter	g/100g as rcvd	79	-	-	-	-
Particle size analysis		-	See attached report	-	See attached report	-
pH	pH Units	5.8	-	5.8	-	5.6
Acid Soluble Sulphide	mg/kg as rcvd	In Progress	-	-	-	-
Acid Insoluble Sulphide	mg/kg as rcvd	In Progress	-	-	-	-
Heavy Metals with Mercury, Screen Level						
Total Recoverable Arsenic	mg/kg dry wt	59	-	48	-	36
Total Recoverable Cadmium	mg/kg dry wt	0.25	-	0.36	-	0.25
Total Recoverable Chromium	mg/kg dry wt	8	-	8	-	7
Total Recoverable Copper	mg/kg dry wt	27	-	27	-	25
Total Recoverable Lead	mg/kg dry wt	260	-	350	-	280
Total Recoverable Mercury	mg/kg dry wt	0.61	-	1.00	-	0.81
Total Recoverable Nickel	mg/kg dry wt	10	-	6	-	5
Total Recoverable Zinc	mg/kg dry wt	21	-	25	-	20

Sample Name:		MA5A3 B 12-May-2017	MA5A4 A 12-May-2017	MA5A4 B 12-May-2017	MA5A5 A 12-May-2017	MA5A5 B 12-May-2017
Lab Number:		1778626.36	1778626.37	1778626.38	1778626.39	1778626.40
Individual Tests						
Particle size analysis		See attached report	-	See attached report	-	See attached report
pH	pH Units	-	5.4	-	5.6	-
Heavy Metals with Mercury, Screen Level						
Total Recoverable Arsenic	mg/kg dry wt	-	27	-	30	-
Total Recoverable Cadmium	mg/kg dry wt	-	0.33	-	0.25	-
Total Recoverable Chromium	mg/kg dry wt	-	9	-	8	-
Total Recoverable Copper	mg/kg dry wt	-	21	-	18	-
Total Recoverable Lead	mg/kg dry wt	-	220	-	250	-
Total Recoverable Mercury	mg/kg dry wt	-	0.53	-	0.57	-
Total Recoverable Nickel	mg/kg dry wt	-	8	-	6	-
Total Recoverable Zinc	mg/kg dry wt	-	22	-	25	-

Sample Name:		MA5A6 A 12-May-2017	MA5A6 B 12-May-2017	MA3A1 A 12-May-2017 2:40 pm	MA3A1 B 12-May-2017 2:40 pm	MA3A1 C 12-May-2017 2:40 pm
Lab Number:		1778626.41	1778626.42	1778626.43	1778626.44	1778626.45

Sample Type: Soil						
Sample Name:		MA5A6 A 12-May-2017	MA5A6 B 12-May-2017	MA3A1 A 12-May-2017 2:40 pm	MA3A1 B 12-May-2017 2:40 pm	MA3A1 C 12-May-2017 2:40 pm
Lab Number:		1778626.41	1778626.42	1778626.43	1778626.44	1778626.45
Individual Tests						
Dry Matter	g/100g as rcvd	-	-	70	-	-
Particle size analysis		-	See attached report	-	See attached report	-
pH	pH Units	5.9	-	6.6	-	6.5
Acid Soluble Sulphide	mg/kg as rcvd	-	-	In Progress	-	-
Acid Insoluble Sulphide	mg/kg as rcvd	-	-	In Progress	-	-
Heavy Metals with Mercury, Screen Level						
Total Recoverable Arsenic	mg/kg dry wt	16	-	24	-	24
Total Recoverable Cadmium	mg/kg dry wt	0.32	-	0.46	-	0.49
Total Recoverable Chromium	mg/kg dry wt	5	-	8	-	8
Total Recoverable Copper	mg/kg dry wt	18	-	43	-	42
Total Recoverable Lead	mg/kg dry wt	195	-	161	-	155
Total Recoverable Mercury	mg/kg dry wt	0.44	-	< 0.10	-	< 0.10
Total Recoverable Nickel	mg/kg dry wt	5	-	5	-	5
Total Recoverable Zinc	mg/kg dry wt	21	-	76	-	70

Sample Name:		MA3A1 D 12-May-2017 2:40 pm	MA3A2 A 12-May-2017	MA3A2 B 12-May-2017	MA3A3 A 12-May-2017	MA3A3 B 12-May-2017
Lab Number:		1778626.46	1778626.47	1778626.48	1778626.49	1778626.50
Individual Tests						
Particle size analysis		See attached report	-	See attached report	-	See attached report
pH	pH Units	-	6.2	-	6.3	-
Heavy Metals with Mercury, Screen Level						
Total Recoverable Arsenic	mg/kg dry wt	-	22	-	21	-
Total Recoverable Cadmium	mg/kg dry wt	-	0.62	-	0.61	-
Total Recoverable Chromium	mg/kg dry wt	-	10	-	10	-
Total Recoverable Copper	mg/kg dry wt	-	49	-	46	-
Total Recoverable Lead	mg/kg dry wt	-	200	-	230	-
Total Recoverable Mercury	mg/kg dry wt	-	< 0.10	-	< 0.10	-
Total Recoverable Nickel	mg/kg dry wt	-	6	-	5	-
Total Recoverable Zinc	mg/kg dry wt	-	62	-	58	-

Sample Name:		MA3A4 A 12-May-2017	MA3A4 B 12-May-2017	MA3A5 A 12-May-2017	MA3A5 B 12-May-2017	MA3A6 A 12-May-2017
Lab Number:		1778626.51	1778626.52	1778626.53	1778626.54	1778626.55
Individual Tests						
Particle size analysis		-	See attached report	-	See attached report	-
pH	pH Units	6.8	-	6.6	-	6.3
Heavy Metals with Mercury, Screen Level						
Total Recoverable Arsenic	mg/kg dry wt	21	-	25	-	24
Total Recoverable Cadmium	mg/kg dry wt	0.43	-	0.54	-	0.56
Total Recoverable Chromium	mg/kg dry wt	10	-	8	-	10
Total Recoverable Copper	mg/kg dry wt	24	-	50	-	41
Total Recoverable Lead	mg/kg dry wt	98	-	210	-	189
Total Recoverable Mercury	mg/kg dry wt	0.21	-	< 0.10	-	< 0.10
Total Recoverable Nickel	mg/kg dry wt	5	-	5	-	7
Total Recoverable Zinc	mg/kg dry wt	63	-	65	-	55

Sample Name:		MA3A6 B 12-May-2017	MA11 A 12-May-2017 1:35 pm	MA11 B 12-May-2017 1:35 pm	MA21 A 13-May-2017 9:30 am	MA21 B 13-May-2017 9:30 am
Lab Number:		1778626.56	1778626.57	1778626.58	1778626.59	1778626.60
Individual Tests						
Dry Matter	g/100g as rcvd	-	-	-	73	-

Sample Type: Soil						
Sample Name:		MA3A6 B 12-May-2017	MA11 A 12-May-2017 1:35 pm	MA11 B 12-May-2017 1:35 pm	MA21 A 13-May-2017 9:30 am	MA21 B 13-May-2017 9:30 am
Lab Number:		1778626.56	1778626.57	1778626.58	1778626.59	1778626.60
Individual Tests						
Particle size analysis		See attached report	-	See attached report	-	See attached report
pH	pH Units	-	5.7	-	7.1	-
Acid Soluble Sulphide	mg/kg as rcvd	-	-	-	In Progress	-
Acid Insoluble Sulphide	mg/kg as rcvd	-	-	-	In Progress	-
Heavy Metals with Mercury, Screen Level						
Total Recoverable Arsenic	mg/kg dry wt	-	24	-	20	-
Total Recoverable Cadmium	mg/kg dry wt	-	0.20	-	0.20	-
Total Recoverable Chromium	mg/kg dry wt	-	5	-	7	-
Total Recoverable Copper	mg/kg dry wt	-	24	-	15	-
Total Recoverable Lead	mg/kg dry wt	-	157	-	100	-
Total Recoverable Mercury	mg/kg dry wt	-	0.52	-	0.16	-
Total Recoverable Nickel	mg/kg dry wt	-	2	-	4	-
Total Recoverable Zinc	mg/kg dry wt	-	11	-	27	-

Sample Name:		MA21 C 13-May-2017 9:30 am	MA21 D 13-May-2017 9:30 am	MA42 A 12-May-2017	MA71 A 13-May-2017 11:00 am	MA71 B 13-May-2017 11:00 am
Lab Number:		1778626.61	1778626.62	1778626.63	1778626.65	1778626.66
Individual Tests						
Dry Matter	g/100g as rcvd	-	-	-	73	-
Particle size analysis		-	See attached report	-	-	See attached report
pH	pH Units	7.2	-	6.7	5.4	-
Acid Soluble Sulphide	mg/kg as rcvd	-	-	-	In Progress	-
Acid Insoluble Sulphide	mg/kg as rcvd	-	-	-	In Progress	-
Heavy Metals with Mercury, Screen Level						
Total Recoverable Arsenic	mg/kg dry wt	24	-	15	25	-
Total Recoverable Cadmium	mg/kg dry wt	0.24	-	0.53	0.18	-
Total Recoverable Chromium	mg/kg dry wt	8	-	8	7	-
Total Recoverable Copper	mg/kg dry wt	16	-	41	16	-
Total Recoverable Lead	mg/kg dry wt	110	-	125	162	-
Total Recoverable Mercury	mg/kg dry wt	0.17	-	0.20	0.42	-
Total Recoverable Nickel	mg/kg dry wt	4	-	5	4	-
Total Recoverable Zinc	mg/kg dry wt	26	-	41	16	-

Sample Name:		MA71 C 13-May-2017 11:00 am	MA72 A 13-May-2017	MA72 B 13-May-2017	MA12 A 12-May-2017	MA12 B 12-May-2017
Lab Number:		1778626.67	1778626.68	1778626.69	1778626.70	1778626.71
Individual Tests						
Particle size analysis		-	-	See attached report	-	See attached report
pH	pH Units	5.4	5.8	-	5.6	-
Heavy Metals with Mercury, Screen Level						
Total Recoverable Arsenic	mg/kg dry wt	22	20	-	27	-
Total Recoverable Cadmium	mg/kg dry wt	0.17	0.28	-	0.24	-
Total Recoverable Chromium	mg/kg dry wt	7	8	-	6	-
Total Recoverable Copper	mg/kg dry wt	14	24	-	28	-
Total Recoverable Lead	mg/kg dry wt	152	133	-	176	-
Total Recoverable Mercury	mg/kg dry wt	0.46	0.39	-	0.50	-
Total Recoverable Nickel	mg/kg dry wt	4	6	-	3	-
Total Recoverable Zinc	mg/kg dry wt	14	22	-	48	-

Sample Name:		MA13 A 12-May-2017	MA13 B 12-May-2017	MA22 A 13-May-2017	MA22 B 13-May-2017	MA23 A 13-May-2017
Lab Number:		1778626.72	1778626.73	1778626.74	1778626.75	1778626.76

Sample Type: Soil						
Sample Name:		MA13 A 12-May-2017	MA13 B 12-May-2017	MA22 A 13-May-2017	MA22 B 13-May-2017	MA23 A 13-May-2017
Lab Number:		1778626.72	1778626.73	1778626.74	1778626.75	1778626.76
Individual Tests						
Particle size analysis		-	See attached report	-	See attached report	-
pH	pH Units	6.3	-	6.8	-	6.9
Heavy Metals with Mercury, Screen Level						
Total Recoverable Arsenic	mg/kg dry wt	28	-	13	-	11
Total Recoverable Cadmium	mg/kg dry wt	0.34	-	0.50	-	0.45
Total Recoverable Chromium	mg/kg dry wt	7	-	10	-	10
Total Recoverable Copper	mg/kg dry wt	38	-	17	-	18
Total Recoverable Lead	mg/kg dry wt	193	-	104	-	73
Total Recoverable Mercury	mg/kg dry wt	0.50	-	0.25	-	0.11
Total Recoverable Nickel	mg/kg dry wt	3	-	8	-	8
Total Recoverable Zinc	mg/kg dry wt	33	-	45	-	60

Sample Name:		MA23 B 13-May-2017	MA24 A 13-May-2017	MA24 B 13-May-2017	MA25 A 13-May-2017	MA25 B 13-May-2017
Lab Number:		1778626.77	1778626.78	1778626.79	1778626.80	1778626.81
Individual Tests						
Particle size analysis		See attached report	-	See attached report	-	See attached report
pH	pH Units	-	6.4	-	6.9	-
Heavy Metals with Mercury, Screen Level						
Total Recoverable Arsenic	mg/kg dry wt	-	16	-	14	-
Total Recoverable Cadmium	mg/kg dry wt	-	0.42	-	0.47	-
Total Recoverable Chromium	mg/kg dry wt	-	12	-	13	-
Total Recoverable Copper	mg/kg dry wt	-	14	-	20	-
Total Recoverable Lead	mg/kg dry wt	-	89	-	83	-
Total Recoverable Mercury	mg/kg dry wt	-	0.11	-	0.11	-
Total Recoverable Nickel	mg/kg dry wt	-	7	-	10	-
Total Recoverable Zinc	mg/kg dry wt	-	41	-	64	-

Sample Name:		MA26 A 13-May-2017	MA26 B 13-May-2017	Unlabelled [A-500]	RNZ01 A [<250um Fraction]	RNZ01 C [<250um Fraction]
Lab Number:		1778626.82	1778626.83	1778626.84	1778626.87	1778626.88
Individual Tests						
Particle size analysis		-	See attached report	-	-	-
Gastric Extractable Arsenic	mg/kg dry wt	-	-	-	1.8	2.9
Total Recoverable Arsenic	mg/kg dry wt	-	-	-	21	21
Total Recoverable Calcium	mg/kg dry wt	-	-	-	12,800	12,800
Total Recoverable Chromium	mg/kg dry wt	-	-	-	194	210
Total Recoverable Copper	mg/kg dry wt	-	-	-	168	179
Total Recoverable Iron	mg/kg dry wt	-	-	-	44,000	45,000
Gastric Extractable Lead	mg/kg dry wt	-	-	-	32	In Progress
Total Recoverable Lead	mg/kg dry wt	-	-	-	68	71
Total Recoverable Manganese	mg/kg dry wt	-	-	-	890	900
Total Recoverable Nickel	mg/kg dry wt	-	-	-	189	200
Total Recoverable Phosphorus	mg/kg dry wt	-	-	-	1,740	1,710
Total Sulphur	g/100g dry wt	-	-	-	0.040	0.040
pH	pH Units	7.1	-	5.7	-	-
Total Organic Carbon	g/100g dry wt	-	-	-	3.8	3.8
Heavy Metals with Mercury, Screen Level						
Total Recoverable Arsenic	mg/kg dry wt	17	-	22	-	-
Total Recoverable Cadmium	mg/kg dry wt	0.51	-	0.29	-	-
Total Recoverable Chromium	mg/kg dry wt	10	-	9	-	-
Total Recoverable Copper	mg/kg dry wt	18	-	19	-	-
Total Recoverable Lead	mg/kg dry wt	109	-	92	-	-
Total Recoverable Mercury	mg/kg dry wt	0.12	-	0.22	-	-

Sample Type: Soil						
Sample Name:		MA26 A 13-May-2017	MA26 B 13-May-2017	Unlabelled [A-500]	RNZ01 A [<250um Fraction]	RNZ01 C [<250um Fraction]
Lab Number:		1778626.82	1778626.83	1778626.84	1778626.87	1778626.88
Heavy Metals with Mercury, Screen Level						
Total Recoverable Nickel	mg/kg dry wt	5	-	5	-	-
Total Recoverable Zinc	mg/kg dry wt	45	-	94	-	-

Sample Name:		RNZ02 A [<250um Fraction]	RNZ03 A [<250um Fraction]	RNZ04 A [<250um Fraction]	RNZ05 A [<250um Fraction]	RNZ06 A [<250um Fraction]
Lab Number:		1778626.89	1778626.90	1778626.91	1778626.92	1778626.93
Individual Tests						
Gastric Extractable Arsenic	mg/kg dry wt	1.9	5.8	3.7	4.2	4.4
Total Recoverable Arsenic	mg/kg dry wt	18	45	28	33	35
Total Recoverable Calcium	mg/kg dry wt	12,500	12,000	11,100	12,400	13,400
Total Recoverable Chromium	mg/kg dry wt	187	195	187	199	200
Total Recoverable Copper	mg/kg dry wt	143	117	96	88	68
Total Recoverable Iron	mg/kg dry wt	43,000	41,000	45,000	43,000	45,000
Gastric Extractable Lead	mg/kg dry wt	24	86	47	57	56
Total Recoverable Lead	mg/kg dry wt	54	155	90	109	102
Total Recoverable Manganese	mg/kg dry wt	860	940	940	940	940
Total Recoverable Nickel	mg/kg dry wt	200	189	200	176	177
Total Recoverable Phosphorus	mg/kg dry wt	1,580	2,000	1,500	1,710	1,770
Total Sulphur	g/100g dry wt	0.040	0.040	0.030	0.040	0.040
Total Organic Carbon	g/100g dry wt	4.1	4.1	3.2	3.7	3.8

Sample Name:		RNZ11 A [<250um Fraction]	RNZ12 A [<250um Fraction]	RNZ12 C [<250um Fraction]	RNZ13 A [<250um Fraction]	RNZ14 A [<250um Fraction]
Lab Number:		1778626.94	1778626.95	1778626.96	1778626.97	1778626.98
Individual Tests						
Gastric Extractable Arsenic	mg/kg dry wt	2.8	4.1	4.6	3.7	5.2
Total Recoverable Arsenic	mg/kg dry wt	25	31	31	27	36
Total Recoverable Calcium	mg/kg dry wt	13,600	13,300	13,100	12,900	12,400
Total Recoverable Chromium	mg/kg dry wt	200	181	175	195	187
Total Recoverable Copper	mg/kg dry wt	145	220	230	210	134
Total Recoverable Iron	mg/kg dry wt	45,000	44,000	43,000	43,000	44,000
Gastric Extractable Lead	mg/kg dry wt	37	53	55	52	74
Total Recoverable Lead	mg/kg dry wt	77	105	104	95	133
Total Recoverable Manganese	mg/kg dry wt	930	990	970	950	1,060
Total Recoverable Nickel	mg/kg dry wt	186	170	176	195	191
Total Recoverable Phosphorus	mg/kg dry wt	2,400	2,900	2,700	2,900	2,400
Total Sulphur	g/100g dry wt	0.040	0.040	0.040	0.040	0.030
Total Organic Carbon	g/100g dry wt	3.8	4.1	4.1	3.8	3.5

Sample Name:		RNZ15 A [<250um Fraction]	RNZ16 A [<250um Fraction]	MA5A1 A [<250um Fraction]	MA5A1 C [<250um Fraction]	MA5A2 A [<250um Fraction]
Lab Number:		1778626.99	1778626.100	1778626.101	1778626.102	1778626.103
Individual Tests						
Gastric Extractable Arsenic	mg/kg dry wt	8.0	8.7	21	19.6	17.1
Total Recoverable Arsenic	mg/kg dry wt	50	63	47	40	40
Total Recoverable Calcium	mg/kg dry wt	13,200	13,400	1,930	1,980	2,400
Total Recoverable Chromium	mg/kg dry wt	184	183	9	8	7
Total Recoverable Copper	mg/kg dry wt	50	43	29	28	27
Total Recoverable Iron	mg/kg dry wt	43,000	46,000	7,200	6,900	6,300
Gastric Extractable Lead	mg/kg dry wt	103	117	199	200	270
Total Recoverable Lead	mg/kg dry wt	172	200	270	260	340
Total Recoverable Manganese	mg/kg dry wt	950	1,080	97	88	58
Total Recoverable Nickel	mg/kg dry wt	168	166	7	7	6
Total Recoverable Phosphorus	mg/kg dry wt	2,200	2,600	740	730	800
Total Sulphur	g/100g dry wt	0.040	0.040	0.020	0.020	0.030
Total Organic Carbon	g/100g dry wt	4.1	4.5	2.3	2.4	2.8

Sample Type: Soil						
Sample Name:		MA5A3 A [<250um Fraction]	MA5A4 A [<250um Fraction]	MA5A5 A [<250um Fraction]	MA5A6 A [<250um Fraction]	MA3A1 A [<250um Fraction]
Lab Number:		1778626.104	1778626.105	1778626.106	1778626.107	1778626.108
Individual Tests						
Gastric Extractable Arsenic	mg/kg dry wt	18.2	10.6	11.6	7.7	8.0
Total Recoverable Arsenic	mg/kg dry wt	33	23	26	15	15
Total Recoverable Calcium	mg/kg dry wt	1,850	2,100	2,200	2,600	3,600
Total Recoverable Chromium	mg/kg dry wt	7	7	6	5	6
Total Recoverable Copper	mg/kg dry wt	26	20	17	17	42
Total Recoverable Iron	mg/kg dry wt	5,800	6,000	6,100	3,200	5,000
Gastric Extractable Lead	mg/kg dry wt	220	184	200	169	119
Total Recoverable Lead	mg/kg dry wt	290	220	230	198	149
Total Recoverable Manganese	mg/kg dry wt	44	65	52	35	91
Total Recoverable Nickel	mg/kg dry wt	5	5	5	4	5
Total Recoverable Phosphorus	mg/kg dry wt	800	810	750	820	910
Total Sulphur	g/100g dry wt	0.020	0.030	0.040	0.030	0.020
Total Organic Carbon	g/100g dry wt	2.0	2.7	3.5	3.4	2.7

Sample Name:		MA3A1 C [<250um Fraction]	MA3A2 A [<250um Fraction]	MA3A3 A [<250um Fraction]	MA3A4 A [<250um Fraction]	MA3A5 A [<250um Fraction]
Lab Number:		1778626.109	1778626.110	1778626.111	1778626.112	1778626.113
Individual Tests						
Gastric Extractable Arsenic	mg/kg dry wt	7.1	10.9	6.6	7.1	12.8
Total Recoverable Arsenic	mg/kg dry wt	15	21	16	20	24
Total Recoverable Calcium	mg/kg dry wt	3,500	5,000	4,000	5,300	5,300
Total Recoverable Chromium	mg/kg dry wt	7	9	8	11	8
Total Recoverable Copper	mg/kg dry wt	41	44	43	24	47
Total Recoverable Iron	mg/kg dry wt	4,700	8,700	6,800	11,600	6,300
Gastric Extractable Lead	mg/kg dry wt	127	165	173	72	178
Total Recoverable Lead	mg/kg dry wt	152	198	199	101	220
Total Recoverable Manganese	mg/kg dry wt	86	112	109	71	92
Total Recoverable Nickel	mg/kg dry wt	4	6	6	5	5
Total Recoverable Phosphorus	mg/kg dry wt	940	1,410	1,300	1,250	1,360
Total Sulphur	g/100g dry wt	0.030	0.050	0.040	0.040	0.050
Total Organic Carbon	g/100g dry wt	2.9	4.6	3.8	3.1	4.3

Sample Name:		MA3A6 A [<250um Fraction]	MA11 A [<250um Fraction]	MA21 A [<250um Fraction]	MA21 C [<250um Fraction]	MA71 A [<250um Fraction]
Lab Number:		1778626.114	1778626.115	1778626.116	1778626.117	1778626.118
Individual Tests						
Gastric Extractable Arsenic	mg/kg dry wt	10.9	9.1	9.6	8.5	5.5
Total Recoverable Arsenic	mg/kg dry wt	20	22	20	21	21
Total Recoverable Calcium	mg/kg dry wt	4,400	1,570	3,700	4,100	2,100
Total Recoverable Chromium	mg/kg dry wt	8	5	8	8	6
Total Recoverable Copper	mg/kg dry wt	41	24	14	16	15
Total Recoverable Iron	mg/kg dry wt	7,900	4,800	7,600	7,800	6,000
Gastric Extractable Lead	mg/kg dry wt	158	125	79	84	121
Total Recoverable Lead	mg/kg dry wt	169	165	99	110	157
Total Recoverable Manganese	mg/kg dry wt	89	88	55	56	100
Total Recoverable Nickel	mg/kg dry wt	7	2	5	5	4
Total Recoverable Phosphorus	mg/kg dry wt	1,350	520	900	950	540
Total Sulphur	g/100g dry wt	0.050	0.020	0.020	0.030	0.030
Total Organic Carbon	g/100g dry wt	4.8	In Progress	In Progress	In Progress	In Progress

Sample Name:		MA71 C [<250um Fraction]	MA72 A [<250um Fraction]	MA12 A [<250um Fraction]	MA13 A [<250um Fraction]	MA22 A [<250um Fraction]
Lab Number:		1778626.119	1778626.120	1778626.121	1778626.122	1778626.123
Individual Tests						
Gastric Extractable Arsenic	mg/kg dry wt	6.4	5.5	7.7	10.8	5.0
Total Recoverable Arsenic	mg/kg dry wt	21	17	22	22	12
Total Recoverable Calcium	mg/kg dry wt	2,100	2,400	1,740	3,900	4,800
Total Recoverable Chromium	mg/kg dry wt	6	8	6	6	10

Sample Type: Soil						
Sample Name:		MA71 C [<250um Fraction]	MA72 A [<250um Fraction]	MA12 A [<250um Fraction]	MA13 A [<250um Fraction]	MA22 A [<250um Fraction]
Lab Number:		1778626.119	1778626.120	1778626.121	1778626.122	1778626.123
Individual Tests						
Total Recoverable Copper	mg/kg dry wt	15	22	26	34	17
Total Recoverable Iron	mg/kg dry wt	5,900	7,700	5,700	5,300	8,700
Gastric Extractable Lead	mg/kg dry wt	121	84	125	144	66
Total Recoverable Lead	mg/kg dry wt	154	118	163	176	93
Total Recoverable Manganese	mg/kg dry wt	97	94	99	111	88
Total Recoverable Nickel	mg/kg dry wt	4	6	2	2	8
Total Recoverable Phosphorus	mg/kg dry wt	550	810	520	1,290	1,490
Total Sulphur	g/100g dry wt	0.030	0.020	0.040	0.040	0.040
Total Organic Carbon	g/100g dry wt	In Progress	2.6	3.1	3.9	3.3

Sample Name:		MA23 A [<250um Fraction]	MA24 A [<250um Fraction]	MA25 A [<250um Fraction]	MA26 A [<250um Fraction]	Unlabelled [A-500] [<250um Fraction]
Lab Number:		1778626.124	1778626.125	1778626.126	1778626.127	1778626.128
Individual Tests						
Gastric Extractable Arsenic	mg/kg dry wt	3.5	4.8	4.5	5.4	2.8
Total Recoverable Arsenic	mg/kg dry wt	9	13	11	14	19
Total Recoverable Calcium	mg/kg dry wt	4,900	4,400	4,900	5,700	2,000
Total Recoverable Chromium	mg/kg dry wt	10	10	11	10	10
Total Recoverable Copper	mg/kg dry wt	19	14	18	18	20
Total Recoverable Iron	mg/kg dry wt	8,100	10,200	10,000	8,800	9,300
Gastric Extractable Lead	mg/kg dry wt	50	60	54	75	61
Total Recoverable Lead	mg/kg dry wt	70	85	76	105	96
Total Recoverable Manganese	mg/kg dry wt	87	67	88	78	104
Total Recoverable Nickel	mg/kg dry wt	7	7	8	7	5
Total Recoverable Phosphorus	mg/kg dry wt	1,250	1,250	1,310	1,340	420
Total Sulphur	g/100g dry wt	0.040	0.040	0.040	0.040	0.020
Total Organic Carbon	g/100g dry wt	3.6	4.0	3.1	3.7	2.8

Analyst's Comments

Amended Report: This report replaces an earlier report issued on 28 Jun 2017 at 12:31 pm
Reason for amendment: Additional testing has been included at the request of the client.

Appendix No.1 - Particle size Report-1778626

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**	**Sample No**
Sieving through 250 um sieve, no gravimetric result	<250µm Dry Sieved with no gravimetric determination.	-	1, 3, 5, 7, 9, 11, 13, 15, 17, 19, 21, 23, 25, 27, 29, 31, 33, 35, 37, 39, 41, 43, 45, 47, 49, 51, 53, 55, 57, 59, 61, 65, 67-68, 70, 72, 74, 76, 78, 80, 82, 84

Sample Type: Soil			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
Soil Prep Dry & Sieve for Agriculture	Air dried at 35°C and sieved, <2mm fraction.	-	1, 3, 5, 7, 9, 11, 13, 15, 17, 19, 21, 23, 25, 27, 29, 31, 33, 35, 37, 39, 41, 43, 45, 47, 49, 51, 53, 55, 57, 59, 61, 63, 65, 67-68, 70, 72, 74, 76, 78, 80, 82, 84
Heavy Metals with Mercury, Screen Level	Dried sample, < 2mm fraction. Nitric/Hydrochloric acid digestion US EPA 200.2. Complies with NES Regulations. ICP-MS screen level, interference removal by Kinetic Energy Discrimination if required.	0.10 - 4 mg/kg dry wt	1, 3, 5, 7, 9, 11, 13, 15, 17, 19, 21, 23, 25, 27, 29, 31, 33, 35, 37, 39, 41, 43, 45, 47, 49, 51, 53, 55, 57, 59, 61, 63, 65, 67-68, 70, 72, 74, 76, 78, 80, 82, 84
Dry Matter (Env)	Dried at 103°C for 4-22hr (removes 3-5% more water than air dry) , gravimetry. (Free water removed before analysis, non-soil objects such as sticks, leaves, grass and stones also removed). US EPA 3550.	0.10 g/100g as rcvd	1, 17, 29, 31, 43, 59, 65
Gastric Extraction	Simulated gastric extraction using glycine/HCl fluid , pH 1.5. Shaken for 1hr at 37°C. Assessing Oral Bioavailability of Metals in Soil, 2002.	-	87-128
Total Recoverable digestion	Nitric / hydrochloric acid digestion. US EPA 200.2.	-	87-128
Particle size analysis	Malvern Laser Sizer particle size analysis. Subcontracted to Earth Sciences Department, Waikato University, Hamilton.	-	2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 60, 62, 66, 69, 71, 73, 75, 77, 79, 81, 83
Gastric Extractable Arsenic	Gastric extraction, 37°C, 1hr, ICP-MS, screen level. APHA 3125 B 22nd ed. 2012.	1.0 mg/kg dry wt	87-128
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	87-128
Total Recoverable Calcium	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	100 mg/kg dry wt	87-128
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	87-128
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	87-128
Total Recoverable Iron	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	40 mg/kg dry wt	87-128
Gastric Extractable Lead	Gastric extraction, 37°C, 1hr, ICP-MS, screen level. APHA 3125 B 22nd ed. 2012.	0.2 mg/kg dry wt	87-128
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	87-128
Total Recoverable Manganese	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	1.0 mg/kg dry wt	87-128

Sample Type: Soil			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
Total Recoverable Nickel	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	2 mg/kg dry wt	87-128
Total Recoverable Phosphorus	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	40 mg/kg dry wt	87-128
Total Sulphur (Sub SGS)	LECO SC32 Sulphur Determinator, high temperature furnace, infra-red detector. Subcontracted to SGS, Waihi. ASTM 4239.	0.005 g/100g dry wt	87-128
pH	1:2 (v/v) soil : water slurry followed by potentiometric determination of pH.	0.1 pH Units	1, 3, 5, 7, 9, 11, 13, 15, 17, 19, 21, 23, 25, 27, 29, 31, 33, 35, 37, 39, 41, 43, 45, 47, 49, 51, 53, 55, 57, 59, 61, 63, 65, 67-68, 70, 72, 74, 76, 78, 80, 82, 84
Acid Soluble Sulphide	Acidify with c.H_2SO_4, distill under N_2 at 70°C, trap in Zn Acetate, iodometric titration. US EPA 9030B then 9034.	3 mg/kg as rcvd	1, 17, 29, 31, 43, 59, 65
Acid Insoluble Sulphide	Acidify with c.HCl, distill under N_2 at 100°C with SnCl, trap in Zn Acetate, iodometric titration. US EPA 9030B then 9034.	3 mg/kg as rcvd	1, 17, 29, 31, 43, 59, 65
Total Organic Carbon	Acid pretreatment to remove carbonates present followed by Catalytic Combustion (900°C, O2), separation, Thermal Conductivity Detector [Elementar Analyser].	0.05 g/100g dry wt	87-128

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.

Graham Corban MSc Tech (Hons)
Client Services Manager - Environmental

Analysis - Over

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

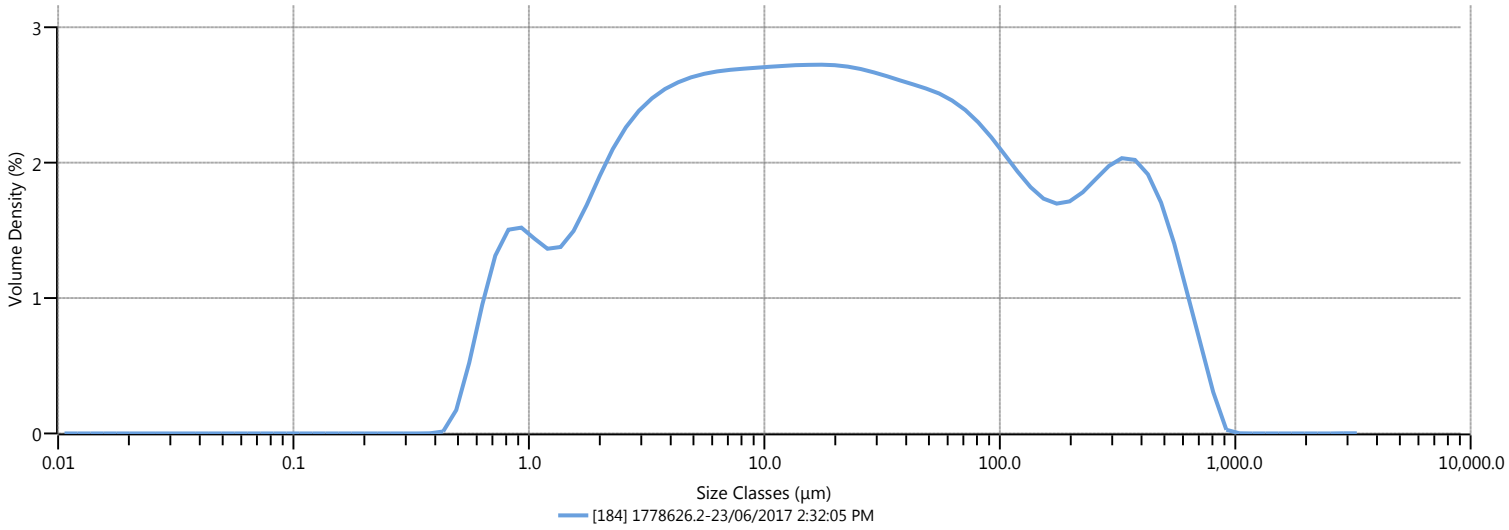
Measurement Details	
Operator Name	rodgers
Sample Name	1778626.2
SOP File Name	Sediment.msop
Lab Number	

Measurement Details	
Analysis Date Time	23/06/2017 2:32:05 PM
Measurement Date Time	23/06/2017 2:32:05 PM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.70 %
Laser Obscuration	22.80 %

Result	
Concentration	0.0182 %
Span	15.055
Uniformity	4.060
Specific Surface Area	1179 m^2/kg
D [3,2]	5.09 µm
D [4,3]	84.7 µm
Dv (10)	1.69 µm
Dv (50)	19.3 µm
Dv (90)	293 µm

Frequency (compatible)



Result

Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over
0.0500	100.00	7.80	66.06	88.0	24.64	350	7.63	1410	0.00
0.0600	100.00	15.6	53.80	105	22.18	420	5.25	1680	0.00
0.120	100.00	31.0	41.67	125	19.92	500	3.20	2000	0.00
0.240	100.00	37.0	38.63	149	17.85	590	1.63	2380	0.00
0.490	99.94	44.0	35.70	177	15.93	710	0.53	2830	0.00
0.980	95.10	53.0	32.60	210	14.02	840	0.05	3360	0.00
2.00	88.08	63.0	29.79	250	11.97	1000	0.00		
3.90	78.04	74.0	27.25	300	9.67	1190	0.00		

Analysis - Over

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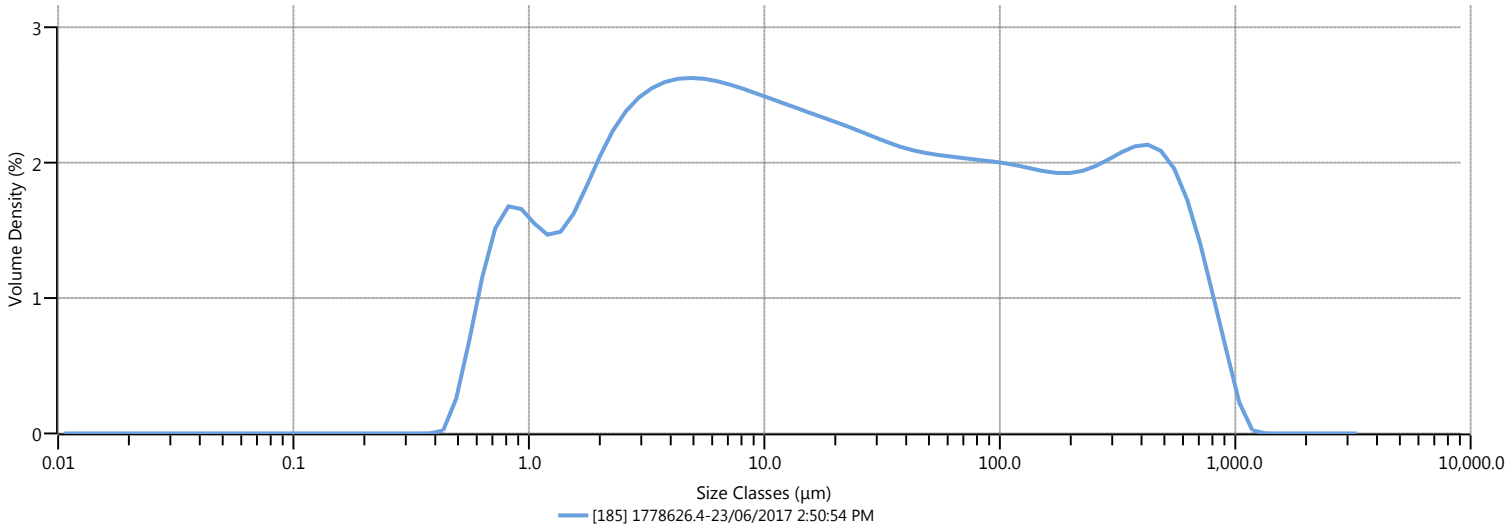
Measurement Details	
Operator Name	rodgers
Sample Name	1778626.4
SOP File Name	Sediment.msop
Lab Number	

Measurement Details	
Analysis Date Time	23/06/2017 2:50:54 PM
Measurement Date Time	23/06/2017 2:50:54 PM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.67 %
Laser Obscuration	33.89 %

Result	
Concentration	0.0274 %
Span	19.599
Uniformity	5.326
Specific Surface Area	1269 m^2/kg
D [3,2]	4.73 µm
D [4,3]	109 µm
Dv (10)	1.52 µm
Dv (50)	19.3 µm
Dv (90)	380 µm

Frequency (compatible)



Result

Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over
0.0500	100.00	7.80	64.42	88.0	28.96	350	11.15	1410	0.00
0.0600	100.00	15.6	53.28	105	26.65	420	8.62	1680	0.00
0.120	100.00	31.0	43.08	125	24.39	500	6.22	2000	0.00
0.240	100.00	37.0	40.60	149	22.15	590	4.08	2380	0.00
0.490	99.90	44.0	38.22	177	19.98	710	2.12	2830	0.00
0.980	94.30	53.0	35.71	210	17.83	840	0.84	3360	0.00
2.00	86.71	63.0	33.39	250	15.62	1000	0.15		
3.90	76.22	74.0	31.25	300	13.24	1190	0.00		

Analysis - Over

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Te Whare Wānanga o Waikato

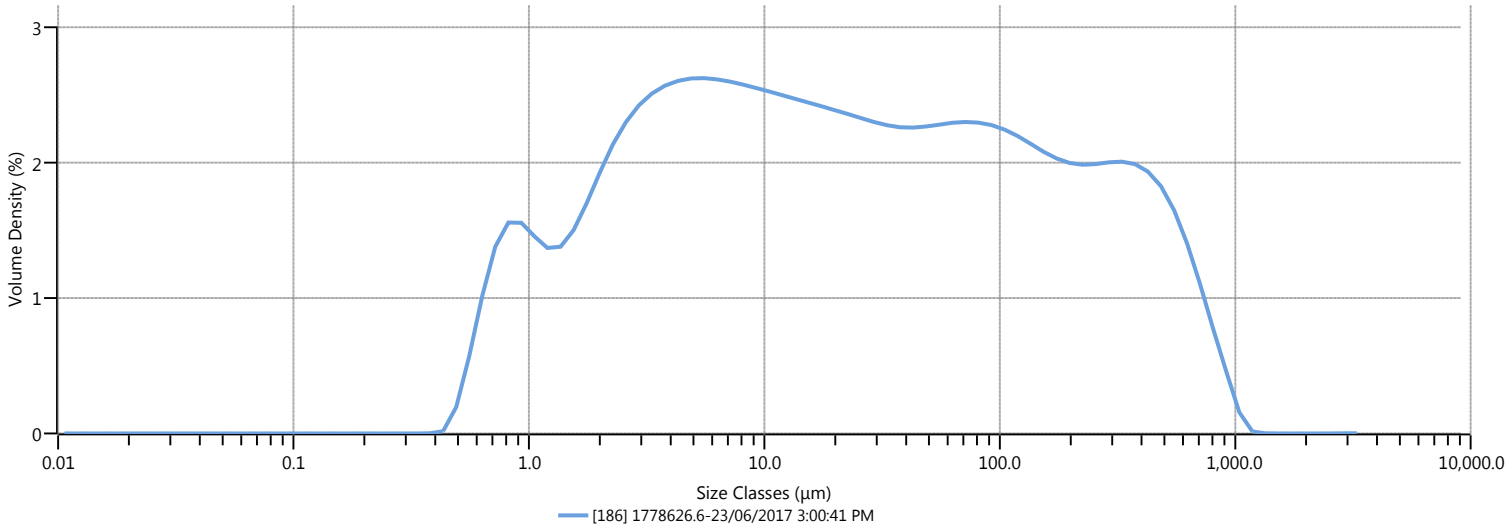
Measurement Details	
Operator Name	rodgers
Sample Name	1778626.6
SOP File Name	Sediment.msop
Lab Number	

Measurement Details	
Analysis Date Time	23/06/2017 3:00:41 PM
Measurement Date Time	23/06/2017 3:00:41 PM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.68 %
Laser Obscuration	23.50 %

Result	
Concentration	0.0187 %
Span	16.216
Uniformity	4.555
Specific Surface Area	1195 m^2/kg
D [3,2]	5.02 µm
D [4,3]	100 µm
Dv (10)	1.65 µm
Dv (50)	20.6 µm
Dv (90)	336 µm

Frequency (compatible)



Result

Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over
0.0500	100.00	7.80	65.78	88.0	28.27	350	9.47	1410	0.00
0.0600	100.00	15.6	54.40	105	25.65	420	7.12	1680	0.00
0.120	100.00	31.0	43.80	125	23.13	500	4.98	2000	0.00
0.240	100.00	37.0	41.17	149	20.68	590	3.17	2380	0.00
0.490	99.93	44.0	38.61	177	18.37	710	1.60	2830	0.00
0.980	94.86	53.0	35.86	210	16.13	840	0.61	3360	0.00
2.00	87.79	63.0	33.28	250	13.87	1000	0.10		
3.90	77.60	74.0	30.86	300	11.50	1190	0.00		

Analysis - Over

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

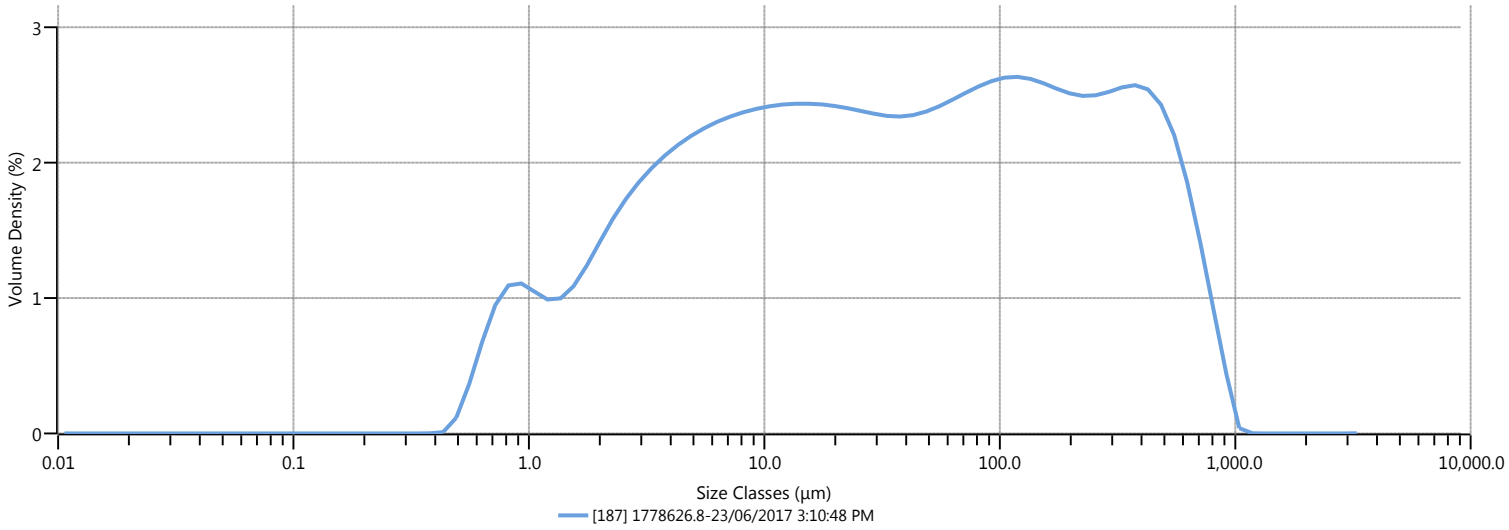
Measurement Details	
Operator Name	rodgers
Sample Name	1778626.8
SOP File Name	Sediment.msop
Lab Number	

Measurement Details	
Analysis Date Time	23/06/2017 3:10:48 PM
Measurement Date Time	23/06/2017 3:10:48 PM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.55 %
Laser Obscuration	22.47 %

Result	
Concentration	0.0232 %
Span	11.368
Uniformity	3.230
Specific Surface Area	905.0 m^2/kg
D [3,2]	6.63 µm
D [4,3]	122 µm
Dv (10)	2.29 µm
Dv (50)	34.7 µm
Dv (90)	396 µm

Frequency (compatible)



Result

Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over
0.0500	100.00	7.80	73.41	88.0	35.20	350	12.10	1410	0.00
0.0600	100.00	15.6	62.49	105	32.19	420	9.04	1680	0.00
0.120	100.00	31.0	51.72	125	29.19	500	6.21	2000	0.00
0.240	100.00	37.0	49.01	149	26.19	590	3.79	2380	0.00
0.490	99.96	44.0	46.36	177	23.30	710	1.72	2830	0.00
0.980	96.47	53.0	43.47	210	20.49	840	0.50	3360	0.00
2.00	91.35	63.0	40.72	250	17.65	1000	0.00		
3.90	83.56	74.0	38.10	300	14.66	1190	0.00		

Analysis - Over

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

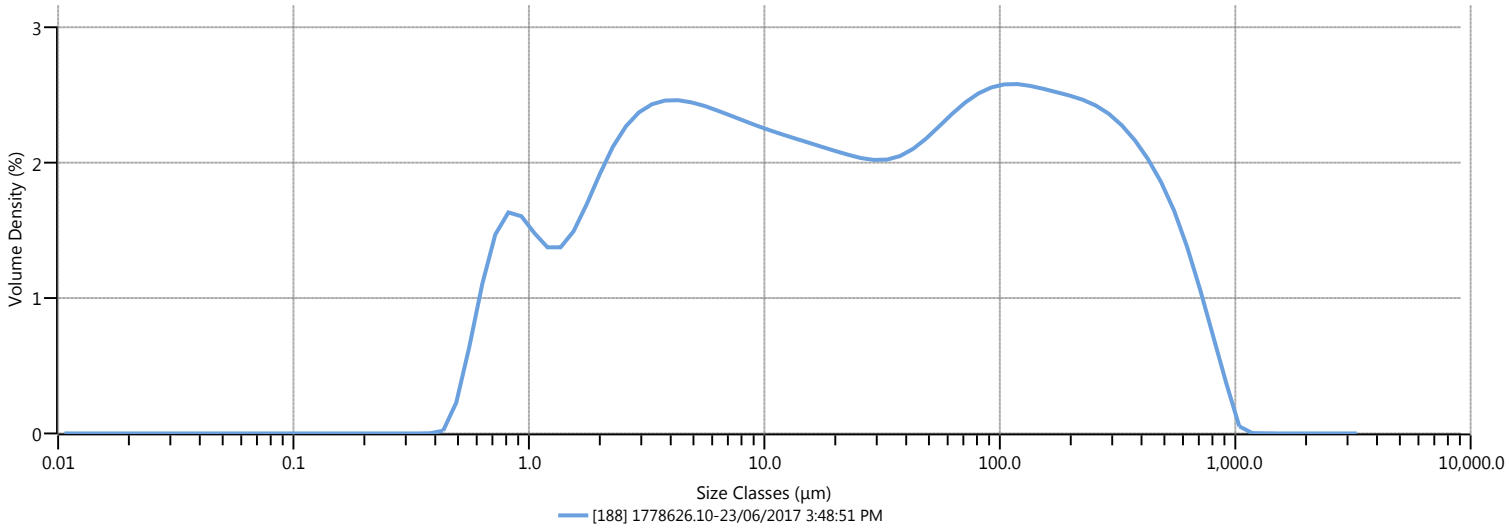
Measurement Details	
Operator Name	rodgers
Sample Name	1778626.10
SOP File Name	Sediment.msop
Lab Number	

Measurement Details	
Analysis Date Time	23/06/2017 3:48:51 PM
Measurement Date Time	23/06/2017 3:48:51 PM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.73 %
Laser Obscuration	22.29 %

Result	
Concentration	0.0176 %
Span	13.393
Uniformity	3.925
Specific Surface Area	1201 m^2/kg
D [3,2]	5.00 µm
D [4,3]	105 µm
Dv (10)	1.60 µm
Dv (50)	25.1 µm
Dv (90)	337 µm

Frequency (compatible)



Result

Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over
0.0500	100.00	7.80	66.57	88.0	31.89	350	9.45	1410	0.00
0.0600	100.00	15.6	56.48	105	28.93	420	6.92	1680	0.00
0.120	100.00	31.0	47.19	125	25.99	500	4.71	2000	0.00
0.240	100.00	37.0	44.85	149	23.05	590	2.90	2380	0.00
0.490	99.91	44.0	42.50	177	20.20	710	1.36	2830	0.00
0.980	94.53	53.0	39.86	210	17.41	840	0.44	3360	0.00
2.00	87.45	63.0	37.26	250	14.61	1000	0.02		
3.90	77.48	74.0	34.73	300	11.76	1190	0.00		

Analysis - Over

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

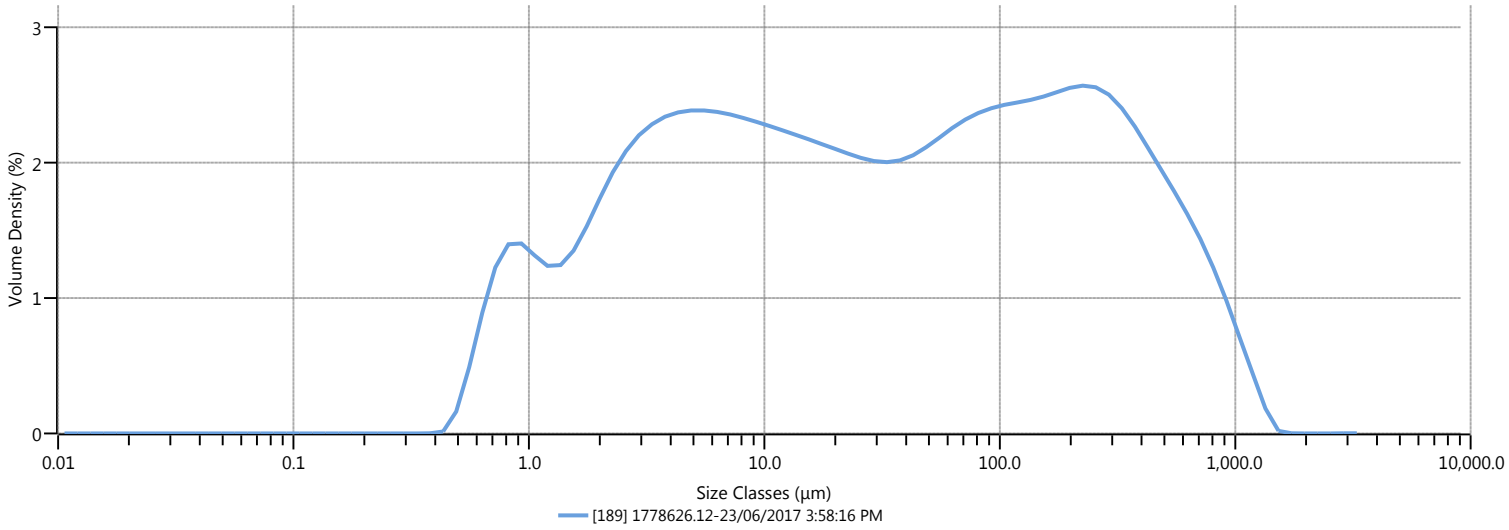
Measurement Details	
Operator Name	rodgers
Sample Name	1778626.12
SOP File Name	Sediment.msop
Lab Number	

Measurement Details	
Analysis Date Time	23/06/2017 3:58:16 PM
Measurement Date Time	23/06/2017 3:58:16 PM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.66 %
Laser Obscuration	18.05 %

Result	
Concentration	0.0154 %
Span	13.667
Uniformity	4.114
Specific Surface Area	1074 m^2/kg
D [3,2]	5.59 µm
D [4,3]	131 µm
Dv (10)	1.84 µm
Dv (50)	29.9 µm
Dv (90)	411 µm

Frequency (compatible)



Result

Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over
0.0500	100.00	7.80	69.08	88.0	34.78	350	12.35	1410	0.02
0.0600	100.00	15.6	58.86	105	31.99	420	9.70	1680	0.00
0.120	100.00	31.0	49.54	125	29.22	500	7.40	2000	0.00
0.240	100.00	37.0	47.23	149	26.39	590	5.44	2380	0.00
0.490	99.94	44.0	44.92	177	23.57	710	3.56	2830	0.00
0.980	95.44	53.0	42.36	210	20.73	840	2.12	3360	0.00
2.00	89.07	63.0	39.86	250	17.81	1000	1.01		
3.90	79.82	74.0	37.45	300	14.80	1190	0.32		

Analysis - Over

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

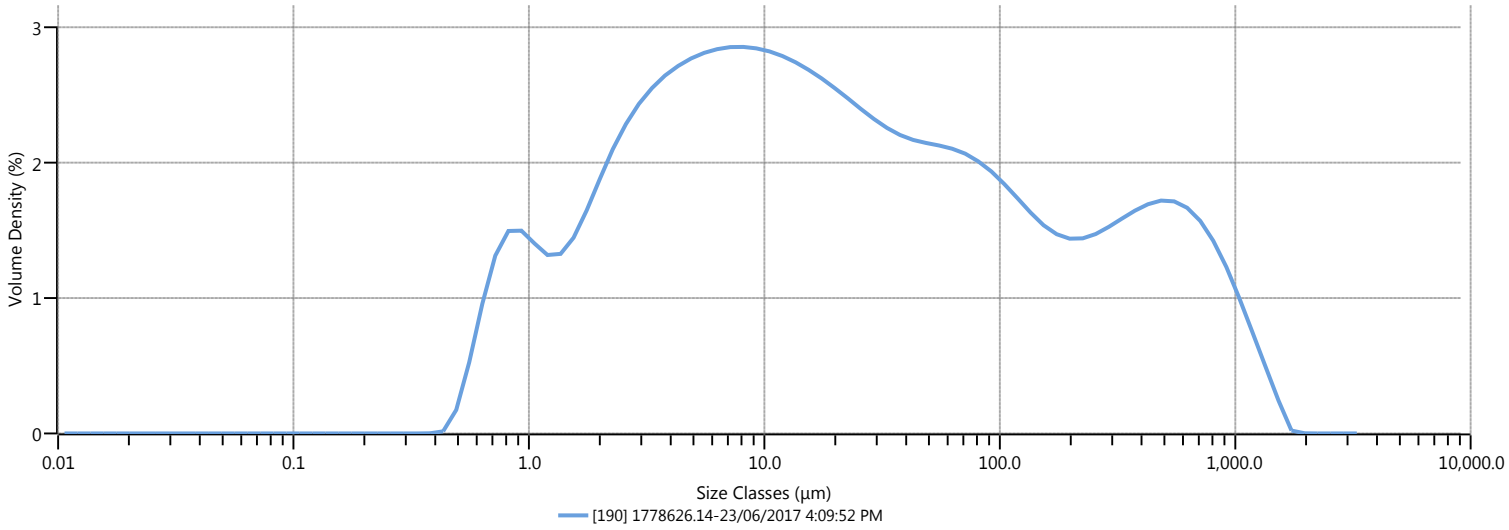
Measurement Details	
Operator Name	rodgers
Sample Name	1778626.14
SOP File Name	Sediment.msop
Lab Number	

Measurement Details	
Analysis Date Time	23/06/2017 4:09:52 PM
Measurement Date Time	23/06/2017 4:09:52 PM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.69 %
Laser Obscuration	19.58 %

Result	
Concentration	0.0154 %
Span	24.370
Uniformity	6.619
Specific Surface Area	1176 m^2/kg
D [3,2]	5.10 µm
D [4,3]	127 µm
Dv (10)	1.72 µm
Dv (50)	18.3 µm
Dv (90)	448 µm

Frequency (compatible)



Result

Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over
0.0500	100.00	7.80	65.43	88.0	27.08	350	12.70	1410	0.25
0.0600	100.00	15.6	52.78	105	24.89	420	10.72	1680	0.00
0.120	100.00	31.0	41.61	125	22.87	500	8.77	2000	0.00
0.240	100.00	37.0	39.02	149	21.02	590	6.92	2380	0.00
0.490	99.94	44.0	36.55	177	19.32	710	4.94	2830	0.00
0.980	95.12	53.0	33.94	210	17.71	840	3.31	3360	0.00
2.00	88.29	63.0	31.55	250	16.07	1000	1.92		
3.90	78.07	74.0	29.36	300	14.28	1190	0.90		

Analysis - Over

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

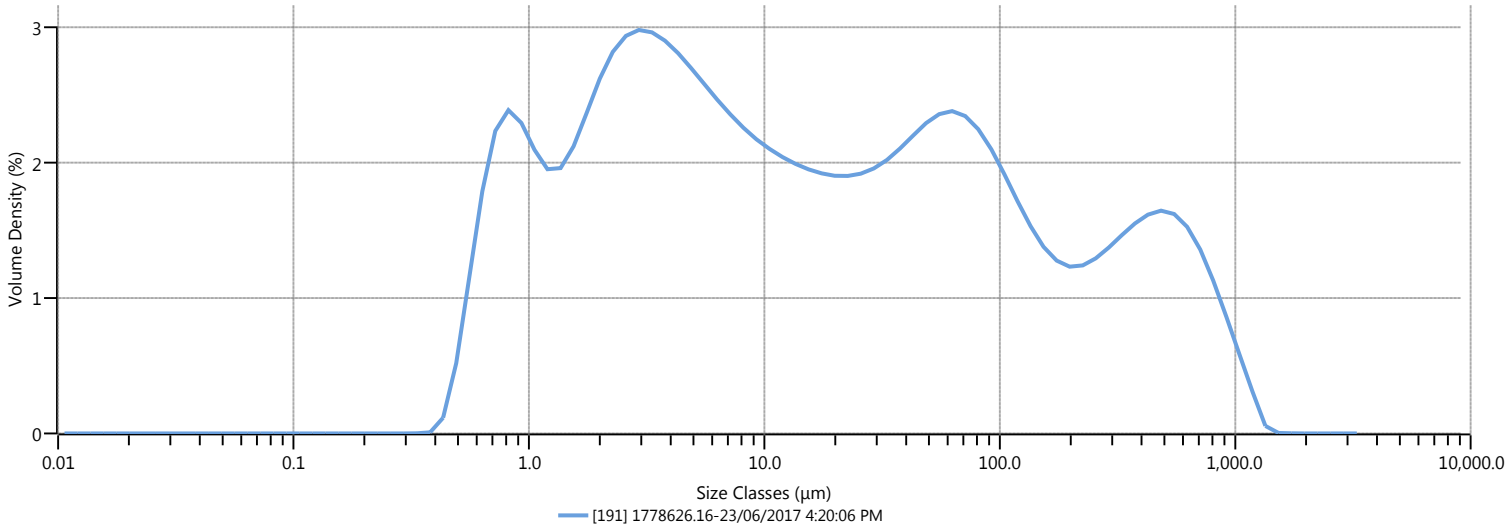
Measurement Details	
Operator Name	rodgers
Sample Name	1778626.16
SOP File Name	Sediment.msop
Lab Number	

Measurement Details	
Analysis Date Time	23/06/2017 4:20:06 PM
Measurement Date Time	23/06/2017 4:20:06 PM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.83 %
Laser Obscuration	32.04 %

Result	
Concentration	0.0200 %
Span	27.666
Uniformity	7.467
Specific Surface Area	1664 m^2/kg
D [3,2]	3.61 µm
D [4,3]	101 µm
Dv (10)	1.08 µm
Dv (50)	13.0 µm
Dv (90)	360 µm

Frequency (compatible)



Result

Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over
0.0500	100.00	7.80	57.07	88.0	23.72	350	10.27	1410	0.00
0.0600	100.00	15.6	47.61	105	21.38	420	8.41	1680	0.00
0.120	100.00	31.0	39.00	125	19.35	500	6.54	2000	0.00
0.240	100.00	37.0	36.64	149	17.61	590	4.78	2380	0.00
0.490	99.72	44.0	34.20	177	16.12	710	3.00	2830	0.00
0.980	91.40	53.0	31.42	210	14.74	840	1.66	3360	0.00
2.00	81.42	63.0	28.75	250	13.32	1000	0.69		
3.90	68.78	74.0	26.27	300	11.73	1190	0.15		

Analysis - Over

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

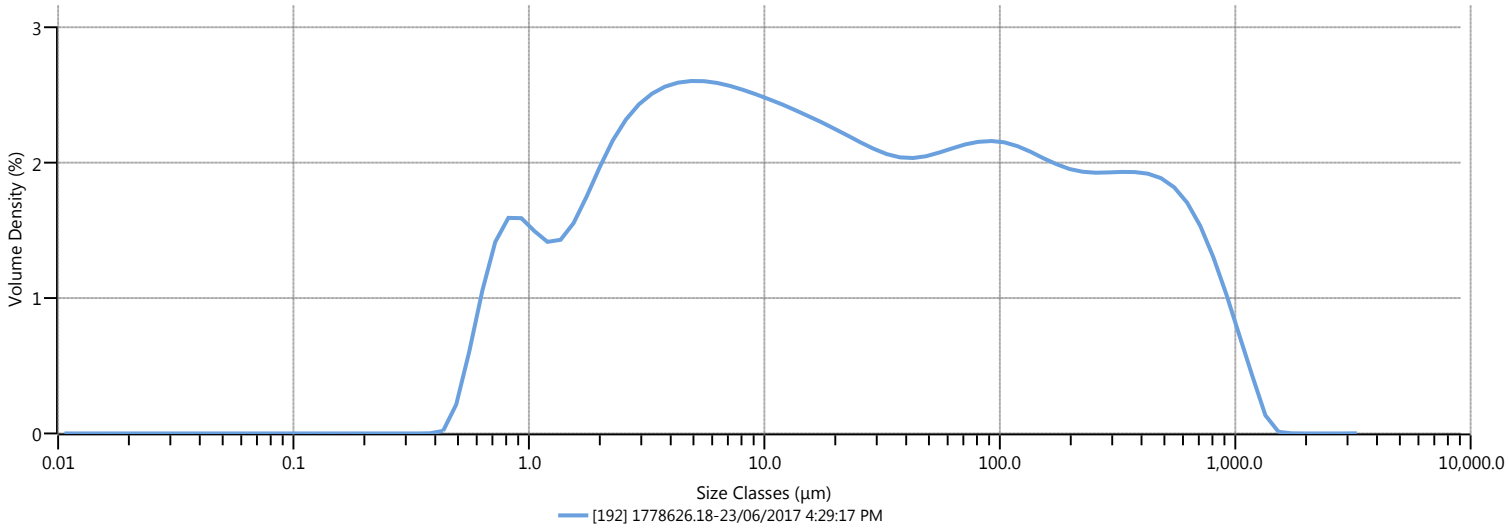
Measurement Details	
Operator Name	rodgers
Sample Name	1778626.18
SOP File Name	Sediment.msop
Lab Number	

Measurement Details	
Analysis Date Time	23/06/2017 4:29:17 PM
Measurement Date Time	23/06/2017 4:29:17 PM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.66 %
Laser Obscuration	28.59 %

Result	
Concentration	0.0232 %
Span	19.678
Uniformity	5.530
Specific Surface Area	1214 m^2/kg
D [3,2]	4.94 µm
D [4,3]	122 µm
Dv (10)	1.60 µm
Dv (50)	20.9 µm
Dv (90)	413 µm

Frequency (compatible)



Result

Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over
0.0500	100.00	7.80	65.45	88.0	30.26	350	12.07	1410	0.01
0.0600	100.00	15.6	54.36	105	27.77	420	9.78	1680	0.00
0.120	100.00	31.0	44.45	125	25.34	500	7.61	2000	0.00
0.240	100.00	37.0	42.07	149	22.96	590	5.63	2380	0.00
0.490	99.92	44.0	39.77	177	20.70	710	3.64	2830	0.00
0.980	94.70	53.0	37.28	210	18.51	840	2.11	3360	0.00
2.00	87.41	63.0	34.93	250	16.31	1000	0.94		
3.90	77.16	74.0	32.69	300	14.02	1190	0.26		

Analysis - Over

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

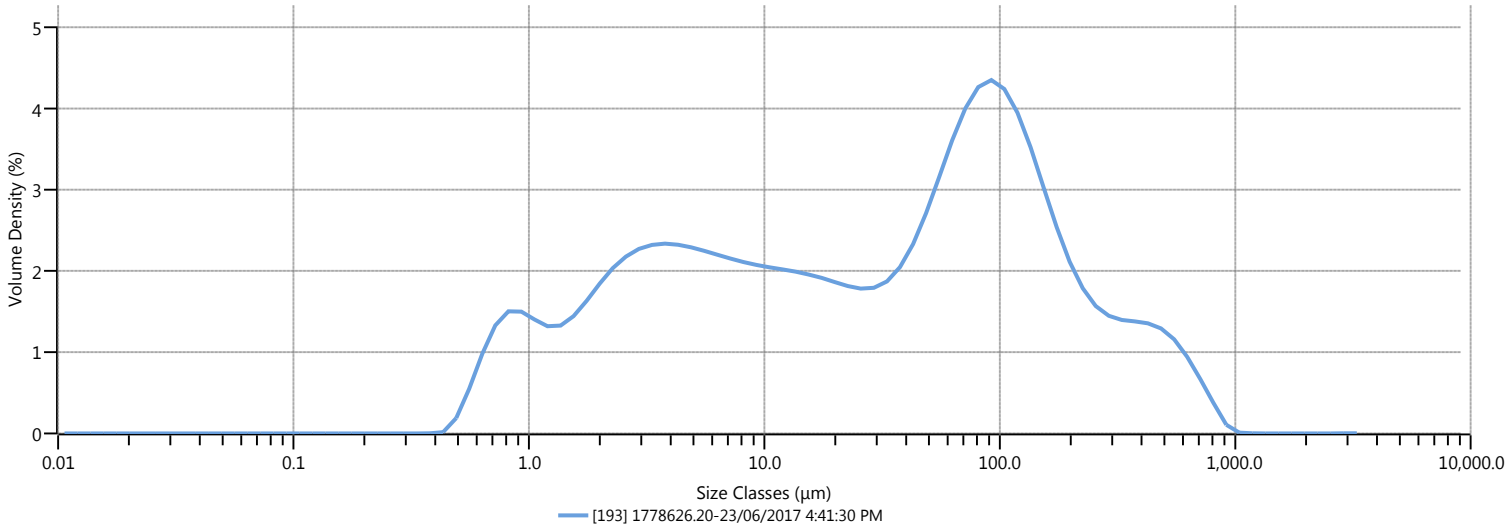
Measurement Details	
Operator Name	rodgers
Sample Name	1778626.20
SOP File Name	Sediment.msop
Lab Number	

Measurement Details	
Analysis Date Time	23/06/2017 4:41:30 PM
Measurement Date Time	23/06/2017 4:41:30 PM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.68 %
Laser Obscuration	20.09 %

Result	
Concentration	0.0167 %
Span	6.874
Uniformity	2.332
Specific Surface Area	1126 m^2/kg
D [3,2]	5.33 µm
D [4,3]	87.3 µm
Dv (10)	1.71 µm
Dv (50)	33.8 µm
Dv (90)	234 µm

Frequency (compatible)



Result

Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over
0.0500	100.00	7.80	68.54	88.0	30.50	350	6.12	1410	0.00
0.0600	100.00	15.6	59.32	105	25.51	420	4.48	1680	0.00
0.120	100.00	31.0	51.07	125	20.89	500	2.97	2000	0.00
0.240	100.00	37.0	48.86	149	16.92	590	1.70	2380	0.00
0.490	99.93	44.0	46.39	177	13.77	710	0.67	2830	0.00
0.980	95.04	53.0	43.13	210	11.29	840	0.13	3360	0.00
2.00	88.24	63.0	39.36	250	9.31	1000	0.00		
3.90	78.69	74.0	35.31	300	7.53	1190	0.00		

Analysis - Over

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

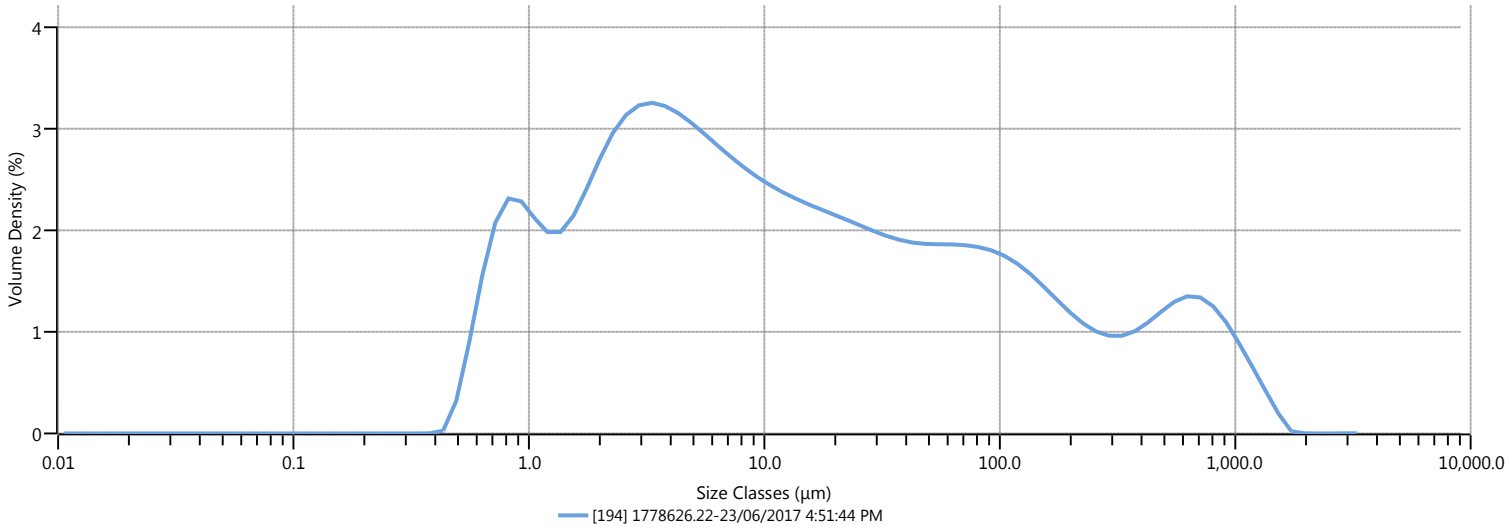
Measurement Details	
Operator Name	rodgers
Sample Name	1778626.22
SOP File Name	Sediment.msop
Lab Number	

Measurement Details	
Analysis Date Time	23/06/2017 4:51:44 PM
Measurement Date Time	23/06/2017 4:51:44 PM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.96 %
Laser Obscuration	18.14 %

Result	
Concentration	0.0104 %
Span	32.084
Uniformity	9.393
Specific Surface Area	1628 m^2/kg
D [3,2]	3.69 µm
D [4,3]	104 µm
Dv (10)	1.15 µm
Dv (50)	10.6 µm
Dv (90)	342 µm

Frequency (compatible)



Result

Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over
0.0500	100.00	7.80	55.15	88.0	21.91	350	9.86	1410	0.20
0.0600	100.00	15.6	44.15	105	19.85	420	8.64	1680	0.00
0.120	100.00	31.0	34.68	125	17.92	500	7.33	2000	0.00
0.240	100.00	37.0	32.45	149	16.14	590	5.95	2380	0.00
0.490	99.88	44.0	30.31	177	14.58	710	4.31	2830	0.00
0.980	92.25	53.0	28.04	210	13.21	840	2.90	3360	0.00
2.00	82.11	63.0	25.94	250	11.99	1000	1.66		
3.90	68.51	74.0	23.99	300	10.83	1190	0.76		

Analysis - Over

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

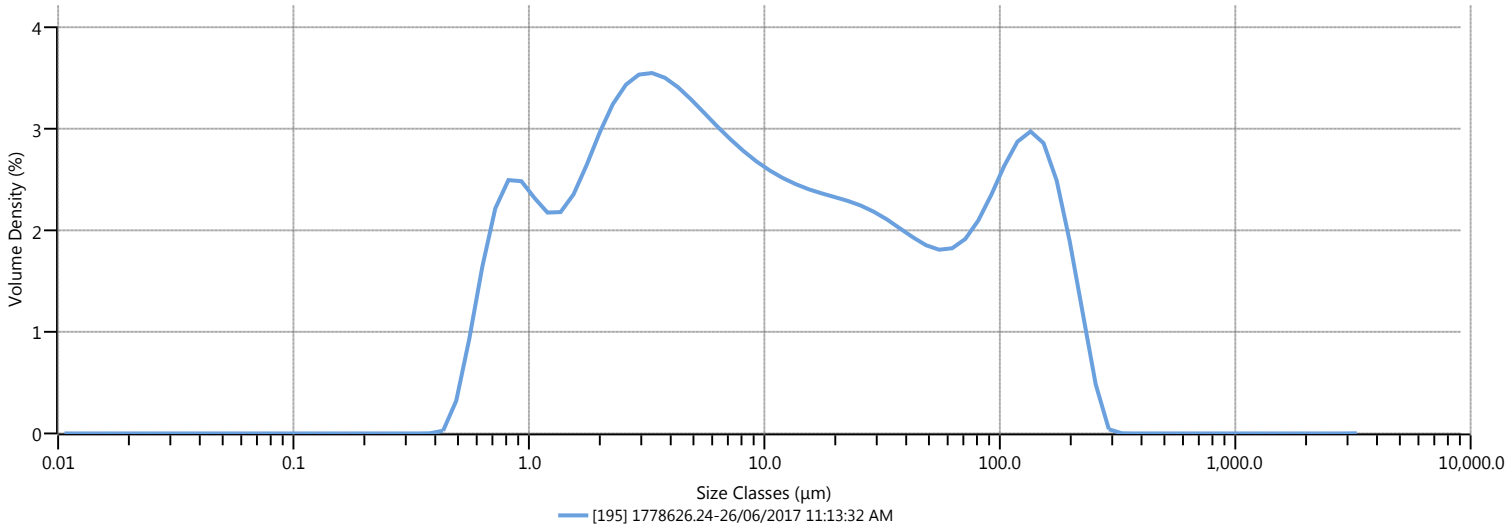
Measurement Details	
Operator Name	rodgers
Sample Name	1778626.24
SOP File Name	Sediment.msop
Lab Number	

Measurement Details	
Analysis Date Time	26/06/2017 11:13:32 AM
Measurement Date Time	26/06/2017 11:13:32 AM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	1.39 %
Laser Obscuration	15.50 %

Result	
Concentration	0.0081 %
Span	14.830
Uniformity	3.898
Specific Surface Area	1756 m^2/kg
D [3,2]	3.42 µm
D [4,3]	36.0 µm
Dv (10)	1.10 µm
Dv (50)	8.44 µm
Dv (90)	126 µm

Frequency (compatible)



Result

Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over
0.0500	100.00	7.80	51.44	88.0	16.22	350	0.00	1410	0.00
0.0600	100.00	15.6	39.77	105	13.38	420	0.00	1680	0.00
0.120	100.00	31.0	29.50	125	10.19	500	0.00	2000	0.00
0.240	100.00	37.0	27.09	149	6.80	590	0.00	2380	0.00
0.490	99.88	44.0	24.86	177	3.75	710	0.00	2830	0.00
0.980	91.73	53.0	22.59	210	1.43	840	0.00	3360	0.00
2.00	80.62	63.0	20.55	250	0.26	1000	0.00		
3.90	65.75	74.0	18.58	300	0.00	1190	0.00		

Analysis - Over

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

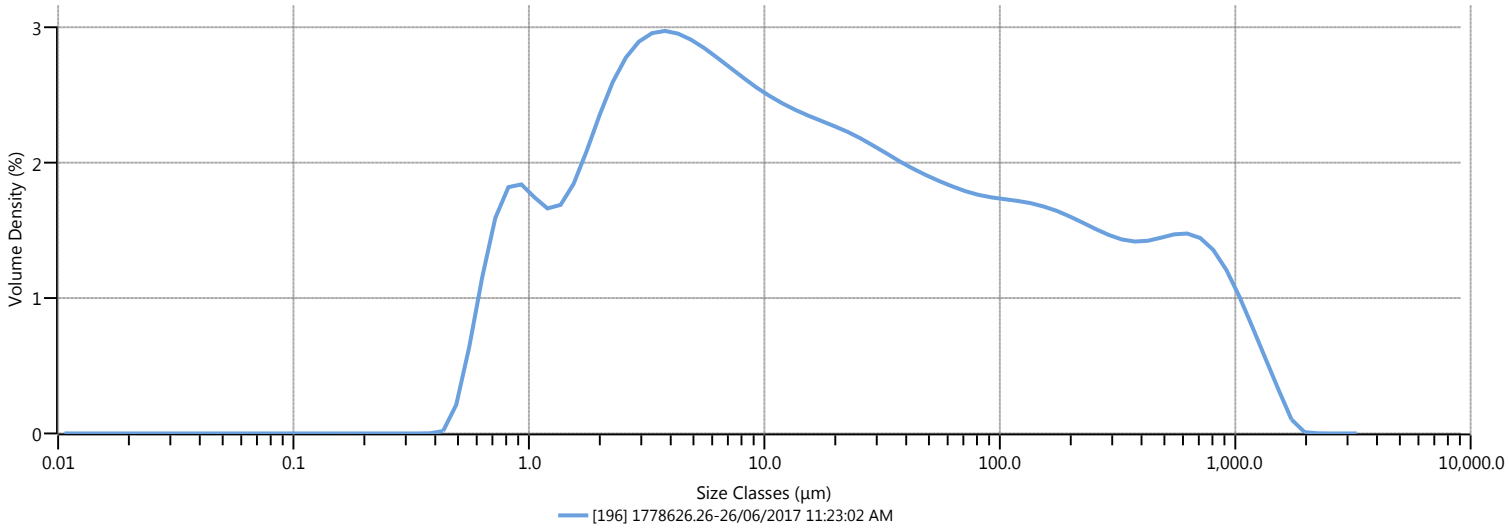
Measurement Details	
Operator Name	rodgers
Sample Name	1778626.26
SOP File Name	Sediment.msop
Lab Number	

Measurement Details	
Analysis Date Time	26/06/2017 11:23:02 AM
Measurement Date Time	26/06/2017 11:23:02 AM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.81 %
Laser Obscuration	20.04 %

Result	
Concentration	0.0136 %
Span	28.391
Uniformity	8.025
Specific Surface Area	1373 m^2/kg
D [3,2]	4.37 µm
D [4,3]	124 µm
Dv (10)	1.41 µm
Dv (50)	14.8 µm
Dv (90)	422 µm

Frequency (compatible)



Result

Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over
0.0500	100.00	7.80	60.43	88.0	26.29	350	11.73	1410	0.40
0.0600	100.00	15.6	49.21	105	24.29	420	10.04	1680	0.06
0.120	100.00	31.0	39.20	125	22.33	500	8.41	2000	0.00
0.240	100.00	37.0	36.83	149	20.38	590	6.82	2380	0.00
0.490	99.92	44.0	34.59	177	18.51	710	5.05	2830	0.00
0.980	94.06	53.0	32.27	210	16.71	840	3.52	3360	0.00
2.00	85.44	63.0	30.18	250	14.95	1000	2.15		
3.90	73.27	74.0	28.29	300	13.18	1190	1.10		

Analysis - Over

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

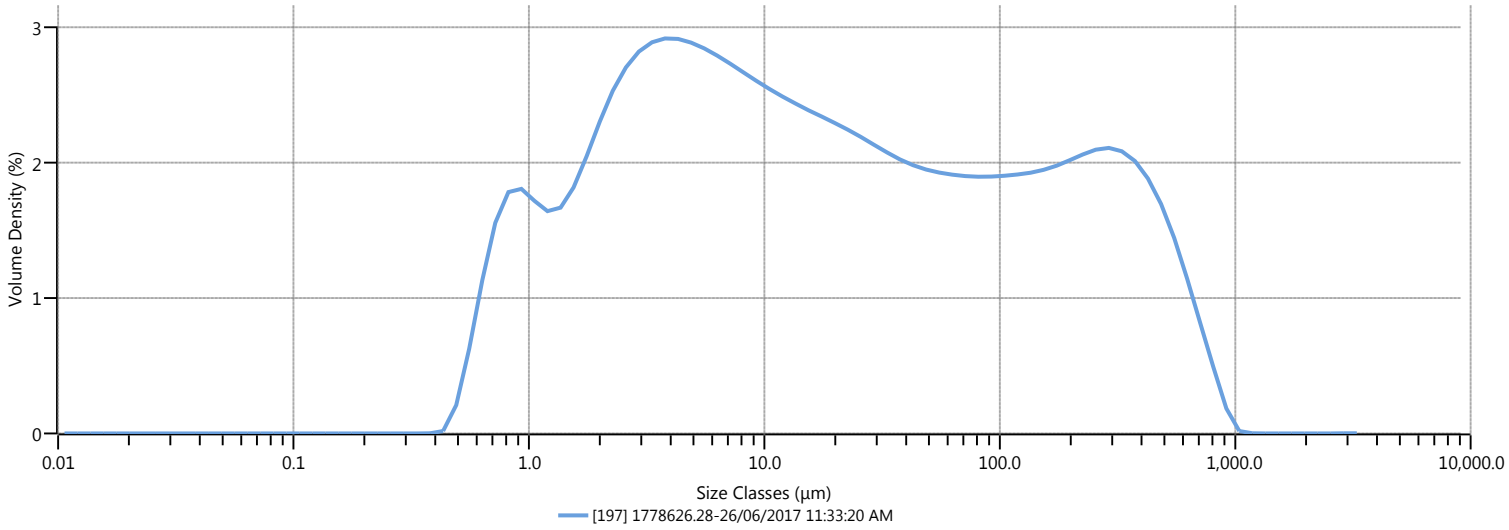
Measurement Details	
Operator Name	rodgers
Sample Name	1778626.28
SOP File Name	Sediment.msop
Lab Number	

Measurement Details	
Analysis Date Time	26/06/2017 11:33:20 AM
Measurement Date Time	26/06/2017 11:33:20 AM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.78 %
Laser Obscuration	22.06 %

Result	
Concentration	0.0153 %
Span	20.044
Uniformity	5.533
Specific Surface Area	1354 m^2/kg
D [3,2]	4.43 µm
D [4,3]	88.7 µm
Dv (10)	1.44 µm
Dv (50)	15.2 µm
Dv (90)	305 µm

Frequency (compatible)



Result

Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over
0.0500	100.00	7.80	60.99	88.0	26.12	350	8.13	1410	0.00
0.0600	100.00	15.6	49.55	105	23.93	420	5.77	1680	0.00
0.120	100.00	31.0	39.45	125	21.76	500	3.74	2000	0.00
0.240	100.00	37.0	37.07	149	19.54	590	2.14	2380	0.00
0.490	99.92	44.0	34.81	177	17.34	710	0.89	2830	0.00
0.980	94.18	53.0	32.43	210	15.10	840	0.22	3360	0.00
2.00	85.69	63.0	30.27	250	12.75	1000	0.00		
3.90	73.81	74.0	28.27	300	10.24	1190	0.00		

Analysis - Over

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

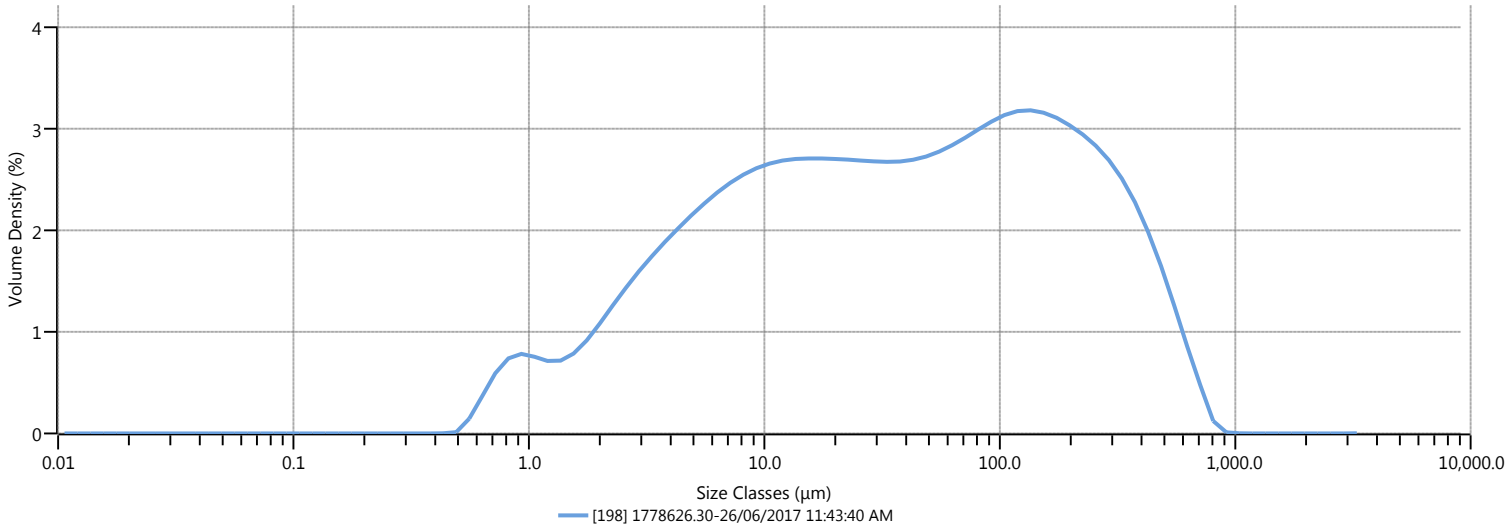
Measurement Details	
Operator Name	rodgers
Sample Name	1778626.30
SOP File Name	Sediment.msop
Lab Number	

Measurement Details	
Analysis Date Time	26/06/2017 11:43:40 AM
Measurement Date Time	26/06/2017 11:43:40 AM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.53 %
Laser Obscuration	18.70 %

Result	
Concentration	0.0232 %
Span	7.888
Uniformity	2.362
Specific Surface Area	713.1 m^2/kg
D [3,2]	8.41 µm
D [4,3]	100 µm
Dv (10)	3.15 µm
Dv (50)	37.3 µm
Dv (90)	297 µm

Frequency (compatible)



Result

Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over
0.0500	100.00	7.80	77.32	88.0	34.21	350	7.27	1410	0.00
0.0600	100.00	15.6	65.31	105	30.64	420	4.64	1680	0.00
0.120	100.00	31.0	53.22	125	27.04	500	2.58	2000	0.00
0.240	100.00	37.0	50.13	149	23.39	590	1.16	2380	0.00
0.490	100.00	44.0	47.09	177	19.86	710	0.28	2830	0.00
0.980	97.85	53.0	43.78	210	16.45	840	0.02	3360	0.00
2.00	94.12	63.0	40.62	250	13.12	1000	0.00		
3.90	87.48	74.0	37.59	300	9.83	1190	0.00		

Analysis - Over

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

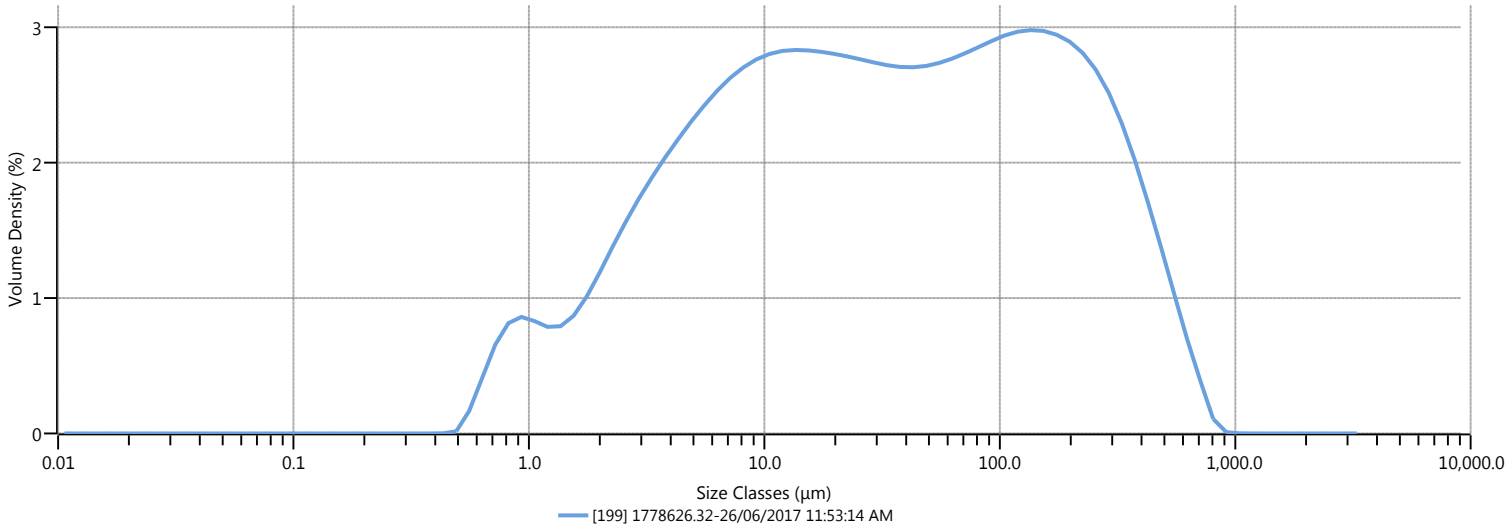
Measurement Details	
Operator Name	rodgers
Sample Name	1778626.32
SOP File Name	Sediment.msop
Lab Number	

Measurement Details	
Analysis Date Time	26/06/2017 11:53:14 AM
Measurement Date Time	26/06/2017 11:53:14 AM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.55 %
Laser Obscuration	19.66 %

Result	
Concentration	0.0227 %
Span	8.618
Uniformity	2.580
Specific Surface Area	772.3 m^2/kg
D [3,2]	7.77 µm
D [4,3]	91.6 µm
Dv (10)	2.89 µm
Dv (50)	31.5 µm
Dv (90)	274 µm

Frequency (compatible)



Result

Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over
0.0500	100.00	7.80	75.41	88.0	31.51	350	6.16	1410	0.00
0.0600	100.00	15.6	62.76	105	28.15	420	3.85	1680	0.00
0.120	100.00	31.0	50.27	125	24.78	500	2.11	2000	0.00
0.240	100.00	37.0	47.13	149	21.36	590	0.95	2380	0.00
0.490	100.00	44.0	44.07	177	18.03	710	0.24	2830	0.00
0.980	97.62	53.0	40.77	210	14.78	840	0.01	3360	0.00
2.00	93.50	63.0	37.67	250	11.61	1000	0.00		
3.90	86.28	74.0	34.73	300	8.51	1190	0.00		

Analysis - Over

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

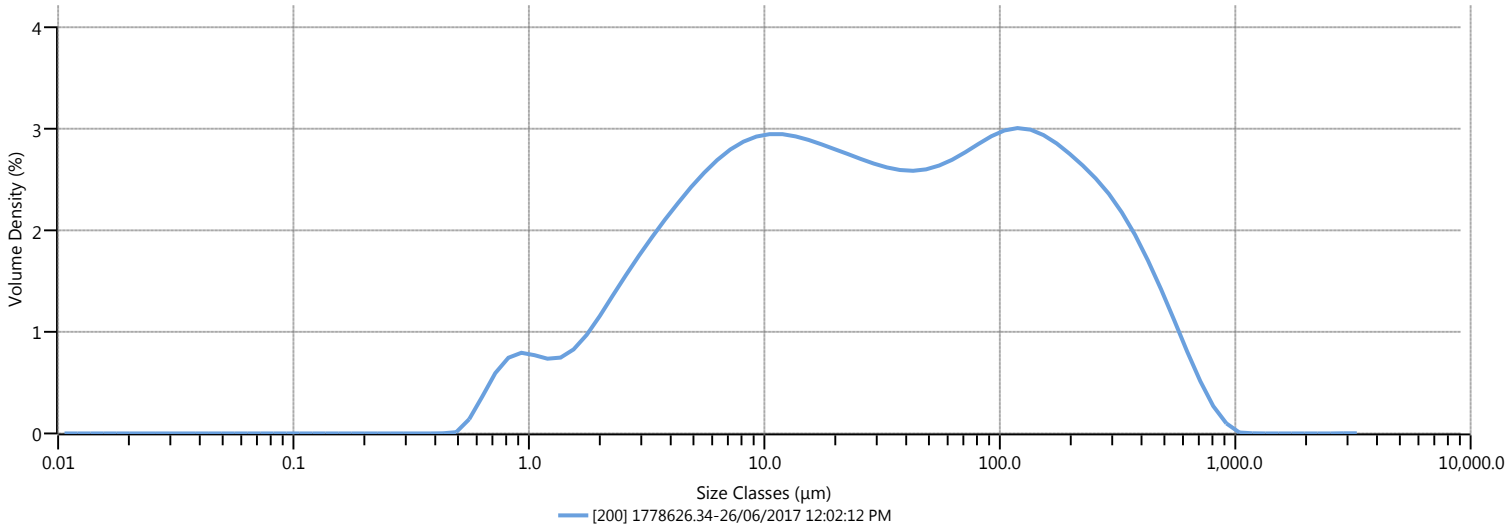
Measurement Details	
Operator Name	rodgers
Sample Name	1778626.34
SOP File Name	Sediment.msop
Lab Number	

Measurement Details	
Analysis Date Time	26/06/2017 12:02:12 PM
Measurement Date Time	26/06/2017 12:02:12 PM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.51 %
Laser Obscuration	21.83 %

Result	
Concentration	0.0261 %
Span	9.122
Uniformity	2.753
Specific Surface Area	753.7 m^2/kg
D [3,2]	7.96 µm
D [4,3]	93.3 µm
Dv (10)	3.01 µm
Dv (50)	30.2 µm
Dv (90)	279 µm

Frequency (compatible)



Result

Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over
0.0500	100.00	7.80	75.18	88.0	31.35	350	6.63	1410	0.00
0.0600	100.00	15.6	61.95	105	27.95	420	4.37	1680	0.00
0.120	100.00	31.0	49.56	125	24.53	500	2.61	2000	0.00
0.240	100.00	37.0	46.54	149	21.11	590	1.36	2380	0.00
0.490	100.00	44.0	43.61	177	17.84	710	0.51	2830	0.00
0.980	97.85	53.0	40.45	210	14.73	840	0.12	3360	0.00
2.00	93.94	63.0	37.45	250	11.76	1000	0.00		
3.90	86.67	74.0	34.57	300	8.86	1190	0.00		

Analysis - Over

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

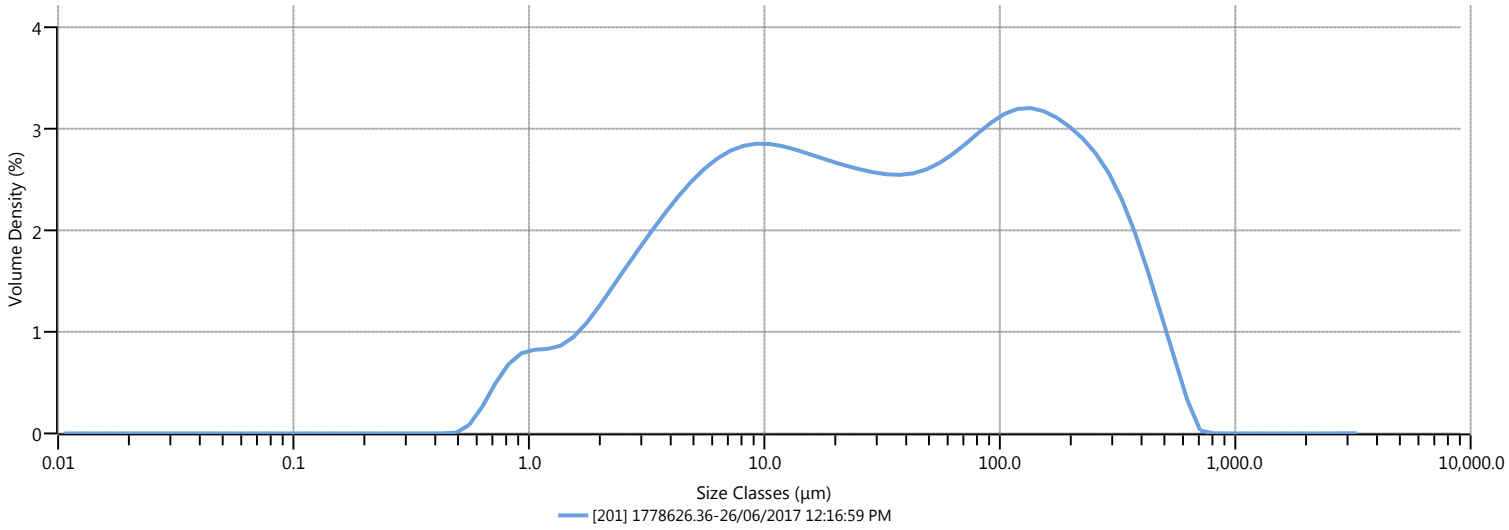
Measurement Details	
Operator Name	rodgers
Sample Name	1778626.36
SOP File Name	Sediment.msop
Lab Number	

Measurement Details	
Analysis Date Time	26/06/2017 12:16:59 PM
Measurement Date Time	26/06/2017 12:16:59 PM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.58 %
Laser Obscuration	18.40 %

Result	
Concentration	0.0213 %
Span	8.245
Uniformity	2.468
Specific Surface Area	754.3 m^2/kg
D [3,2]	7.95 µm
D [4,3]	86.0 µm
Dv (10)	2.91 µm
Dv (50)	30.8 µm
Dv (90)	257 µm

Frequency (compatible)



Result

Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over
0.0500	100.00	7.80	74.52	88.0	31.55	350	4.93	1410	0.00
0.0600	100.00	15.6	61.74	105	27.98	420	2.68	1680	0.00
0.120	100.00	31.0	49.88	125	24.36	500	1.13	2000	0.00
0.240	100.00	37.0	46.93	149	20.69	590	0.26	2380	0.00
0.490	100.00	44.0	44.04	177	17.15	710	0.00	2830	0.00
0.980	98.13	53.0	40.89	210	13.75	840	0.00	3360	0.00
2.00	93.76	63.0	37.85	250	10.47	1000	0.00		
3.90	86.16	74.0	34.89	300	7.31	1190	0.00		

Analysis - Over

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

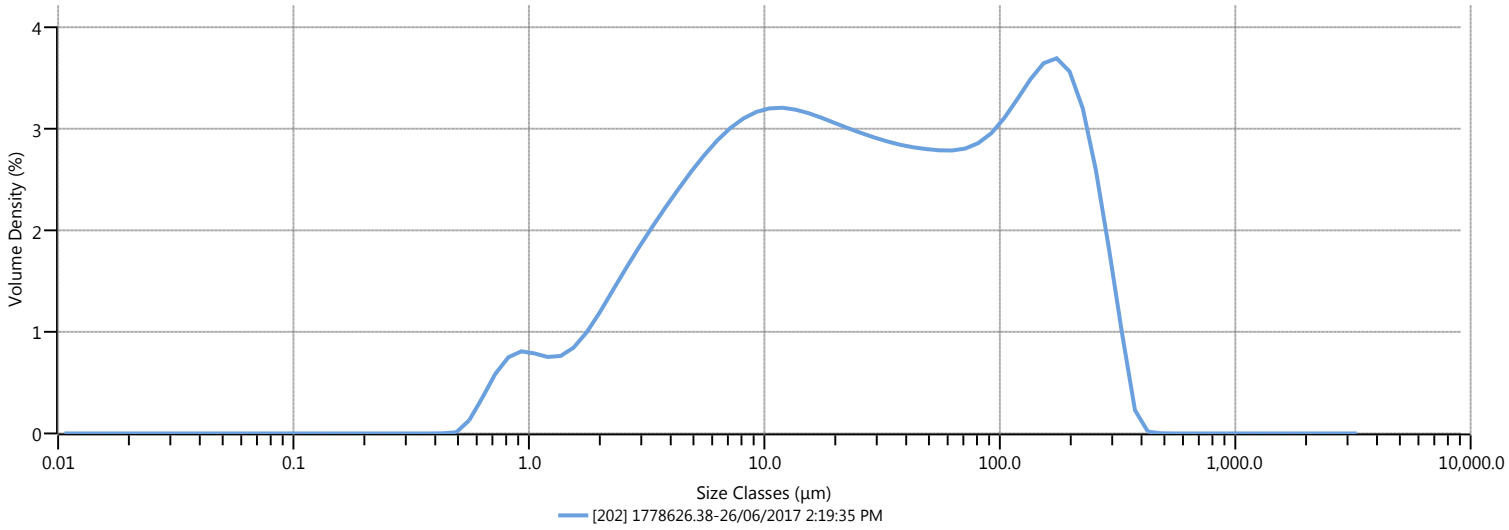
Measurement Details	
Operator Name	rodgers
Sample Name	1778626.38
SOP File Name	Sediment.msop
Lab Number	

Measurement Details	
Analysis Date Time	26/06/2017 2:19:35 PM
Measurement Date Time	26/06/2017 2:19:35 PM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.97 %
Laser Obscuration	14.91 %

Result	
Concentration	0.0164 %
Span	7.352
Uniformity	2.147
Specific Surface Area	782.3 m^2/kg
D [3,2]	7.67 µm
D [4,3]	63.3 µm
Dv (10)	2.95 µm
Dv (50)	25.3 µm
Dv (90)	189 µm

Frequency (compatible)



Result

Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over
0.0500	100.00	7.80	73.99	88.0	26.84	350	0.18	1410	0.00
0.0600	100.00	15.6	59.62	105	23.36	420	0.00	1680	0.00
0.120	100.00	31.0	46.07	125	19.69	500	0.00	2000	0.00
0.240	100.00	37.0	42.76	149	15.66	590	0.00	2380	0.00
0.490	100.00	44.0	39.56	177	11.52	710	0.00	2830	0.00
0.980	97.86	53.0	36.15	210	7.49	840	0.00	3360	0.00
2.00	93.86	63.0	33.01	250	3.97	1000	0.00		
3.90	86.26	74.0	30.07	300	1.35	1190	0.00		

Analysis - Over

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

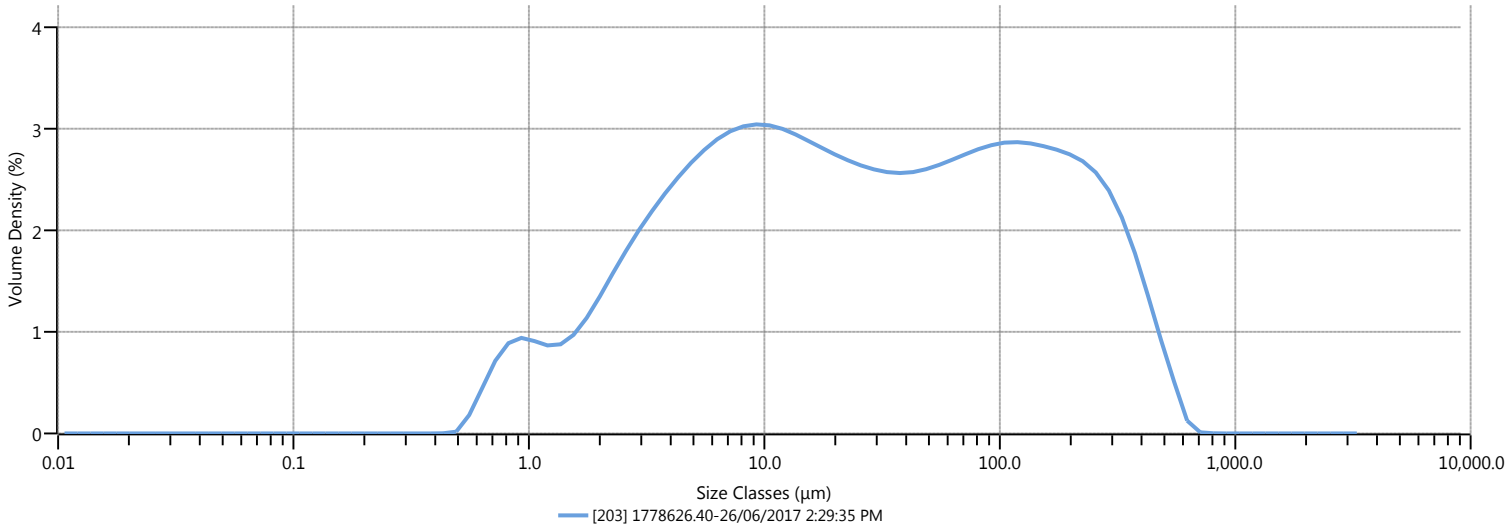
Measurement Details	
Operator Name	rodgers
Sample Name	1778626.40
SOP File Name	Sediment.msop
Lab Number	

Measurement Details	
Analysis Date Time	26/06/2017 2:29:35 PM
Measurement Date Time	26/06/2017 2:29:35 PM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.63 %
Laser Obscuration	19.64 %

Result	
Concentration	0.0205 %
Span	9.406
Uniformity	2.747
Specific Surface Area	852.9 m^2/kg
D [3,2]	7.04 µm
D [4,3]	77.0 µm
Dv (10)	2.62 µm
Dv (50)	24.9 µm
Dv (90)	237 µm

Frequency (compatible)



Result

Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over
0.0500	100.00	7.80	72.01	88.0	28.22	350	3.95	1410	0.00
0.0600	100.00	15.6	58.45	105	24.93	420	1.96	1680	0.00
0.120	100.00	31.0	46.29	125	21.66	500	0.69	2000	0.00
0.240	100.00	37.0	43.32	149	18.39	590	0.08	2380	0.00
0.490	100.00	44.0	40.41	177	15.23	710	0.00	2830	0.00
0.980	97.40	53.0	37.25	210	12.14	840	0.00	3360	0.00
2.00	92.82	63.0	34.25	250	9.11	1000	0.00		
3.90	84.50	74.0	31.38	300	6.16	1190	0.00		

Analysis - Over

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

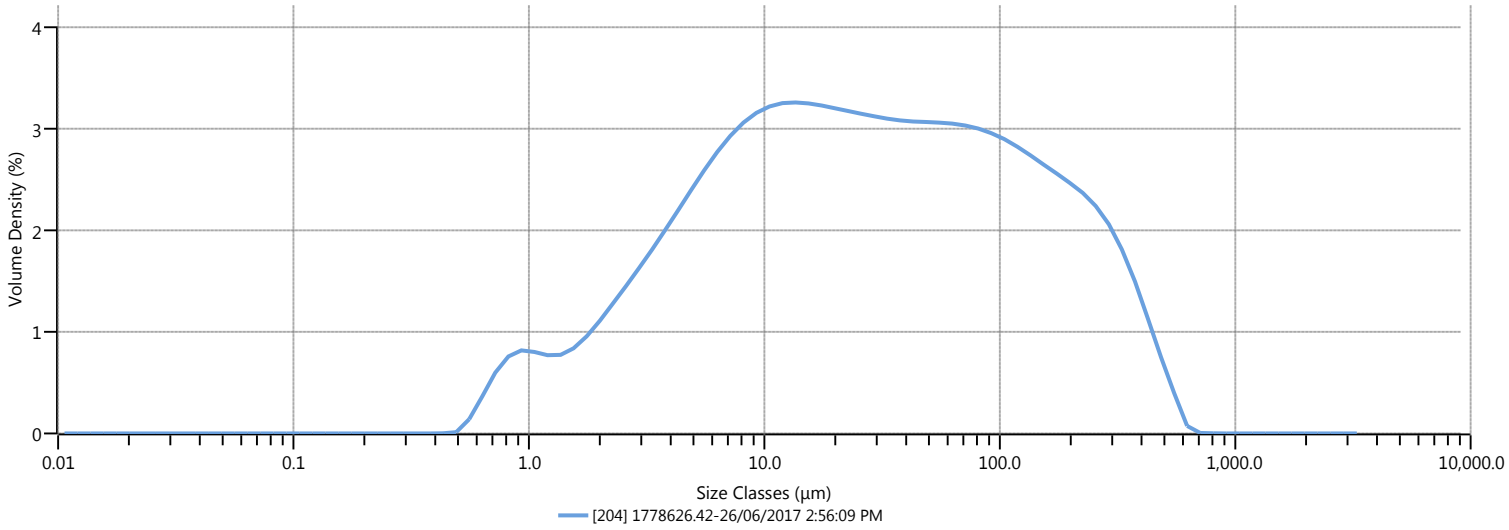
Measurement Details	
Operator Name	rodgers
Sample Name	1778626.42
SOP File Name	Sediment.msop
Lab Number	

Measurement Details	
Analysis Date Time	26/06/2017 2:56:09 PM
Measurement Date Time	26/06/2017 2:56:09 PM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.57 %
Laser Obscuration	29.16 %

Result	
Concentration	0.0360 %
Span	8.044
Uniformity	2.357
Specific Surface Area	764.7 m^2/kg
D [3,2]	7.85 µm
D [4,3]	71.7 µm
Dv (10)	3.06 µm
Dv (50)	26.3 µm
Dv (90)	215 µm

Frequency (compatible)



Result

Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over
0.0500	100.00	7.80	75.42	88.0	25.83	350	3.24	1410	0.00
0.0600	100.00	15.6	60.93	105	22.44	420	1.57	1680	0.00
0.120	100.00	31.0	46.66	125	19.20	500	0.52	2000	0.00
0.240	100.00	37.0	43.08	149	16.07	590	0.04	2380	0.00
0.490	100.00	44.0	39.60	177	13.14	710	0.00	2830	0.00
0.980	97.81	53.0	35.87	210	10.35	840	0.00	3360	0.00
2.00	93.85	63.0	32.42	250	7.68	1000	0.00		
3.90	87.03	74.0	29.22	300	5.13	1190	0.00		

Analysis - Over

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

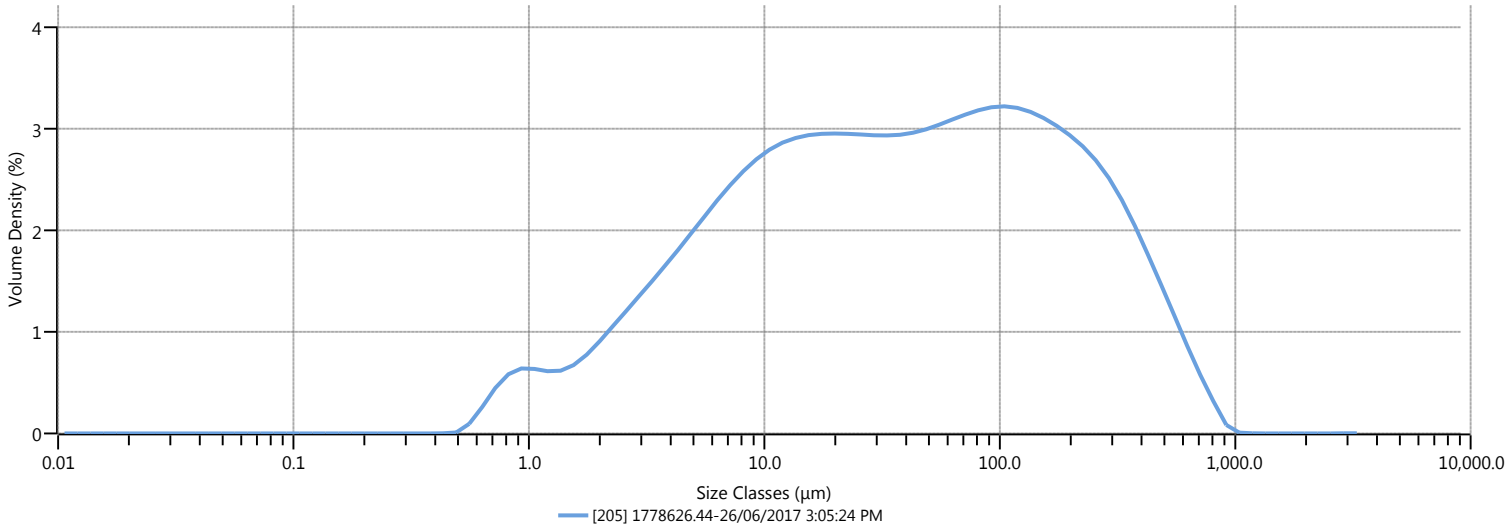
Measurement Details	
Operator Name	rodgers
Sample Name	1778626.44
SOP File Name	Sediment.msop
Lab Number	

Measurement Details	
Analysis Date Time	26/06/2017 3:05:24 PM
Measurement Date Time	26/06/2017 3:05:24 PM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.44 %
Laser Obscuration	16.83 %

Result	
Concentration	0.0232 %
Span	7.415
Uniformity	2.251
Specific Surface Area	629.1 m^2/kg
D [3,2]	9.54 µm
D [4,3]	99.4 µm
Dv (10)	3.73 µm
Dv (50)	38.3 µm
Dv (90)	288 µm

Frequency (compatible)



Result

Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over
0.0500	100.00	7.80	79.93	88.0	33.36	350	6.96	1410	0.00
0.0600	100.00	15.6	67.27	105	29.65	420	4.61	1680	0.00
0.120	100.00	31.0	54.06	125	25.99	500	2.79	2000	0.00
0.240	100.00	37.0	50.67	149	22.37	590	1.48	2380	0.00
0.490	100.00	44.0	47.33	177	18.91	710	0.56	2830	0.00
0.980	98.35	53.0	43.69	210	15.60	840	0.10	3360	0.00
2.00	95.17	63.0	40.24	250	12.42	1000	0.00		
3.90	89.53	74.0	36.96	300	9.32	1190	0.00		

Analysis - Over

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

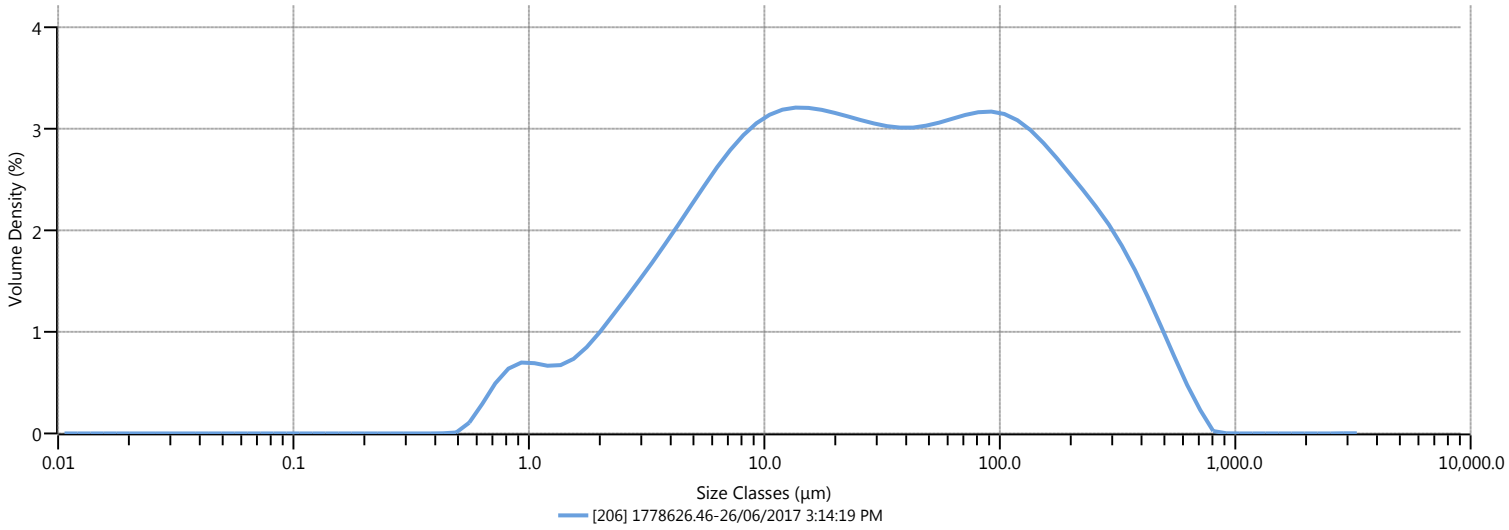
Measurement Details	
Operator Name	rodgers
Sample Name	1778626.46
SOP File Name	Sediment.msop
Lab Number	

Measurement Details	
Analysis Date Time	26/06/2017 3:14:19 PM
Measurement Date Time	26/06/2017 3:14:19 PM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.49 %
Laser Obscuration	21.54 %

Result	
Concentration	0.0278 %
Span	7.731
Uniformity	2.339
Specific Surface Area	692.2 m^2/kg
D [3,2]	8.67 µm
D [4,3]	80.9 µm
Dv (10)	3.42 µm
Dv (50)	30.0 µm
Dv (90)	235 µm

Frequency (compatible)



Result

Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over
0.0500	100.00	7.80	77.49	88.0	28.41	350	4.62	1410	0.00
0.0600	100.00	15.6	63.35	105	24.76	420	2.78	1680	0.00
0.120	100.00	31.0	49.32	125	21.23	500	1.43	2000	0.00
0.240	100.00	37.0	45.83	149	17.82	590	0.57	2380	0.00
0.490	100.00	44.0	42.42	177	14.68	710	0.10	2830	0.00
0.980	98.19	53.0	38.74	210	11.77	840	0.00	3360	0.00
2.00	94.72	63.0	35.27	250	9.08	1000	0.00		
3.90	88.43	74.0	31.99	300	6.53	1190	0.00		

Analysis - Over

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

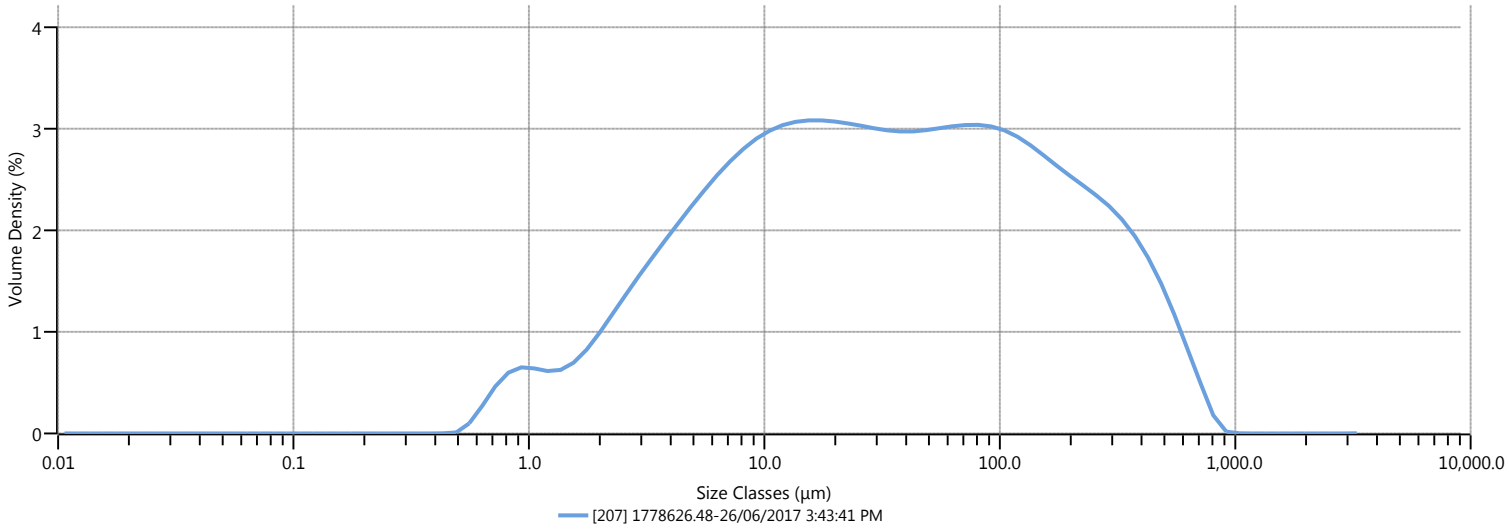
Measurement Details	
Operator Name	rodgers
Sample Name	1778626.48
SOP File Name	Sediment.msop
Lab Number	

Measurement Details	
Analysis Date Time	26/06/2017 3:43:41 PM
Measurement Date Time	26/06/2017 3:43:41 PM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.50 %
Laser Obscuration	17.78 %

Result	
Concentration	0.0231 %
Span	8.483
Uniformity	2.507
Specific Surface Area	670.9 m^2/kg
D [3,2]	8.94 µm
D [4,3]	91.8 µm
Dv (10)	3.47 µm
Dv (50)	32.1 µm
Dv (90)	276 µm

Frequency (compatible)



Result

Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over
0.0500	100.00	7.80	77.84	88.0	30.21	350	6.61	1410	0.00
0.0600	100.00	15.6	64.36	105	26.74	420	4.35	1680	0.00
0.120	100.00	31.0	50.67	125	23.38	500	2.54	2000	0.00
0.240	100.00	37.0	47.23	149	20.14	590	1.22	2380	0.00
0.490	100.00	44.0	43.86	177	17.12	710	0.35	2830	0.00
0.980	98.30	53.0	40.24	210	14.25	840	0.03	3360	0.00
2.00	95.02	63.0	36.83	250	11.49	1000	0.00		
3.90	88.58	74.0	33.65	300	8.76	1190	0.00		

Analysis - Over

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

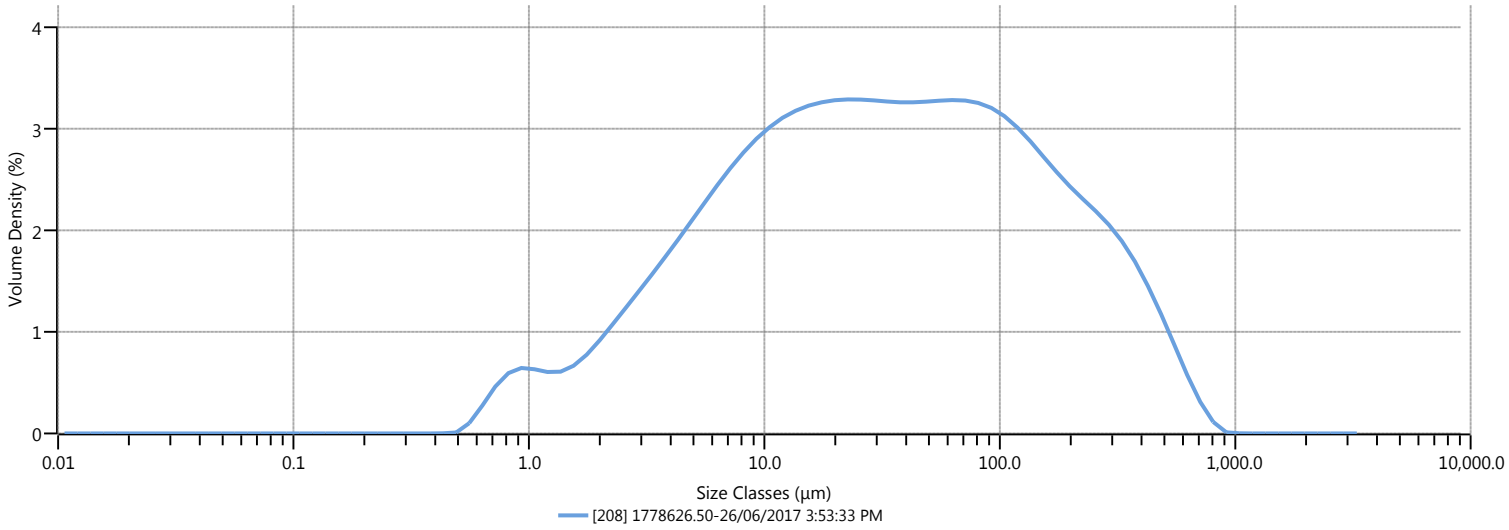
Measurement Details	
Operator Name	rodgers
Sample Name	1778626.50
SOP File Name	Sediment.msop
Lab Number	

Measurement Details	
Analysis Date Time	26/06/2017 3:53:33 PM
Measurement Date Time	26/06/2017 3:53:33 PM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.46 %
Laser Obscuration	23.76 %

Result	
Concentration	0.0330 %
Span	7.515
Uniformity	2.254
Specific Surface Area	652.5 m^2/kg
D [3,2]	9.20 µm
D [4,3]	84.1 µm
Dv (10)	3.67 µm
Dv (50)	32.1 µm
Dv (90)	245 µm

Frequency (compatible)



Result

Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over
0.0500	100.00	7.80	79.11	88.0	28.44	350	5.22	1410	0.00
0.0600	100.00	15.6	65.41	105	24.78	420	3.27	1680	0.00
0.120	100.00	31.0	50.71	125	21.30	500	1.79	2000	0.00
0.240	100.00	37.0	46.94	149	18.03	590	0.80	2380	0.00
0.490	100.00	44.0	43.25	177	15.04	710	0.21	2830	0.00
0.980	98.31	53.0	39.28	210	12.28	840	0.02	3360	0.00
2.00	95.16	63.0	35.58	250	9.68	1000	0.00		
3.90	89.31	74.0	32.13	300	7.16	1190	0.00		

Analysis - Over

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

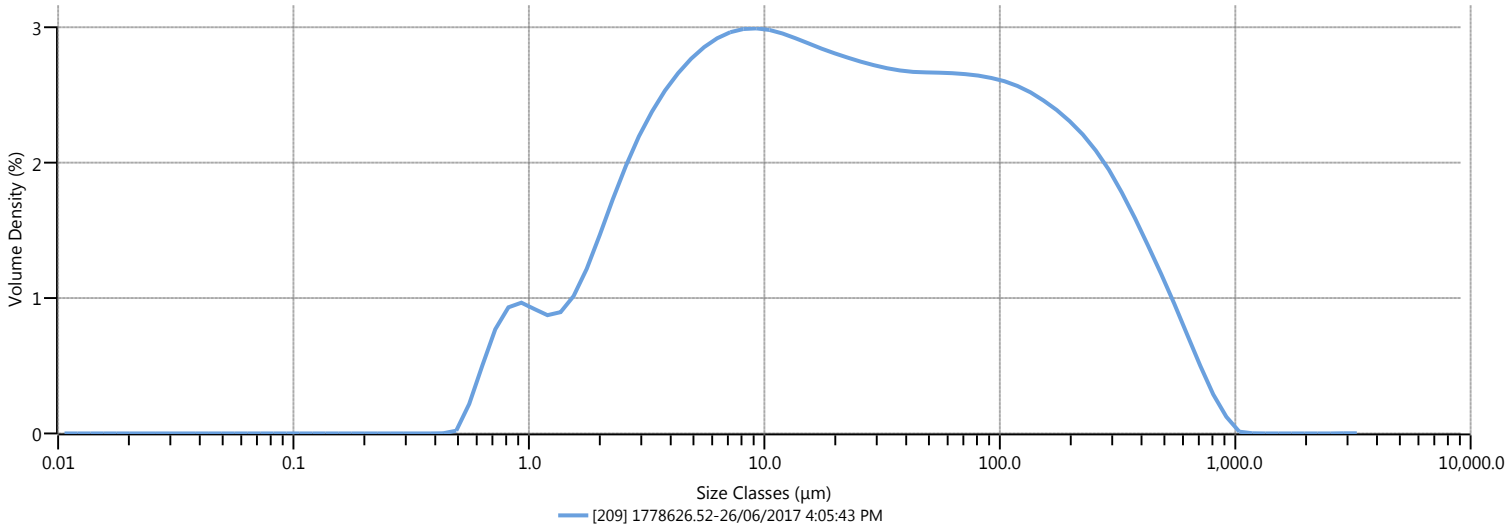
Measurement Details	
Operator Name	rodgers
Sample Name	1778626.52
SOP File Name	Sediment.msop
Lab Number	

Measurement Details	
Analysis Date Time	26/06/2017 4:05:43 PM
Measurement Date Time	26/06/2017 4:05:43 PM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.60 %
Laser Obscuration	19.12 %

Result	
Concentration	0.0191 %
Span	10.647
Uniformity	3.205
Specific Surface Area	893.6 m^2/kg
D [3,2]	6.71 µm
D [4,3]	81.9 µm
Dv (10)	2.50 µm
Dv (50)	23.1 µm
Dv (90)	248 µm

Frequency (compatible)



Result

Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over
0.0500	100.00	7.80	70.62	88.0	26.57	350	5.69	1410	0.00
0.0600	100.00	15.6	57.23	105	23.55	420	3.85	1680	0.00
0.120	100.00	31.0	44.74	125	20.61	500	2.40	2000	0.00
0.240	100.00	37.0	41.62	149	17.73	590	1.33	2380	0.00
0.490	100.00	44.0	38.60	177	15.00	710	0.54	2830	0.00
0.980	97.23	53.0	35.36	210	12.40	840	0.14	3360	0.00
2.00	92.47	63.0	32.35	250	9.91	1000	0.00		
3.90	83.40	74.0	29.56	300	7.51	1190	0.00		

Analysis - Over

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

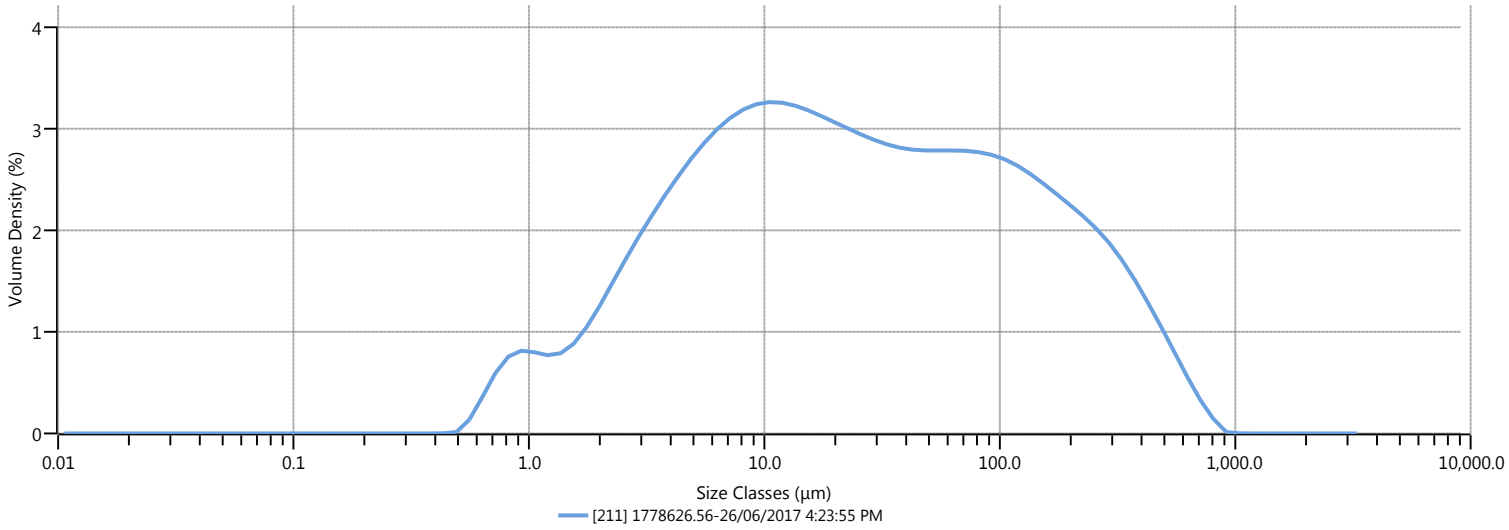
Measurement Details	
Operator Name	rodgers
Sample Name	1778626.56
SOP File Name	Sediment.msop
Lab Number	

Measurement Details	
Analysis Date Time	26/06/2017 4:23:55 PM
Measurement Date Time	26/06/2017 4:23:55 PM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.54 %
Laser Obscuration	22.13 %

Result	
Concentration	0.0247 %
Span	9.683
Uniformity	2.903
Specific Surface Area	804.9 m^2/kg
D [3,2]	7.45 µm
D [4,3]	76.6 µm
Dv (10)	2.86 µm
Dv (50)	23.5 µm
Dv (90)	230 µm

Frequency (compatible)



Result

Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over
0.0500	100.00	7.80	72.85	88.0	25.63	350	4.79	1410	0.00
0.0600	100.00	15.6	58.22	105	22.48	420	3.06	1680	0.00
0.120	100.00	31.0	44.67	125	19.45	500	1.74	2000	0.00
0.240	100.00	37.0	41.39	149	16.54	590	0.83	2380	0.00
0.490	100.00	44.0	38.22	177	13.83	710	0.25	2830	0.00
0.980	97.84	53.0	34.84	210	11.28	840	0.02	3360	0.00
2.00	93.69	63.0	31.69	250	8.87	1000	0.00		
3.90	85.65	74.0	28.77	300	6.55	1190	0.00		

Analysis - Over

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

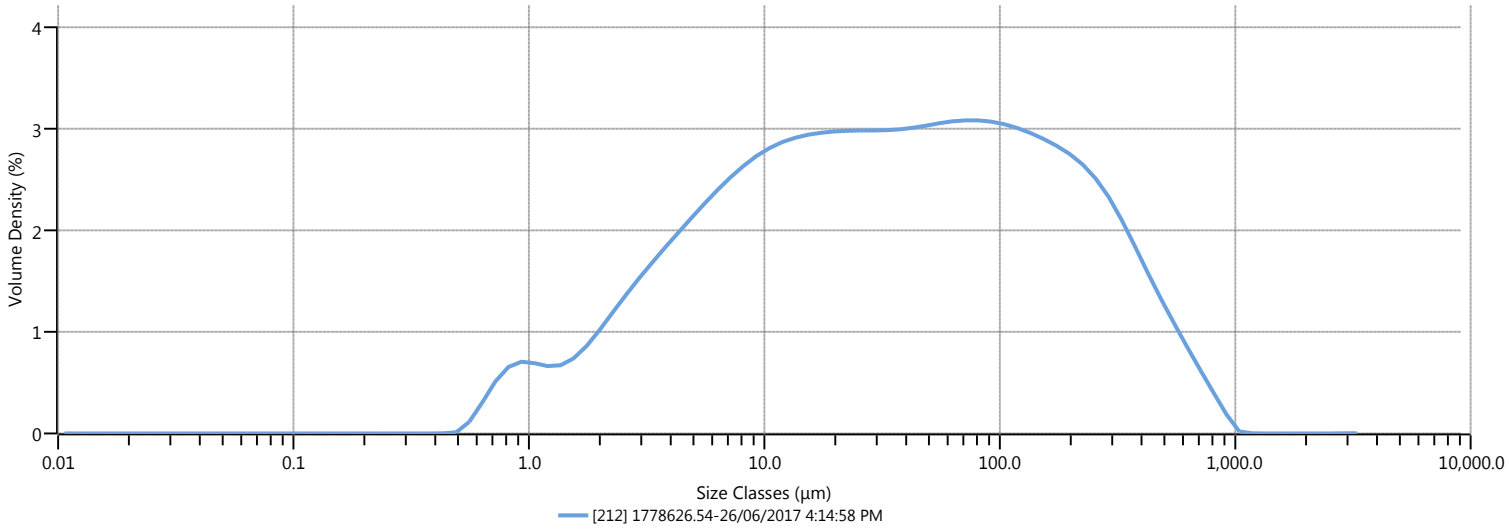
Measurement Details	
Operator Name	rodgers
Sample Name	1778626.54
SOP File Name	Sediment.msop
Lab Number	

Measurement Details	
Analysis Date Time	26/06/2017 4:14:58 PM
Measurement Date Time	26/06/2017 4:14:58 PM
Result Source	Edited

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.49 %
Laser Obscuration	17.80 %

Result	
Concentration	0.0229 %
Span	7.952
Uniformity	2.431
Specific Surface Area	681.4 m^2/kg
D [3,2]	8.81 µm
D [4,3]	95.7 µm
Dv (10)	3.37 µm
Dv (50)	34.5 µm
Dv (90)	277 µm

Frequency (compatible)



Result

Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over
0.0500	100.00	7.80	78.14	88.0	31.35	350	6.65	1410	0.00
0.0600	100.00	15.6	65.40	105	27.82	420	4.53	1680	0.00
0.120	100.00	31.0	52.06	125	24.38	500	2.90	2000	0.00
0.240	100.00	37.0	48.61	149	20.99	590	1.69	2380	0.00
0.490	100.00	44.0	45.21	177	17.77	710	0.75	2830	0.00
0.980	98.13	53.0	41.53	210	14.67	840	0.22	3360	0.00
2.00	94.65	63.0	38.07	250	11.68	1000	0.00		
3.90	88.30	74.0	34.84	300	8.81	1190	0.00		

Analysis - Over

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

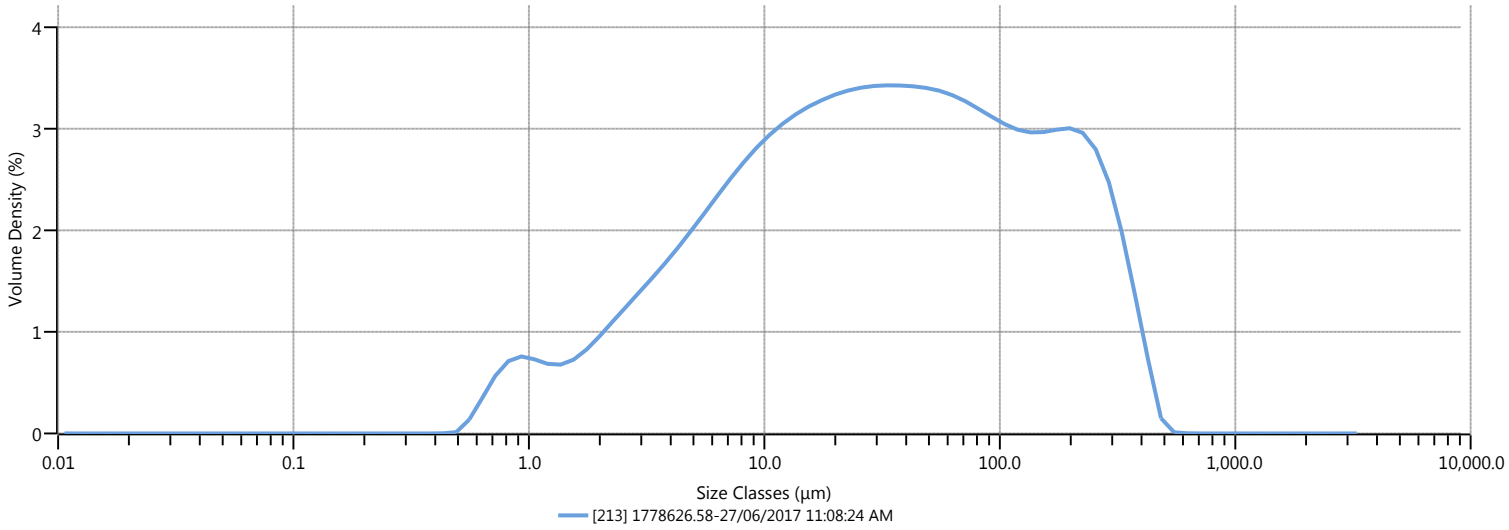
Measurement Details	
Operator Name	rodgers
Sample Name	1778626.58
SOP File Name	Sediment.msop
Lab Number	

Measurement Details	
Analysis Date Time	27/06/2017 11:08:24 AM
Measurement Date Time	27/06/2017 11:08:24 AM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.98 %
Laser Obscuration	21.05 %

Result	
Concentration	0.0273 %
Span	6.705
Uniformity	1.926
Specific Surface Area	692.6 m^2/kg
D [3,2]	8.66 µm
D [4,3]	72.6 µm
Dv (10)	3.44 µm
Dv (50)	31.6 µm
Dv (90)	215 µm

Frequency (compatible)



Result

Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over
0.0500	100.00	7.80	78.88	88.0	27.58	350	1.90	1410	0.00
0.0600	100.00	15.6	65.47	105	24.02	420	0.46	1680	0.00
0.120	100.00	31.0	50.43	125	20.59	500	0.02	2000	0.00
0.240	100.00	37.0	46.47	149	17.19	590	0.00	2380	0.00
0.490	100.00	44.0	42.60	177	13.84	710	0.00	2830	0.00
0.980	97.94	53.0	38.46	210	10.49	840	0.00	3360	0.00
2.00	94.46	63.0	34.67	250	7.15	1000	0.00		
3.90	88.65	74.0	31.20	300	4.01	1190	0.00		

Analysis - Over

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

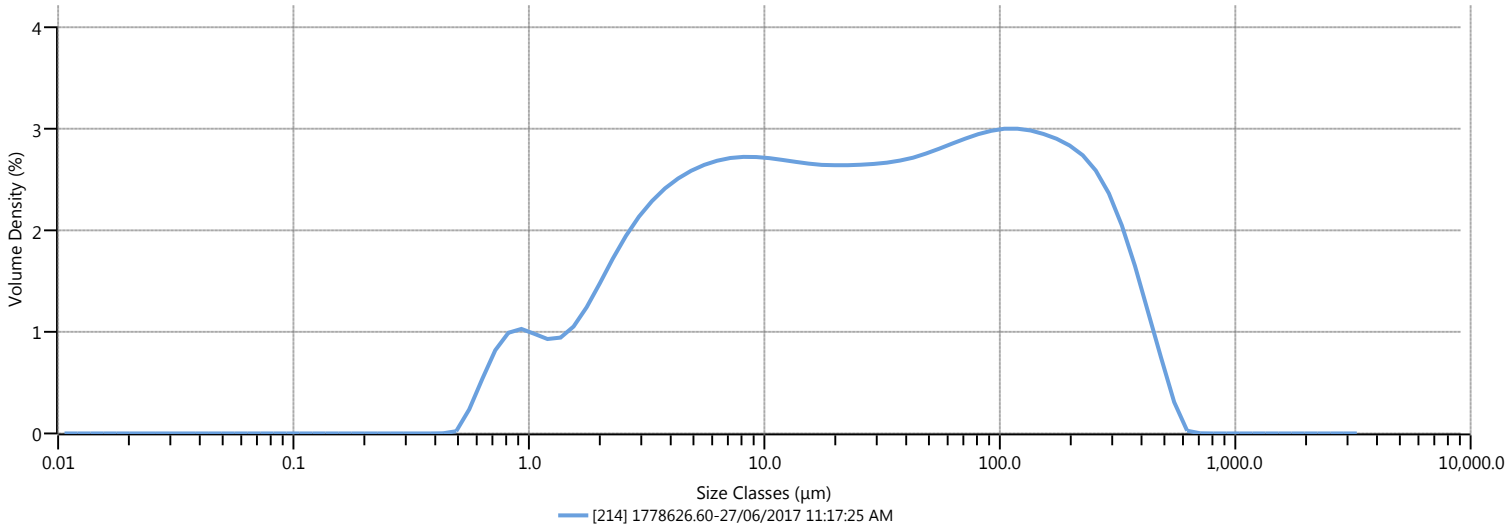
Measurement Details	
Operator Name	rodgers
Sample Name	1778626.60
SOP File Name	Sediment.msop
Lab Number	

Measurement Details	
Analysis Date Time	27/06/2017 11:17:25 AM
Measurement Date Time	27/06/2017 11:17:25 AM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.70 %
Laser Obscuration	17.34 %

Result	
Concentration	0.0171 %
Span	8.514
Uniformity	2.508
Specific Surface Area	897.7 m^2/kg
D [3,2]	6.68 µm
D [4,3]	75.0 µm
Dv (10)	2.43 µm
Dv (50)	26.5 µm
Dv (90)	228 µm

Frequency (compatible)



Result

Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over
0.0500	100.00	7.80	71.37	88.0	28.24	350	3.31	1410	0.00
0.0600	100.00	15.6	59.15	105	24.80	420	1.48	1680	0.00
0.120	100.00	31.0	47.28	125	21.38	500	0.40	2000	0.00
0.240	100.00	37.0	44.20	149	17.96	590	0.00	2380	0.00
0.490	100.00	44.0	41.14	177	14.67	710	0.00	2830	0.00
0.980	97.04	53.0	37.80	210	11.48	840	0.00	3360	0.00
2.00	92.08	63.0	34.61	250	8.39	1000	0.00		
3.90	83.23	74.0	31.58	300	5.45	1190	0.00		

Analysis - Over

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

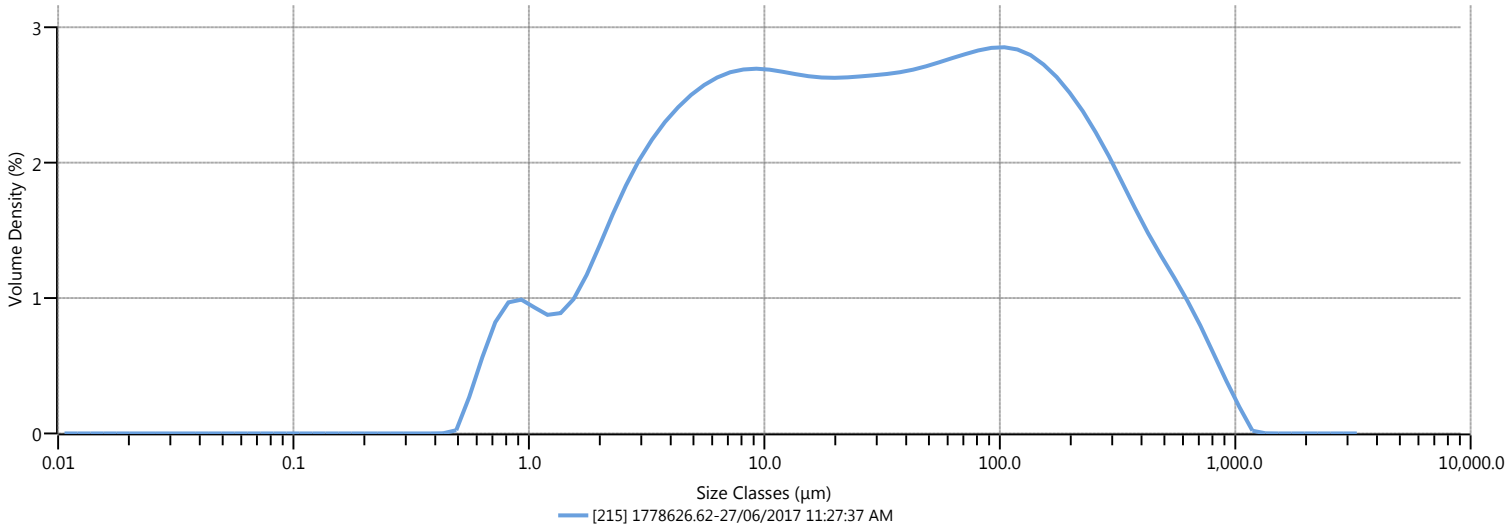
Measurement Details	
Operator Name	rodgers
Sample Name	1778626.62
SOP File Name	Sediment.msop
Lab Number	

Measurement Details	
Analysis Date Time	27/06/2017 11:27:37 AM
Measurement Date Time	27/06/2017 11:27:37 AM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.56 %
Laser Obscuration	26.30 %

Result	
Concentration	0.0283 %
Span	9.763
Uniformity	3.044
Specific Surface Area	871.9 m^2/kg
D [3,2]	6.88 µm
D [4,3]	95.9 µm
Dv (10)	2.51 µm
Dv (50)	28.5 µm
Dv (90)	281 µm

Frequency (compatible)



Result

Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over
0.0500	100.00	7.80	72.46	88.0	29.91	350	7.20	1410	0.00
0.0600	100.00	15.6	60.35	105	26.62	420	5.27	1680	0.00
0.120	100.00	31.0	48.54	125	23.38	500	3.69	2000	0.00
0.240	100.00	37.0	45.47	149	20.19	590	2.43	2380	0.00
0.490	100.00	44.0	42.44	177	17.17	710	1.31	2830	0.00
0.980	97.04	53.0	39.15	210	14.32	840	0.58	3360	0.00
2.00	92.36	63.0	36.04	250	11.65	1000	0.14		
3.90	84.00	74.0	33.11	300	9.11	1190	0.00		

Analysis - Over

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

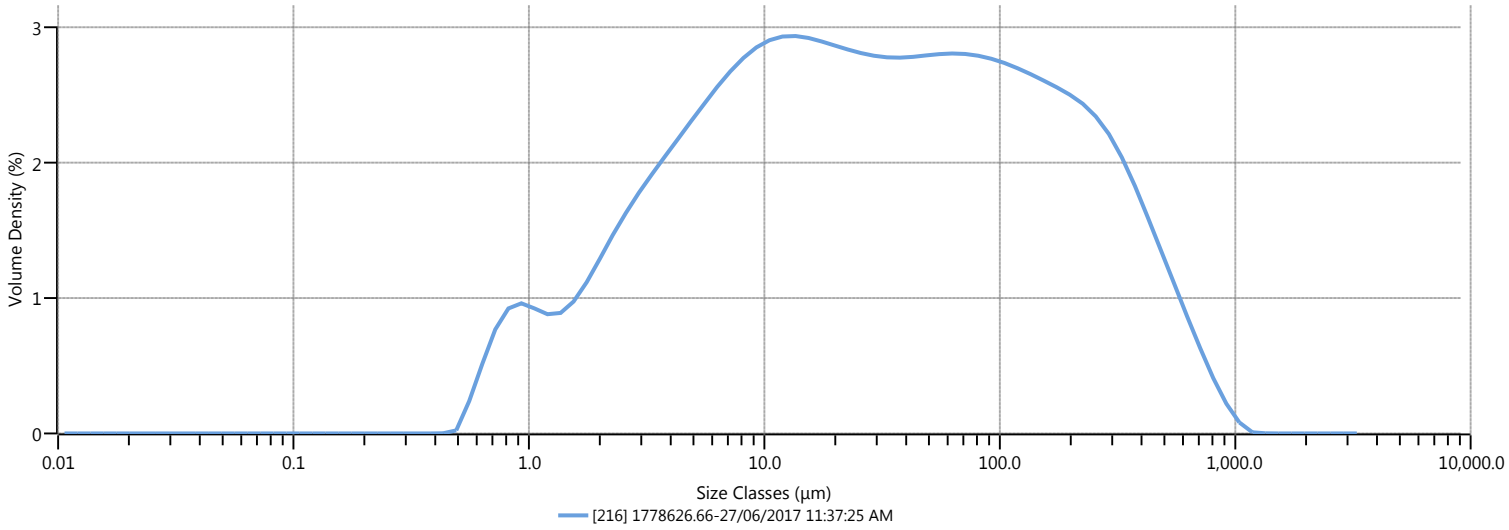
Measurement Details	
Operator Name	rodgers
Sample Name	1778626.66
SOP File Name	Sediment.msop
Lab Number	

Measurement Details	
Analysis Date Time	27/06/2017 11:37:25 AM
Measurement Date Time	27/06/2017 11:37:25 AM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.53 %
Laser Obscuration	31.65 %

Result	
Concentration	0.0368 %
Span	9.698
Uniformity	2.921
Specific Surface Area	835.9 m^2/kg
D [3,2]	7.18 µm
D [4,3]	92.4 µm
Dv (10)	2.63 µm
Dv (50)	28.4 µm
Dv (90)	278 µm

Frequency (compatible)



Result

Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over
0.0500	100.00	7.80	74.22	88.0	29.36	350	6.79	1410	0.00
0.0600	100.00	15.6	61.14	105	26.18	420	4.68	1680	0.00
0.120	100.00	31.0	48.38	125	23.10	500	3.02	2000	0.00
0.240	100.00	37.0	45.17	149	20.06	590	1.79	2380	0.00
0.490	100.00	44.0	42.03	177	17.15	710	0.84	2830	0.00
0.980	97.21	53.0	38.63	210	14.34	840	0.30	3360	0.00
2.00	92.63	63.0	35.47	250	11.59	1000	0.05		
3.90	85.18	74.0	32.52	300	8.88	1190	0.00		

Analysis - Over

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

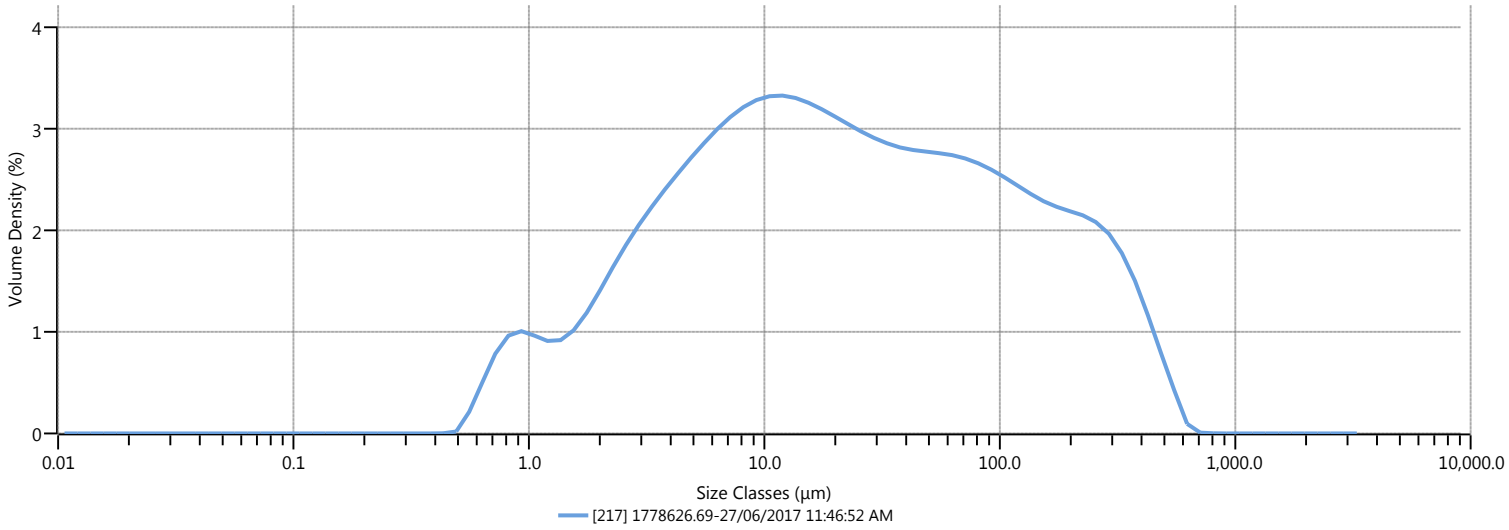
Measurement Details	
Operator Name	rodgers
Sample Name	1778626.69
SOP File Name	Sediment.msop
Lab Number	

Measurement Details	
Analysis Date Time	27/06/2017 11:46:52 AM
Measurement Date Time	27/06/2017 11:46:52 AM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.65 %
Laser Obscuration	18.35 %

Result	
Concentration	0.0181 %
Span	9.955
Uniformity	2.852
Specific Surface Area	902.3 m^2/kg
D [3,2]	6.65 µm
D [4,3]	67.3 µm
Dv (10)	2.50 µm
Dv (50)	20.9 µm
Dv (90)	210 µm

Frequency (compatible)



Result

Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over
0.0500	100.00	7.80	70.96	88.0	23.50	350	3.36	1410	0.00
0.0600	100.00	15.6	56.06	105	20.54	420	1.66	1680	0.00
0.120	100.00	31.0	42.31	125	17.73	500	0.57	2000	0.00
0.240	100.00	37.0	39.02	149	15.03	590	0.06	2380	0.00
0.490	100.00	44.0	35.85	177	12.49	710	0.00	2830	0.00
0.980	97.16	53.0	32.48	210	10.03	840	0.00	3360	0.00
2.00	92.36	63.0	29.37	250	7.60	1000	0.00		
3.90	83.81	74.0	26.51	300	5.19	1190	0.00		

Analysis - Over

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

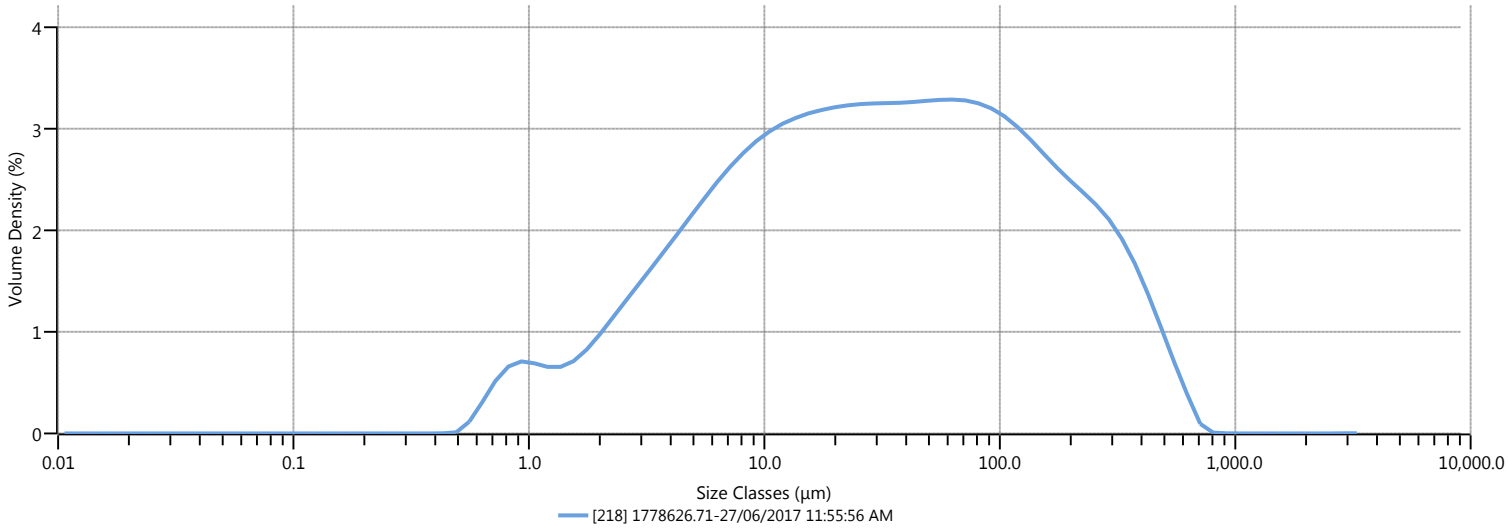
Measurement Details	
Operator Name	rodgers
Sample Name	1778626.71
SOP File Name	Sediment.msop
Lab Number	

Measurement Details	
Analysis Date Time	27/06/2017 11:55:56 AM
Measurement Date Time	27/06/2017 11:55:56 AM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.50 %
Laser Obscuration	19.89 %

Result	
Concentration	0.0258 %
Span	7.354
Uniformity	2.187
Specific Surface Area	685.2 m^2/kg
D [3,2]	8.76 µm
D [4,3]	80.0 µm
Dv (10)	3.45 µm
Dv (50)	31.4 µm
Dv (90)	234 µm

Frequency (compatible)



Result

Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over
0.0500	100.00	7.80	78.19	88.0	27.98	350	4.44	1410	0.00
0.0600	100.00	15.6	64.68	105	24.32	420	2.54	1680	0.00
0.120	100.00	31.0	50.25	125	20.84	500	1.18	2000	0.00
0.240	100.00	37.0	46.49	149	17.54	590	0.37	2380	0.00
0.490	100.00	44.0	42.80	177	14.51	710	0.03	2830	0.00
0.980	98.12	53.0	38.82	210	11.69	840	0.00	3360	0.00
2.00	94.72	63.0	35.11	250	9.01	1000	0.00		
3.90	88.58	74.0	31.66	300	6.41	1190	0.00		

Analysis - Over

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

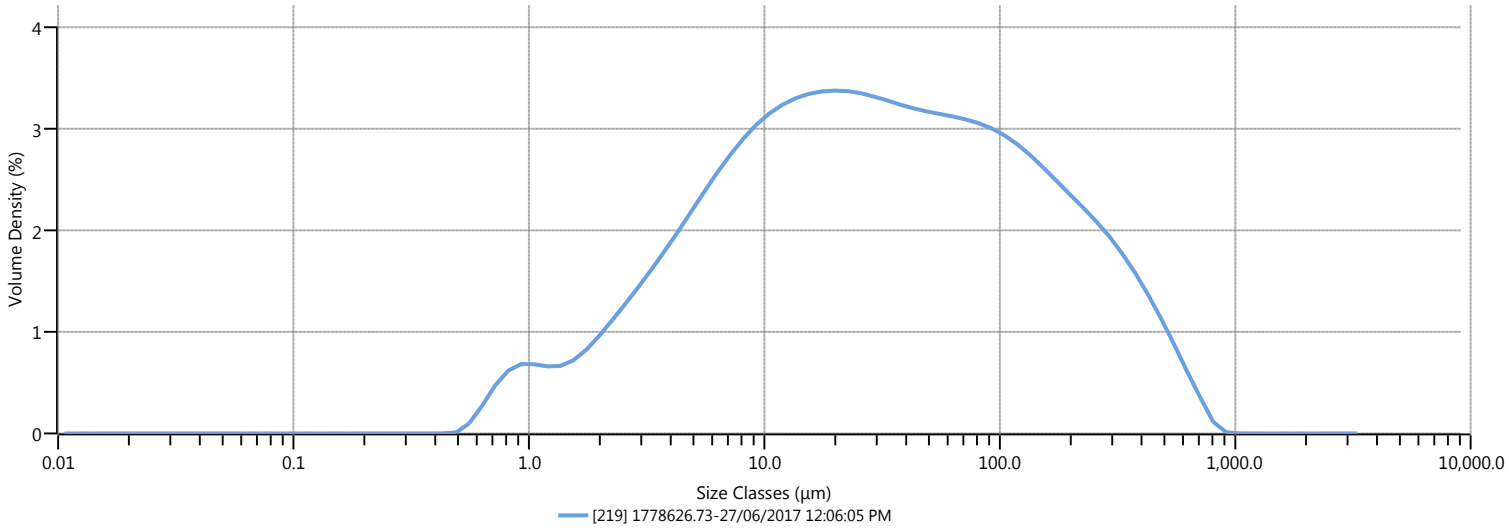
Measurement Details	
Operator Name	rodgers
Sample Name	1778626.73
SOP File Name	Sediment.msop
Lab Number	

Measurement Details	
Analysis Date Time	27/06/2017 12:06:05 PM
Measurement Date Time	27/06/2017 12:06:05 PM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.46 %
Laser Obscuration	20.90 %

Result	
Concentration	0.0273 %
Span	8.009
Uniformity	2.409
Specific Surface Area	680.9 m^2/kg
D [3,2]	8.81 µm
D [4,3]	81.4 µm
Dv (10)	3.51 µm
Dv (50)	29.2 µm
Dv (90)	238 µm

Frequency (compatible)



Result

Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over
0.0500	100.00	7.80	78.09	88.0	27.19	350	5.08	1410	0.00
0.0600	100.00	15.6	63.79	105	23.76	420	3.26	1680	0.00
0.120	100.00	31.0	48.74	125	20.48	500	1.85	2000	0.00
0.240	100.00	37.0	44.96	149	17.36	590	0.86	2380	0.00
0.490	100.00	44.0	41.32	177	14.48	710	0.23	2830	0.00
0.980	98.25	53.0	37.46	210	11.81	840	0.02	3360	0.00
2.00	94.84	63.0	33.92	250	9.31	1000	0.00		
3.90	88.78	74.0	30.65	300	6.90	1190	0.00		

Analysis - Over

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

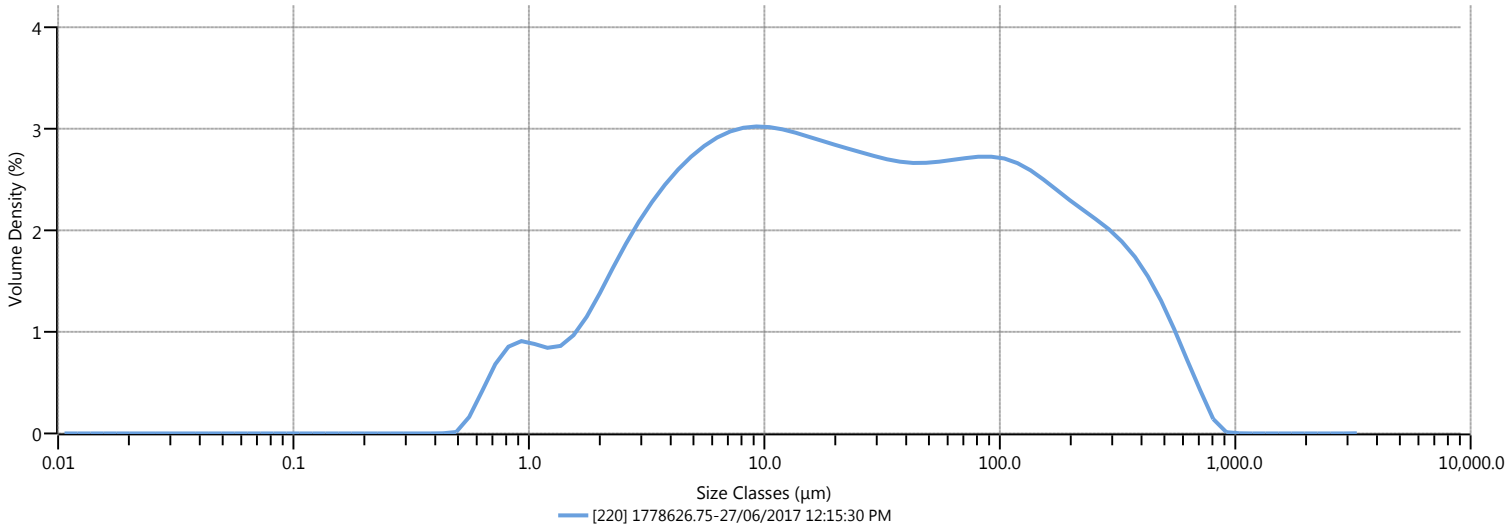
Measurement Details	
Operator Name	rodgers
Sample Name	1778626.75
SOP File Name	Sediment.msop
Lab Number	

Measurement Details	
Analysis Date Time	27/06/2017 12:15:30 PM
Measurement Date Time	27/06/2017 12:15:30 PM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.61 %
Laser Obscuration	18.42 %

Result	
Concentration	0.0191 %
Span	10.396
Uniformity	3.068
Specific Surface Area	849.7 m^2/kg
D [3,2]	7.06 µm
D [4,3]	82.4 µm
Dv (10)	2.64 µm
Dv (50)	24.1 µm
Dv (90)	254 µm

Frequency (compatible)



Result

Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over
0.0500	100.00	7.80	71.68	88.0	27.18	350	5.82	1410	0.00
0.0600	100.00	15.6	58.13	105	24.05	420	3.80	1680	0.00
0.120	100.00	31.0	45.51	125	21.00	500	2.19	2000	0.00
0.240	100.00	37.0	42.40	149	18.04	590	1.03	2380	0.00
0.490	100.00	44.0	39.38	177	15.28	710	0.28	2830	0.00
0.980	97.53	53.0	36.14	210	12.68	840	0.02	3360	0.00
2.00	92.98	63.0	33.11	250	10.20	1000	0.00		
3.90	84.35	74.0	30.27	300	7.75	1190	0.00		

Analysis - Over

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

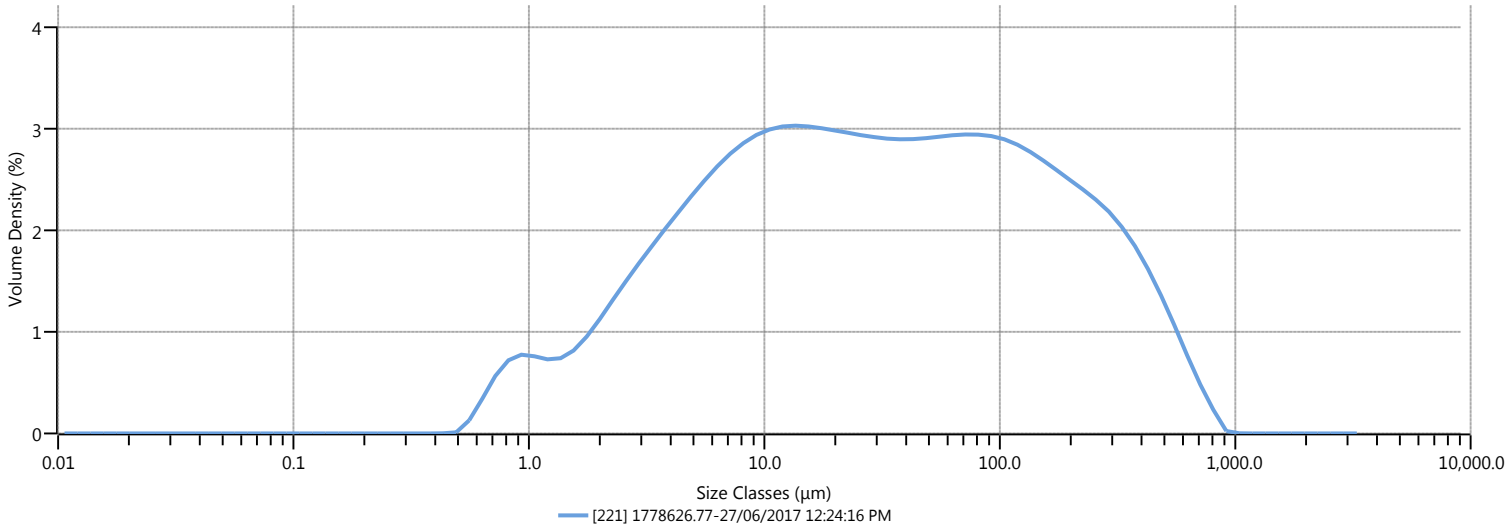
Measurement Details	
Operator Name	rodgers
Sample Name	1778626.77
SOP File Name	Sediment.msop
Lab Number	

Measurement Details	
Analysis Date Time	27/06/2017 12:24:16 PM
Measurement Date Time	27/06/2017 12:24:16 PM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.51 %
Laser Obscuration	20.94 %

Result	
Concentration	0.0253 %
Span	8.887
Uniformity	2.642
Specific Surface Area	739.5 m^2/kg
D [3,2]	8.11 µm
D [4,3]	88.7 µm
Dv (10)	3.09 µm
Dv (50)	29.7 µm
Dv (90)	267 µm

Frequency (compatible)



Result

Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over
0.0500	100.00	7.80	75.95	88.0	29.27	350	6.22	1410	0.00
0.0600	100.00	15.6	62.46	105	25.90	420	4.09	1680	0.00
0.120	100.00	31.0	49.15	125	22.64	500	2.40	2000	0.00
0.240	100.00	37.0	45.80	149	19.47	590	1.20	2380	0.00
0.490	100.00	44.0	42.52	177	16.50	710	0.40	2830	0.00
0.980	97.93	53.0	38.99	210	13.68	840	0.04	3360	0.00
2.00	94.09	63.0	35.69	250	10.97	1000	0.00		
3.90	87.11	74.0	32.59	300	8.30	1190	0.00		

Analysis - Over

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

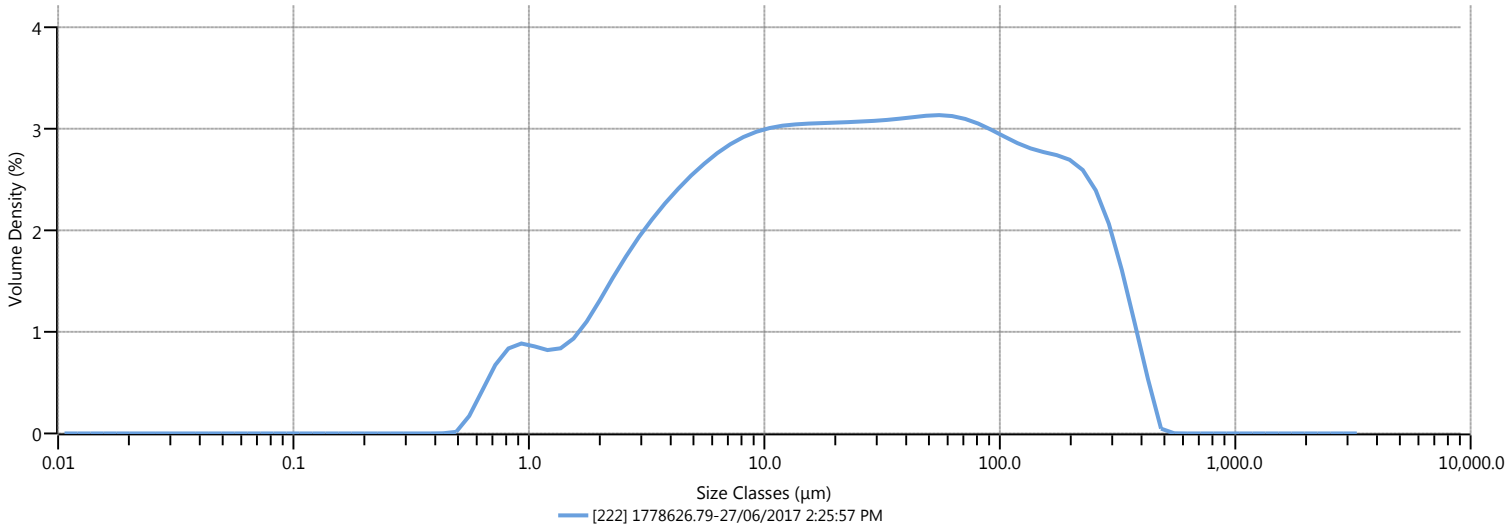
Measurement Details	
Operator Name	rodgers
Sample Name	1778626.79
SOP File Name	Sediment.msop
Lab Number	

Measurement Details	
Analysis Date Time	27/06/2017 2:25:57 PM
Measurement Date Time	27/06/2017 2:25:57 PM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.73 %
Laser Obscuration	23.68 %

Result	
Concentration	0.0261 %
Span	7.613
Uniformity	2.197
Specific Surface Area	827.4 m^2/kg
D [3,2]	7.25 µm
D [4,3]	64.4 µm
Dv (10)	2.73 µm
Dv (50)	25.2 µm
Dv (90)	195 µm

Frequency (compatible)



Result

Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over
0.0500	100.00	7.80	73.21	88.0	24.73	350	1.40	1410	0.00
0.0600	100.00	15.6	59.62	105	21.31	420	0.27	1680	0.00
0.120	100.00	31.0	45.87	125	18.03	500	0.00	2000	0.00
0.240	100.00	37.0	42.30	149	14.81	590	0.00	2380	0.00
0.490	100.00	44.0	38.79	177	11.71	710	0.00	2830	0.00
0.980	97.56	53.0	34.98	210	8.68	840	0.00	3360	0.00
2.00	93.17	63.0	31.45	250	5.77	1000	0.00		
3.90	85.13	74.0	28.18	300	3.12	1190	0.00		

Analysis - Over

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Te Whare Wānanga o Waikato

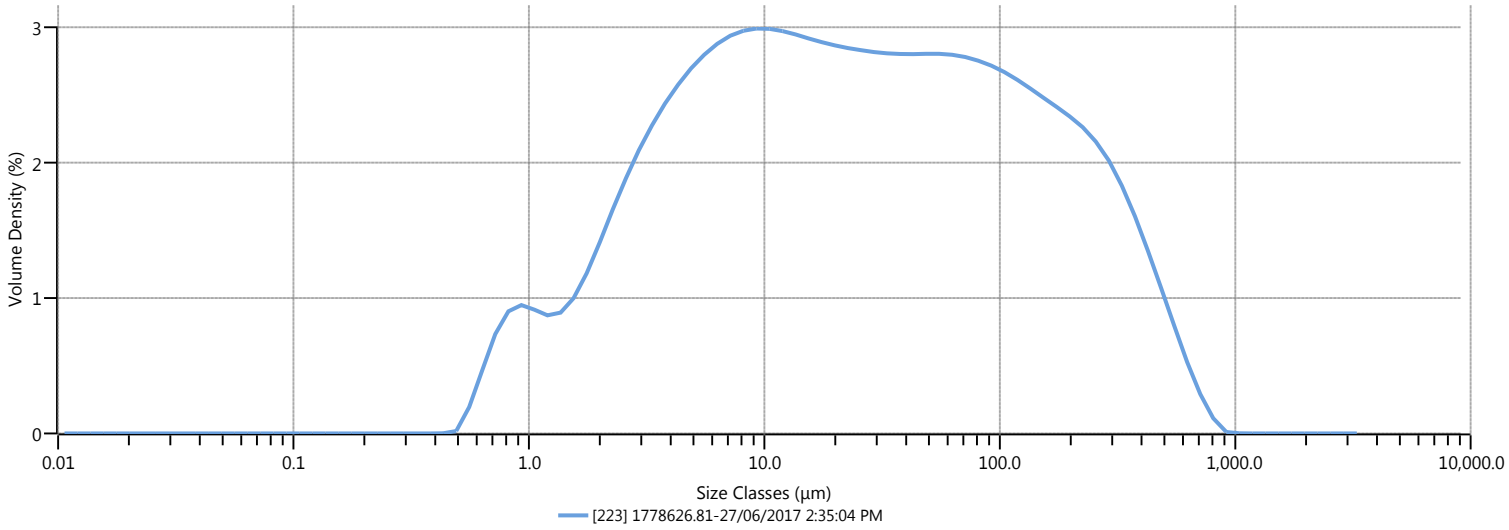
Measurement Details	
Operator Name	rodgers
Sample Name	1778626.81
SOP File Name	Sediment.msop
Lab Number	

Measurement Details	
Analysis Date Time	27/06/2017 2:35:04 PM
Measurement Date Time	27/06/2017 2:35:04 PM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.59 %
Laser Obscuration	22.51 %

Result	
Concentration	0.0234 %
Span	9.791
Uniformity	2.903
Specific Surface Area	872.0 m^2/kg
D [3,2]	6.88 µm
D [4,3]	77.6 µm
Dv (10)	2.56 µm
Dv (50)	23.9 µm
Dv (90)	237 µm

Frequency (compatible)



Result

Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over
0.0500	100.00	7.80	71.45	88.0	26.17	350	4.85	1410	0.00
0.0600	100.00	15.6	58.01	105	23.06	420	3.01	1680	0.00
0.120	100.00	31.0	45.20	125	20.06	500	1.65	2000	0.00
0.240	100.00	37.0	41.96	149	17.15	590	0.74	2380	0.00
0.490	100.00	44.0	38.79	177	14.40	710	0.21	2830	0.00
0.980	97.34	53.0	35.38	210	11.76	840	0.02	3360	0.00
2.00	92.65	63.0	32.22	250	9.21	1000	0.00		
3.90	83.98	74.0	29.29	300	6.73	1190	0.00		

Analysis - Over

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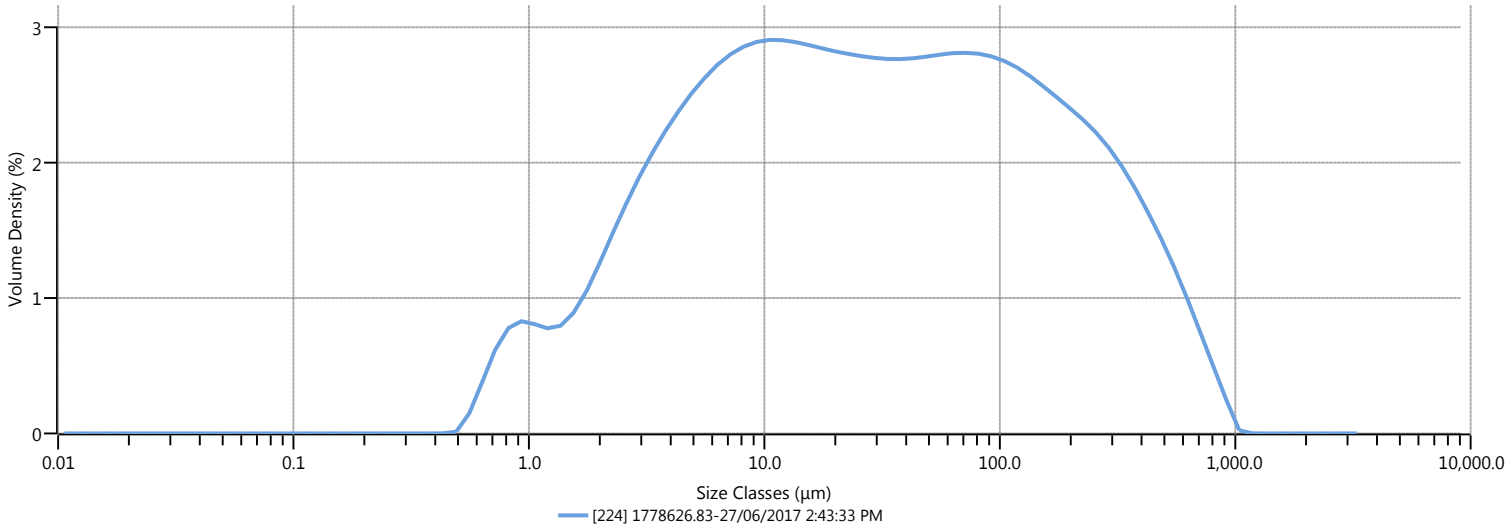
Measurement Details	
Operator Name	rodgers
Sample Name	1778626.83
SOP File Name	Sediment.msop
Lab Number	

Measurement Details	
Analysis Date Time	27/06/2017 2:43:33 PM
Measurement Date Time	27/06/2017 2:43:33 PM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.53 %
Laser Obscuration	22.90 %

Result	
Concentration	0.0263 %
Span	9.966
Uniformity	2.984
Specific Surface Area	787.6 m^2/kg
D [3,2]	7.62 µm
D [4,3]	93.8 µm
Dv (10)	2.84 µm
Dv (50)	28.2 µm
Dv (90)	284 µm

Frequency (compatible)



Result

Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over	Size (µm)	% Volume Over
0.0500	100.00	7.80	73.99	88.0	29.31	350	7.24	1410	0.00
0.0600	100.00	15.6	60.91	105	26.11	420	5.13	1680	0.00
0.120	100.00	31.0	48.30	125	23.01	500	3.39	2000	0.00
0.240	100.00	37.0	45.11	149	20.00	590	2.03	2380	0.00
0.490	100.00	44.0	41.98	177	17.16	710	0.93	2830	0.00
0.980	97.75	53.0	38.60	210	14.45	840	0.28	3360	0.00
2.00	93.58	63.0	35.43	250	11.83	1000	0.00		
3.90	85.74	74.0	32.48	300	9.25	1190	0.00		

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QUALITY ASSURANCE REPORT

Client:	Tasman District Council ENVIRONMENTAL	**Lab No:**	1778626	QCPv1
Contact:	Anna MacKenzie	**Date Received:**	19-May-2017	
	C/- Tasman District Council ENVIRONMENTAL	**Date Reported:**	24-Jul-2017	
	Private Bag 4	**Quote No:**	83731	
	Richmond 7050	**Order No:**	337657	
		Client Reference:		
		Submitted By:	P Sheldon	

Blank QCs

Digest Blank 1 PrepWS esDig - High Volume Environmental Soils by ICP-MS: 1607.18

		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Arsenic	mg/kg dry wt	< 2	-2.0 – 2.0	No
Total Recoverable Cadmium	mg/kg dry wt	< 0.10	-0.10 – 0.10	No
Total Recoverable Chromium	mg/kg dry wt	< 2	-2.0 – 2.0	No
Total Recoverable Copper	mg/kg dry wt	< 2	-2.0 – 2.0	No
Total Recoverable Lead	mg/kg dry wt	< 0.4	-0.40 – 0.40	No
Total Recoverable Mercury	mg/kg dry wt	< 0.10	-0.10 – 0.10	No
Total Recoverable Nickel	mg/kg dry wt	< 2	-2.0 – 2.0	No
Total Recoverable Zinc	mg/kg dry wt	< 4	-4.0 – 4.0	No

Digest Blank 2 PrepWS esDig - High Volume Environmental Soils by ICP-MS: 1607.45

		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Arsenic	mg/kg dry wt	< 2	-2.0 – 2.0	No
Total Recoverable Cadmium	mg/kg dry wt	< 0.10	-0.10 – 0.10	No
Total Recoverable Chromium	mg/kg dry wt	< 2	-2.0 – 2.0	No
Total Recoverable Copper	mg/kg dry wt	< 2	-2.0 – 2.0	No
Total Recoverable Lead	mg/kg dry wt	< 0.4	-0.40 – 0.40	No
Total Recoverable Mercury	mg/kg dry wt	< 0.10	-0.10 – 0.10	No
Total Recoverable Nickel	mg/kg dry wt	< 2	-2.0 – 2.0	No
Total Recoverable Zinc	mg/kg dry wt	< 4	-4.0 – 4.0	No

Digest Blank 1 PrepWS esDig - High Volume Environmental Soils by ICP-MS: 1609.11

		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Arsenic	mg/kg dry wt	< 2	-2.0 – 2.0	No
Total Recoverable Cadmium	mg/kg dry wt	< 0.10	-0.10 – 0.10	No
Total Recoverable Chromium	mg/kg dry wt	< 2	-2.0 – 2.0	No
Total Recoverable Copper	mg/kg dry wt	< 2	-2.0 – 2.0	No
Total Recoverable Lead	mg/kg dry wt	< 0.4	-0.40 – 0.40	No
Total Recoverable Mercury	mg/kg dry wt	0.11	-0.10 – 0.10	**Yes** [#1]
Total Recoverable Nickel	mg/kg dry wt	< 2	-2.0 – 2.0	No
Total Recoverable Zinc	mg/kg dry wt	< 4	-4.0 – 4.0	No

Digest Blank 2 PrepWS esDig - High Volume Environmental Soils by ICP-MS: 1609.37

		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Arsenic	mg/kg dry wt	< 2	-2.0 – 2.0	No
Total Recoverable Cadmium	mg/kg dry wt	< 0.10	-0.10 – 0.10	No
Total Recoverable Chromium	mg/kg dry wt	< 2	-2.0 – 2.0	No

Digest Blank 2 PrepWS esDig - High Volume Environmental Soils by ICP-MS: 1609.37				
		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Copper	mg/kg dry wt	< 2	-2.0 – 2.0	No
Total Recoverable Lead	mg/kg dry wt	< 0.4	-0.40 – 0.40	No
Total Recoverable Mercury	mg/kg dry wt	< 0.10	-0.10 – 0.10	No
Total Recoverable Nickel	mg/kg dry wt	< 2	-2.0 – 2.0	No
Total Recoverable Zinc	mg/kg dry wt	< 4	-4.0 – 4.0	No

50x Manual Dilution Digest Blank PrepWS esDig - High Volume Environmental Soils by ICP-MS: 1609.74				
		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Arsenic	mg/kg dry wt	< 2	-2.0 – 2.0	No
Total Recoverable Cadmium	mg/kg dry wt	< 0.10	-0.10 – 0.10	No
Total Recoverable Chromium	mg/kg dry wt	< 2	-2.0 – 2.0	No
Total Recoverable Copper	mg/kg dry wt	< 2	-2.0 – 2.0	No
Total Recoverable Lead	mg/kg dry wt	< 0.4	-0.40 – 0.40	No
Total Recoverable Mercury	mg/kg dry wt	< 0.10	-0.10 – 0.10	No
Total Recoverable Nickel	mg/kg dry wt	< 2	-2.0 – 2.0	No
Total Recoverable Zinc	mg/kg dry wt	< 4	-4.0 – 4.0	No

50x Manual Dilution Digest Blank PrepWS esDig - High Volume Environmental Soils by ICP-MS: 1613.50				
		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Zinc	mg/kg dry wt	< 4	-4.0 – 4.0	No

Digest Blank 1 PrepWS esDig - High Volume Environmental Soils by ICP-MS: 1614.11				
		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Arsenic	mg/kg dry wt	< 2	-2.0 – 2.0	No
Total Recoverable Cadmium	mg/kg dry wt	< 0.10	-0.10 – 0.10	No
Total Recoverable Nickel	mg/kg dry wt	< 2	-2.0 – 2.0	No

Digest Blank 2 PrepWS esDig - High Volume Environmental Soils by ICP-MS: 1614.17				
		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Arsenic	mg/kg dry wt	< 2	-2.0 – 2.0	No
Total Recoverable Cadmium	mg/kg dry wt	< 0.10	-0.10 – 0.10	No
Total Recoverable Nickel	mg/kg dry wt	< 2	-2.0 – 2.0	No

50x Manual Dilution Digest Blank PrepWS esDig - High Volume Environmental Soils by ICP-MS: 1614.56				
		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Arsenic	mg/kg dry wt	< 2	-2.0 – 2.0	No
Total Recoverable Cadmium	mg/kg dry wt	< 0.10	-0.10 – 0.10	No
Total Recoverable Nickel	mg/kg dry wt	< 2	-2.0 – 2.0	No

Blk - Nitrogen/Carbon by Combustion - ES: 3195.1				
		Results	Control Limits	Outside Limit (Yes/No)
Total Organic Carbon	g/100g dry wt	< 0.05	-0.050 – 0.050	No

Blk - Nitrogen/Carbon by Combustion - ES: 3196.1				
		Results	Control Limits	Outside Limit (Yes/No)
Total Organic Carbon	g/100g dry wt	< 0.05	-0.050 – 0.050	No

Digest Blank 1 PrepWS esDig - High Volume Environmental Soils by ICP-MS: 1668.11				
		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Arsenic	mg/kg dry wt	< 2	-2.0 – 2.0	No
Total Recoverable Chromium	mg/kg dry wt	< 2	-2.0 – 2.0	No
Total Recoverable Copper	mg/kg dry wt	< 2	-2.0 – 2.0	No
Total Recoverable Lead	mg/kg dry wt	< 0.4	-0.40 – 0.40	No

Digest Blank 1 PrepWS esDig - High Volume Environmental Soils by ICP-MS: 1668.11				
		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Nickel	mg/kg dry wt	< 2	-2.0 – 2.0	No

Digest Blank 2 PrepWS esDig - High Volume Environmental Soils by ICP-MS: 1668.25				
		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Arsenic	mg/kg dry wt	< 2	-2.0 – 2.0	No
Total Recoverable Chromium	mg/kg dry wt	< 2	-2.0 – 2.0	No
Total Recoverable Copper	mg/kg dry wt	< 2	-2.0 – 2.0	No
Total Recoverable Lead	mg/kg dry wt	< 0.4	-0.40 – 0.40	No
Total Recoverable Nickel	mg/kg dry wt	< 2	-2.0 – 2.0	No

Digest Blank 1 PrepWS esDig - Environmental Soils by ICP-MS: 9820.11				
		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Calcium	mg/kg dry wt	< 100	-100 – 100	No
Total Recoverable Iron	mg/kg dry wt	< 40	-40 – 40	No
Total Recoverable Manganese	mg/kg dry wt	< 1.0	-1.0 – 1.0	No
Total Recoverable Phosphorus	mg/kg dry wt	< 40	-40 – 40	No

Digest Blank 2 PrepWS esDig - Environmental Soils by ICP-MS: 9820.14				
		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Calcium	mg/kg dry wt	< 100	-100 – 100	No
Total Recoverable Iron	mg/kg dry wt	< 40	-40 – 40	No
Total Recoverable Manganese	mg/kg dry wt	< 1.0	-1.0 – 1.0	No
Total Recoverable Phosphorus	mg/kg dry wt	< 40	-40 – 40	No

Digest Blank 1 PrepWS esDig - High Volume Environmental Soils by ICP-MS: 1673.11				
		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Arsenic	mg/kg dry wt	< 2	-2.0 – 2.0	No
Total Recoverable Chromium	mg/kg dry wt	< 2	-2.0 – 2.0	No
Total Recoverable Copper	mg/kg dry wt	< 2	-2.0 – 2.0	No
Total Recoverable Lead	mg/kg dry wt	< 0.4	-0.40 – 0.40	No
Total Recoverable Nickel	mg/kg dry wt	< 2	-2.0 – 2.0	No

Digest Blank 2 PrepWS esDig - High Volume Environmental Soils by ICP-MS: 1673.39				
		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Arsenic	mg/kg dry wt	< 2	-2.0 – 2.0	No
Total Recoverable Chromium	mg/kg dry wt	< 2	-2.0 – 2.0	No
Total Recoverable Copper	mg/kg dry wt	< 2	-2.0 – 2.0	No
Total Recoverable Lead	mg/kg dry wt	< 0.4	-0.40 – 0.40	No
Total Recoverable Nickel	mg/kg dry wt	< 2	-2.0 – 2.0	No

Digest Blank 1 PrepWS esDig - Environmental Soils by ICP-MS: 9821.11				
		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Calcium	mg/kg dry wt	< 100	-100 – 100	No
Total Recoverable Iron	mg/kg dry wt	< 40	-40 – 40	No
Total Recoverable Manganese	mg/kg dry wt	< 1.0	-1.0 – 1.0	No
Total Recoverable Phosphorus	mg/kg dry wt	< 40	-40 – 40	No

Digest Blank 2 PrepWS esDig - Environmental Soils by ICP-MS: 9821.39				
		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Calcium	mg/kg dry wt	< 100	-100 – 100	No
Total Recoverable Iron	mg/kg dry wt	< 40	-40 – 40	No
Total Recoverable Manganese	mg/kg dry wt	< 1.0	-1.0 – 1.0	No

Digest Blank 2 PrepWS esDig - Environmental Soils by ICP-MS: 9821.39				
		Results	**Control Limits**	**Outside Limit (Yes/No)**
Total Recoverable Phosphorus	mg/kg dry wt	< 40	-40 – 40	No

50x Manual Dilution Digest Blank PrepWS esDig - High Volume Environmental Soils by ICP-MS: 1681.36				
		Results	**Control Limits**	**Outside Limit (Yes/No)**
Total Recoverable Nickel	mg/kg dry wt	< 2	-2.0 – 2.0	No

Blk - Nitrogen/Carbon by Combustion - ES: 3198.1				
		Results	**Control Limits**	**Outside Limit (Yes/No)**
Total Organic Carbon	g/100g dry wt	< 0.05	-0.050 – 0.050	No

Blk - Nitrogen/Carbon by Combustion - ES: 3199.1				
		Results	**Control Limits**	**Outside Limit (Yes/No)**
Total Organic Carbon	g/100g dry wt	< 0.05	-0.050 – 0.050	No

Blk - Nitrogen/Carbon by Combustion - ES: 3200.1				
		Results	**Control Limits**	**Outside Limit (Yes/No)**
Total Organic Carbon	g/100g dry wt	0.20	-0.050 – 0.050	**Yes** [#2]

Blk - Nitrogen/Carbon by Combustion - ES: 3201.1				
		Results	**Control Limits**	**Outside Limit (Yes/No)**
Total Organic Carbon	g/100g dry wt	< 0.05	-0.050 – 0.050	No

Extn Blank 1 PrepWS GastricExtn - Environmental Soils by ICP-MS: 9826.11				
		Results	**Control Limits**	**Outside Limit (Yes/No)**
Gastric Extractable Arsenic	mg/kg dry wt	< 1.0	-1.0 – 1.0	No
Gastric Extractable Lead	mg/kg dry wt	< 0.2	-0.20 – 0.20	No

Extn Blank 2 PrepWS GastricExtn - Environmental Soils by ICP-MS: 9826.12				
		Results	**Control Limits**	**Outside Limit (Yes/No)**
Gastric Extractable Arsenic	mg/kg dry wt	< 1.0	-1.0 – 1.0	No
Gastric Extractable Lead	mg/kg dry wt	< 0.2	-0.20 – 0.20	No

Extn Blank 1 PrepWS GastricExtn - Environmental Soils by ICP-MS: 9828.11				
		Results	**Control Limits**	**Outside Limit (Yes/No)**
Gastric Extractable Arsenic	mg/kg dry wt	< 1.0	-1.0 – 1.0	No
Gastric Extractable Lead	mg/kg dry wt	< 0.2	-0.20 – 0.20	No

Extn Blank 2 PrepWS GastricExtn - Environmental Soils by ICP-MS: 9828.12				
		Results	**Control Limits**	**Outside Limit (Yes/No)**
Gastric Extractable Arsenic	mg/kg dry wt	< 1.0	-1.0 – 1.0	No
Gastric Extractable Lead	mg/kg dry wt	< 0.2	-0.20 – 0.20	No

Extn Blank 1 PrepWS GastricExtn - Environmental Soils by ICP-MS: 9828.48				
		Results	**Control Limits**	**Outside Limit (Yes/No)**
Gastric Extractable Arsenic	mg/kg dry wt	< 1.0	-1.0 – 1.0	No
Gastric Extractable Lead	mg/kg dry wt	0.3	-0.20 – 0.20	**Yes** [#3]

Extn Blank 2 PrepWS GastricExtn - Environmental Soils by ICP-MS: 9828.49				
		Results	**Control Limits**	**Outside Limit (Yes/No)**
Gastric Extractable Arsenic	mg/kg dry wt	< 1.0	-1.0 – 1.0	No
Gastric Extractable Lead	mg/kg dry wt	0.4	-0.20 – 0.20	**Yes** [#3]

Extn Blank 1 PrepWS GastricExtn - Environmental Soils by ICP-MS: 9832.45				
		Results	**Control Limits**	**Outside Limit (Yes/No)**
Gastric Extractable Arsenic	mg/kg dry wt	< 1.0	-1.0 – 1.0	No
Gastric Extractable Lead	mg/kg dry wt	< 0.2	-0.20 – 0.20	No

Extn Blank 2 PrepWS GastricExtn - Environmental Soils by ICP-MS: 9832.46				
		Results	**Control Limits**	**Outside Limit (Yes/No)**
Gastric Extractable Arsenic	mg/kg dry wt	< 1.0	-1.0 – 1.0	No
Gastric Extractable Lead	mg/kg dry wt	< 0.2	-0.20 – 0.20	No

Blk - Nitrogen/Carbon by Combustion - ES: 3208.1				
		Results	**Control Limits**	**Outside Limit (Yes/No)**
Total Organic Carbon	g/100g dry wt	< 0.05	-0.050 – 0.050	No

Extn Blank 1 PrepWS GastricExtn - Environmental Soils by ICP-MS: 9834.11				
		Results	**Control Limits**	**Outside Limit (Yes/No)**
Gastric Extractable Lead	mg/kg dry wt	< 0.2	-0.20 – 0.20	No

Extn Blank 2 PrepWS GastricExtn - Environmental Soils by ICP-MS: 9834.12				
		Results	**Control Limits**	**Outside Limit (Yes/No)**
Gastric Extractable Lead	mg/kg dry wt	< 0.2	-0.20 – 0.20	No

Digest Blank 1 PrepWS esDig - High Volume Environmental Soils by ICP-MS: 1707.11				
		Results	**Control Limits**	**Outside Limit (Yes/No)**
Total Recoverable Lead	mg/kg dry wt	< 0.4	-0.40 – 0.40	No

Digest Blank 2 PrepWS esDig - High Volume Environmental Soils by ICP-MS: 1707.21				
		Results	**Control Limits**	**Outside Limit (Yes/No)**
Total Recoverable Lead	mg/kg dry wt	< 0.4	-0.40 – 0.40	No

Sample Spike QCs

Blank Spike PrepWS GastricExtn - Environmental Soils by ICP-MS: 9826.13				
		Results	**Control Limits**	**Outside Limit (Yes/No)**
Gastric Extractable Arsenic	%	107	80 – 120	No
Gastric Extractable Lead	%	99	80 – 120	No

Spike PrepWS GastricExtn - Environmental Soils by ICP-MS: 9826.36				
		Results	**Control Limits**	**Outside Limit (Yes/No)**
Gastric Extractable Arsenic	%	78	80 – 120	**Yes** [#4]
Gastric Extractable Lead	%	86	80 – 120	No

Blank Spike PrepWS GastricExtn - Environmental Soils by ICP-MS: 9828.13				
		Results	**Control Limits**	**Outside Limit (Yes/No)**
Gastric Extractable Arsenic	%	108	80 – 120	No
Gastric Extractable Lead	%	104	80 – 120	No

Spike PrepWS GastricExtn - Environmental Soils by ICP-MS: 9828.34				
		Results	**Control Limits**	**Outside Limit (Yes/No)**
Gastric Extractable Arsenic	%	92	80 – 120	No
Gastric Extractable Lead	%	87	80 – 120	No

Blank Spike PrepWS GastricExtn - Environmental Soils by ICP-MS: 9828.50				
		Results	**Control Limits**	**Outside Limit (Yes/No)**
Gastric Extractable Arsenic	%	103	80 – 120	No
Gastric Extractable Lead	%	103	80 – 120	No

Spike PrepWS GastricExtn - Environmental Soils by ICP-MS: 9828.69				
		Results	**Control Limits**	**Outside Limit (Yes/No)**
Gastric Extractable Arsenic	%	95	80 – 120	No
Gastric Extractable Lead	%	91	80 – 120	No

Blank Spike PrepWS GastricExtn - Environmental Soils by ICP-MS: 9832.47				
		Results	**Control Limits**	**Outside Limit (Yes/No)**
Gastric Extractable Arsenic	%	90	80 – 120	No
Gastric Extractable Lead	%	101	80 – 120	No

Spike PrepWS GastricExtn - Environmental Soils by ICP-MS: 9832.66				
		Results	Control Limits	Outside Limit (Yes/No)
Gastric Extractable Arsenic	%	91	80 – 120	No
Gastric Extractable Lead	%	105	80 – 120	No

Blank Spike PrepWS GastricExtn - Environmental Soils by ICP-MS: 9834.13				
		Results	Control Limits	Outside Limit (Yes/No)
Gastric Extractable Lead	%	98	80 – 120	No

Spike PrepWS GastricExtn - Environmental Soils by ICP-MS: 9834.22				
		Results	Control Limits	Outside Limit (Yes/No)
Gastric Extractable Lead	%	98	80 – 120	No

Reference Material QCs

Soil-58 (217988) - Soil Basic: 20631.3				
		Results	Control Limits	Outside Limit (Yes/No)
pH	pH Units	5.6	5.5 – 5.8	No

Soil-58 (217988) - Soil Basic: 20631.32				
		Results	Control Limits	Outside Limit (Yes/No)
pH	pH Units	5.6	5.5 – 5.8	No

Soil-61 (234067) - Soil Basic: 20631.41				
		Results	Control Limits	Outside Limit (Yes/No)
pH	pH Units	5.6	5.5 – 5.8	No

Soil-58 (217988) - Soil Basic: 20636.3				
		Results	Control Limits	Outside Limit (Yes/No)
pH	pH Units	5.6	5.5 – 5.8	No

QC A5 PrepWS esDig - High Volume Environmental Soils by ICP-MS: 1607.19				
		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Arsenic	mg/kg dry wt	110	82 – 150	No
Total Recoverable Cadmium	mg/kg dry wt	0.32	0.25 – 0.41	No
Total Recoverable Chromium	mg/kg dry wt	38	30 – 41	No
Total Recoverable Copper	mg/kg dry wt	133	110 – 160	No
Total Recoverable Lead	mg/kg dry wt	121	94 – 150	No
Total Recoverable Mercury	mg/kg dry wt	0.39	0.25 – 0.49	No
Total Recoverable Nickel	mg/kg dry wt	26	22 – 31	No
Total Recoverable Zinc	mg/kg dry wt	1010	800 – 1100	No

QC A5 PrepWS esDig - High Volume Environmental Soils by ICP-MS: 1607.64				
		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Arsenic	mg/kg dry wt	113	82 – 150	No
Total Recoverable Cadmium	mg/kg dry wt	0.38	0.25 – 0.41	No
Total Recoverable Chromium	mg/kg dry wt	35	30 – 41	No
Total Recoverable Copper	mg/kg dry wt	135	110 – 160	No
Total Recoverable Lead	mg/kg dry wt	124	94 – 150	No
Total Recoverable Mercury	mg/kg dry wt	0.40	0.25 – 0.49	No
Total Recoverable Nickel	mg/kg dry wt	24	22 – 31	No
Total Recoverable Zinc	mg/kg dry wt	960	800 – 1100	No

AGAL-10 QC PrepWS esDig - High Volume Environmental Soils by ICP-MS: 1607.65				
		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Arsenic	mg/kg dry wt	17.4	15 – 21	No
Total Recoverable Cadmium	mg/kg dry wt	9.3	8.5 – 11	No
Total Recoverable Chromium	mg/kg dry wt	48	37 – 54	No

AGAL-10 QC PrepWS esDig - High Volume Environmental Soils by ICP-MS: 1607.65				
		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Copper	mg/kg dry wt	24	21 – 28	No
Total Recoverable Lead	mg/kg dry wt	40	38 – 47	No
Total Recoverable Mercury	mg/kg dry wt	10.3	9.6 – 13	No
Total Recoverable Nickel	mg/kg dry wt	11.7	9.6 – 14	No
Total Recoverable Zinc	mg/kg dry wt	50	45 – 65	No

QC A5 PrepWS esDig - High Volume Environmental Soils by ICP-MS: 1609.12				
		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Arsenic	mg/kg dry wt	108	82 – 150	No
Total Recoverable Cadmium	mg/kg dry wt	0.38	0.25 – 0.41	No
Total Recoverable Chromium	mg/kg dry wt	36	30 – 41	No
Total Recoverable Copper	mg/kg dry wt	126	110 – 160	No
Total Recoverable Lead	mg/kg dry wt	127	94 – 150	No
Total Recoverable Mercury	mg/kg dry wt	0.45	0.25 – 0.49	No
Total Recoverable Nickel	mg/kg dry wt	26	22 – 31	No
Total Recoverable Zinc	mg/kg dry wt	940	800 – 1100	No

QC A5 PrepWS esDig - High Volume Environmental Soils by ICP-MS: 1609.51				
		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Arsenic	mg/kg dry wt	123	82 – 150	No
Total Recoverable Cadmium	mg/kg dry wt	0.41	0.25 – 0.41	No
Total Recoverable Chromium	mg/kg dry wt	37	30 – 41	No
Total Recoverable Copper	mg/kg dry wt	126	110 – 160	No
Total Recoverable Lead	mg/kg dry wt	126	94 – 150	No
Total Recoverable Mercury	mg/kg dry wt	0.40	0.25 – 0.49	No
Total Recoverable Nickel	mg/kg dry wt	28	22 – 31	No
Total Recoverable Zinc	mg/kg dry wt	910	800 – 1100	No

AGAL-10 QC PrepWS esDig - High Volume Environmental Soils by ICP-MS: 1609.52				
		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Arsenic	mg/kg dry wt	20	15 – 21	No
Total Recoverable Cadmium	mg/kg dry wt	9.8	8.5 – 11	No
Total Recoverable Chromium	mg/kg dry wt	51	37 – 54	No
Total Recoverable Copper	mg/kg dry wt	23	21 – 28	No
Total Recoverable Lead	mg/kg dry wt	46	38 – 47	No
Total Recoverable Mercury	mg/kg dry wt	11.6	9.6 – 13	No
Total Recoverable Nickel	mg/kg dry wt	13	9.6 – 14	No
Total Recoverable Zinc	mg/kg dry wt	54	45 – 65	No

QC A5 PrepWS esDig - High Volume Environmental Soils by ICP-MS: 1609.75				
		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Arsenic	mg/kg dry wt	100	82 – 150	No
Total Recoverable Cadmium	mg/kg dry wt	0.37	0.25 – 0.41	No
Total Recoverable Chromium	mg/kg dry wt	34	30 – 41	No
Total Recoverable Copper	mg/kg dry wt	120	110 – 160	No
Total Recoverable Lead	mg/kg dry wt	120	94 – 150	No
Total Recoverable Mercury	mg/kg dry wt	0.40	0.25 – 0.49	No
Total Recoverable Nickel	mg/kg dry wt	25	22 – 31	No
Total Recoverable Zinc	mg/kg dry wt	870	800 – 1100	No

Soil-58 (217988) - Soil Basic: 20646.3				
		Results	Control Limits	Outside Limit (Yes/No)
pH	pH Units	5.6	5.5 – 5.8	No

QC A5 PrepWS esDig - High Volume Environmental Soils by ICP-MS: 1613.51				
		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Zinc	mg/kg dry wt	930	800 – 1100	No

QC A5 PrepWS esDig - High Volume Environmental Soils by ICP-MS: 1614.12				
		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Arsenic	mg/kg dry wt	109	82 – 150	No
Total Recoverable Cadmium	mg/kg dry wt	0.30	0.25 – 0.41	No
Total Recoverable Nickel	mg/kg dry wt	26	22 – 31	No

QC A5 PrepWS esDig - High Volume Environmental Soils by ICP-MS: 1614.46				
		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Arsenic	mg/kg dry wt	103	82 – 150	No
Total Recoverable Cadmium	mg/kg dry wt	0.36	0.25 – 0.41	No
Total Recoverable Nickel	mg/kg dry wt	29	22 – 31	No

AGAL-10 QC PrepWS esDig - High Volume Environmental Soils by ICP-MS: 1614.47				
		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Arsenic	mg/kg dry wt	18	15 – 21	No
Total Recoverable Cadmium	mg/kg dry wt	9.8	8.5 – 11	No
Total Recoverable Nickel	mg/kg dry wt	13	9.6 – 14	No

QC A5 PrepWS esDig - High Volume Environmental Soils by ICP-MS: 1614.57				
		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Arsenic	mg/kg dry wt	108	82 – 150	No
Total Recoverable Cadmium	mg/kg dry wt	0.35	0.25 – 0.41	No
Total Recoverable Nickel	mg/kg dry wt	26	22 – 31	No

QC Soil A5 (Acid Treated) - Nitrogen/Carbon by Combustion - ES: 3195.2				
		Results	Control Limits	Outside Limit (Yes/No)
Total Organic Carbon	g/100g dry wt	2.8	2.8 – 2.9	No

QC Soil A5 (Acid Treated) - Nitrogen/Carbon by Combustion - ES: 3196.2				
		Results	Control Limits	Outside Limit (Yes/No)
Total Organic Carbon	g/100g dry wt	2.9	2.8 – 2.9	No

QC A5 PrepWS esDig - High Volume Environmental Soils by ICP-MS: 1668.12				
		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Arsenic	mg/kg dry wt	109	82 – 150	No
Total Recoverable Chromium	mg/kg dry wt	35	30 – 41	No
Total Recoverable Copper	mg/kg dry wt	131	110 – 160	No
Total Recoverable Lead	mg/kg dry wt	121	94 – 150	No
Total Recoverable Nickel	mg/kg dry wt	24	22 – 31	No

QC A5 PrepWS esDig - High Volume Environmental Soils by ICP-MS: 1668.54				
		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Arsenic	mg/kg dry wt	124	82 – 150	No
Total Recoverable Chromium	mg/kg dry wt	36	30 – 41	No
Total Recoverable Copper	mg/kg dry wt	129	110 – 160	No
Total Recoverable Lead	mg/kg dry wt	117	94 – 150	No
Total Recoverable Nickel	mg/kg dry wt	25	22 – 31	No

AGAL-10 QC PrepWS esDig - High Volume Environmental Soils by ICP-MS: 1668.55				
		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Arsenic	mg/kg dry wt	18	15 – 21	No
Total Recoverable Chromium	mg/kg dry wt	45	37 – 54	No
Total Recoverable Copper	mg/kg dry wt	24	21 – 28	No
Total Recoverable Lead	mg/kg dry wt	44	38 – 47	No
Total Recoverable Nickel	mg/kg dry wt	13	9.6 – 14	No

QC A5 PrepWS esDig - Environmental Soils by ICP-MS: 9820.12				
		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Calcium	mg/kg dry wt	10700	10000 – 13000	No
Total Recoverable Iron	mg/kg dry wt	25000	24000 – 34000	No
Total Recoverable Manganese	mg/kg dry wt	500	470 – 650	No
Total Recoverable Phosphorus	mg/kg dry wt	1020	820 – 1300	No

QC A5 PrepWS esDig - Environmental Soils by ICP-MS: 9820.19				
		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Calcium	mg/kg dry wt	10800	10000 – 13000	No
Total Recoverable Iron	mg/kg dry wt	25000	24000 – 34000	No
Total Recoverable Manganese	mg/kg dry wt	490	470 – 650	No
Total Recoverable Phosphorus	mg/kg dry wt	980	820 – 1300	No

AGAL-10 QC PrepWS esDig - Environmental Soils by ICP-MS: 9820.20				
		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Calcium	mg/kg dry wt	2200	1900 – 2400	No
Total Recoverable Iron	mg/kg dry wt	17800	15000 – 22000	No
Total Recoverable Manganese	mg/kg dry wt	250	220 – 280	No
Total Recoverable Phosphorus	mg/kg dry wt	340	280 – 400	No

QC A5 PrepWS esDig - High Volume Environmental Soils by ICP-MS: 1673.12				
		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Arsenic	mg/kg dry wt	127	82 – 150	No
Total Recoverable Chromium	mg/kg dry wt	35	30 – 41	No
Total Recoverable Copper	mg/kg dry wt	124	110 – 160	No
Total Recoverable Lead	mg/kg dry wt	133	94 – 150	No
Total Recoverable Nickel	mg/kg dry wt	25	22 – 31	No

QC A5 PrepWS esDig - High Volume Environmental Soils by ICP-MS: 1673.63				
		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Arsenic	mg/kg dry wt	112	82 – 150	No
Total Recoverable Chromium	mg/kg dry wt	36	30 – 41	No
Total Recoverable Copper	mg/kg dry wt	128	110 – 160	No
Total Recoverable Lead	mg/kg dry wt	119	94 – 150	No
Total Recoverable Nickel	mg/kg dry wt	26	22 – 31	No

AGAL-10 QC PrepWS esDig - High Volume Environmental Soils by ICP-MS: 1673.64				
		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Arsenic	mg/kg dry wt	17.8	15 – 21	No
Total Recoverable Chromium	mg/kg dry wt	41	37 – 54	No
Total Recoverable Copper	mg/kg dry wt	25	21 – 28	No
Total Recoverable Lead	mg/kg dry wt	43	38 – 47	No
Total Recoverable Nickel	mg/kg dry wt	12.0	9.6 – 14	No

QC A5 PrepWS esDig - Environmental Soils by ICP-MS: 9821.12				
		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Calcium	mg/kg dry wt	10800	10000 – 13000	No
Total Recoverable Iron	mg/kg dry wt	26000	24000 – 34000	No
Total Recoverable Manganese	mg/kg dry wt	490	470 – 650	No
Total Recoverable Phosphorus	mg/kg dry wt	980	820 – 1300	No

QC A5 PrepWS esDig - Environmental Soils by ICP-MS: 9821.63				
		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Calcium	mg/kg dry wt	10600	10000 – 13000	No
Total Recoverable Iron	mg/kg dry wt	28000	24000 – 34000	No
Total Recoverable Manganese	mg/kg dry wt	480	470 – 650	No
Total Recoverable Phosphorus	mg/kg dry wt	990	820 – 1300	No

AGAL-10 QC PrepWS esDig - Environmental Soils by ICP-MS: 9821.64				
		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Calcium	mg/kg dry wt	2100	1900 – 2400	No
Total Recoverable Iron	mg/kg dry wt	18700	15000 – 22000	No
Total Recoverable Manganese	mg/kg dry wt	230	220 – 280	No
Total Recoverable Phosphorus	mg/kg dry wt	320	280 – 400	No

QC A5 PrepWS esDig - High Volume Environmental Soils by ICP-MS: 1681.37				
		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Nickel	mg/kg dry wt	26	22 – 31	No

QC Soil A5 (Acid Treated) - Nitrogen/Carbon by Combustion - ES: 3198.2				
		Results	Control Limits	Outside Limit (Yes/No)
Total Organic Carbon	g/100g dry wt	2.9	2.8 – 2.9	No

QC Soil A5 (Acid Treated) - Nitrogen/Carbon by Combustion - ES: 3199.2				
		Results	Control Limits	Outside Limit (Yes/No)
Total Organic Carbon	g/100g dry wt	2.8	2.8 – 2.9	No

QC Soil A5 (Acid Treated) - Nitrogen/Carbon by Combustion - ES: 3200.2				
		Results	Control Limits	Outside Limit (Yes/No)
Total Organic Carbon	g/100g dry wt	2.8	2.8 – 2.9	No

QC Soil A5 (Acid Treated) - Nitrogen/Carbon by Combustion - ES: 3201.2				
		Results	Control Limits	Outside Limit (Yes/No)
Total Organic Carbon	g/100g dry wt	2.9	2.8 – 2.9	No

QC A3 dup 1 PrepWS GastricExtn - Environmental Soils by ICP-MS: 9826.16				
		Results	Control Limits	Outside Limit (Yes/No)
Gastric Extractable Arsenic	mg/kg dry wt	9.6	7.6 – 16	No
Gastric Extractable Lead	mg/kg dry wt	57	58 – 73	**Yes** [#5]

QC A5 PrepWS GastricExtn - Environmental Soils by ICP-MS: 9826.39				
		Results	Control Limits	Outside Limit (Yes/No)
Gastric Extractable Arsenic	mg/kg dry wt	5.8	Undefined	N/A [#6]
Gastric Extractable Lead	mg/kg dry wt	81	Undefined	N/A [#6]

QC A3 dup 2 PrepWS GastricExtn - Environmental Soils by ICP-MS: 9826.43				
		Results	Control Limits	Outside Limit (Yes/No)
Gastric Extractable Arsenic	mg/kg dry wt	9.5	7.6 – 16	No
Gastric Extractable Lead	mg/kg dry wt	61	58 – 73	No

2711a Montana II Soil PrepWS GastricExtn - Environmental Soils by ICP-MS: 9826.45				
		Results	**Control Limits**	**Outside Limit (Yes/No)**
Gastric Extractable Arsenic	mg/kg dry wt	57	49 – 61	No
Gastric Extractable Lead	mg/kg dry wt	1070	1000 – 1300	No

QC A3 dup 1 PrepWS GastricExtn - Environmental Soils by ICP-MS: 9828.16				
		Results	**Control Limits**	**Outside Limit (Yes/No)**
Gastric Extractable Arsenic	mg/kg dry wt	11.9	7.6 – 16	No
Gastric Extractable Lead	mg/kg dry wt	63	58 – 73	No

QC A5 PrepWS GastricExtn - Environmental Soils by ICP-MS: 9828.37				
		Results	**Control Limits**	**Outside Limit (Yes/No)**
Gastric Extractable Arsenic	mg/kg dry wt	6.2	Undefined	N/A [#6]
Gastric Extractable Lead	mg/kg dry wt	80	Undefined	N/A [#6]

QC A3 dup 2 PrepWS GastricExtn - Environmental Soils by ICP-MS: 9828.41				
		Results	**Control Limits**	**Outside Limit (Yes/No)**
Gastric Extractable Arsenic	mg/kg dry wt	24	7.6 – 16	**Yes** [#7]
Gastric Extractable Lead	mg/kg dry wt	31	58 – 73	**Yes** [#5]

2711a Montana II Soil PrepWS GastricExtn - Environmental Soils by ICP-MS: 9828.42				
		Results	**Control Limits**	**Outside Limit (Yes/No)**
Gastric Extractable Arsenic	mg/kg dry wt	57	49 – 61	No
Gastric Extractable Lead	mg/kg dry wt	1100	1000 – 1300	No

QC A3 dup 1 PrepWS GastricExtn - Environmental Soils by ICP-MS: 9828.53				
		Results	**Control Limits**	**Outside Limit (Yes/No)**
Gastric Extractable Arsenic	mg/kg dry wt	9.7	7.6 – 16	No
Gastric Extractable Lead	mg/kg dry wt	66	58 – 73	No

QC A5 PrepWS GastricExtn - Environmental Soils by ICP-MS: 9828.72				
		Results	**Control Limits**	**Outside Limit (Yes/No)**
Gastric Extractable Arsenic	mg/kg dry wt	6.4	Undefined	N/A [#6]
Gastric Extractable Lead	mg/kg dry wt	86	Undefined	N/A [#6]

QC A5 PrepWS GastricExtn - Environmental Soils by ICP-MS: 9828.73				
		Results	**Control Limits**	**Outside Limit (Yes/No)**
Gastric Extractable Arsenic	mg/kg dry wt	5.8	Undefined	N/A [#6]
Gastric Extractable Lead	mg/kg dry wt	87	Undefined	N/A [#6]

QC A3 dup 2 PrepWS GastricExtn - Environmental Soils by ICP-MS: 9828.77				
		Results	**Control Limits**	**Outside Limit (Yes/No)**
Gastric Extractable Arsenic	mg/kg dry wt	10.1	7.6 – 16	No
Gastric Extractable Lead	mg/kg dry wt	69	58 – 73	No

2711a Montana II Soil PrepWS GastricExtn - Environmental Soils by ICP-MS: 9828.78				
		Results	**Control Limits**	**Outside Limit (Yes/No)**
Gastric Extractable Arsenic	mg/kg dry wt	57	49 – 61	No
Gastric Extractable Lead	mg/kg dry wt	1130	1000 – 1300	No

QC A3 dup 1 PrepWS GastricExtn - Environmental Soils by ICP-MS: 9832.50				
		Results	**Control Limits**	**Outside Limit (Yes/No)**
Gastric Extractable Arsenic	mg/kg dry wt	9.8	7.6 – 16	No
Gastric Extractable Lead	mg/kg dry wt	61	58 – 73	No

QC A5 PrepWS GastricExtn - Environmental Soils by ICP-MS: 9832.69				
		Results	**Control Limits**	**Outside Limit (Yes/No)**
Gastric Extractable Arsenic	mg/kg dry wt	5.4	Undefined	N/A [#6]
Gastric Extractable Lead	mg/kg dry wt	85	Undefined	N/A [#6]

QC A5 PrepWS GastricExtn - Environmental Soils by ICP-MS: 9832.70				
		Results	Control Limits	Outside Limit (Yes/No)
Gastric Extractable Arsenic	mg/kg dry wt	5.2	Undefined	N/A [#6]
Gastric Extractable Lead	mg/kg dry wt	91	Undefined	N/A [#6]

QC A3 dup 2 PrepWS GastricExtn - Environmental Soils by ICP-MS: 9832.74				
		Results	Control Limits	Outside Limit (Yes/No)
Gastric Extractable Arsenic	mg/kg dry wt	9.4	7.6 – 16	No
Gastric Extractable Lead	mg/kg dry wt	61	58 – 73	No

2711a Montana II Soil PrepWS GastricExtn - Environmental Soils by ICP-MS: 9832.75				
		Results	Control Limits	Outside Limit (Yes/No)
Gastric Extractable Arsenic	mg/kg dry wt	50	49 – 61	No
Gastric Extractable Lead	mg/kg dry wt	1140	1000 – 1300	No

QC Soil A5 (Acid Treated) - Nitrogen/Carbon by Combustion - ES: 3208.2				
		Results	Control Limits	Outside Limit (Yes/No)
Total Organic Carbon	g/100g dry wt	2.8	2.8 – 2.9	No

QC A3 dup 1 PrepWS GastricExtn - Environmental Soils by ICP-MS: 9834.16				
		Results	Control Limits	Outside Limit (Yes/No)
Gastric Extractable Lead	mg/kg dry wt	71	58 – 73	No

QC A5 PrepWS GastricExtn - Environmental Soils by ICP-MS: 9834.36				
		Results	Control Limits	Outside Limit (Yes/No)
Gastric Extractable Lead	mg/kg dry wt	85	Undefined	N/A [#6]

QC A5 PrepWS GastricExtn - Environmental Soils by ICP-MS: 9834.37				
		Results	Control Limits	Outside Limit (Yes/No)
Gastric Extractable Lead	mg/kg dry wt	83	Undefined	N/A [#6]

QC A3 dup 2 PrepWS GastricExtn - Environmental Soils by ICP-MS: 9834.38				
		Results	Control Limits	Outside Limit (Yes/No)
Gastric Extractable Lead	mg/kg dry wt	71	58 – 73	No

2711a Montana II Soil PrepWS GastricExtn - Environmental Soils by ICP-MS: 9834.39				
		Results	Control Limits	Outside Limit (Yes/No)
Gastric Extractable Lead	mg/kg dry wt	1170	1000 – 1300	No

QC A5 PrepWS esDig - High Volume Environmental Soils by ICP-MS: 1707.12				
		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Lead	mg/kg dry wt	121	94 – 150	No

QC A5 PrepWS esDig - High Volume Environmental Soils by ICP-MS: 1707.39				
		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Lead	mg/kg dry wt	117	94 – 150	No

AGAL-10 QC PrepWS esDig - High Volume Environmental Soils by ICP-MS: 1707.40				
		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Lead	mg/kg dry wt	45	38 – 47	No

Replicates

High Volume Environmental Soils by ICP-MS: 1607.51				
		Replicate 1	Replicate 2	Pass/Fail
Total Recoverable Chromium	mg/kg dry wt	9.8 ± 2.1	9.3 ± 2.0	Pass
Total Recoverable Copper	mg/kg dry wt	45.9 ± 6.4	44.6 ± 6.3	Pass
Total Recoverable Mercury	mg/kg dry wt	< 0.10 ± 0.067	< 0.10 ± 0.067	Pass
Total Recoverable Lead	mg/kg dry wt	229 ± 35	200 ± 30	Pass
Total Recoverable Zinc	mg/kg dry wt	58.2 ± 4.9	51.7 ± 4.5	Pass

Environmental Soils by ICP-MS: 9826.35				
		Replicate 1	**Replicate 2**	**Pass/Fail**
Gastric Extractable Arsenic	mg/kg dry wt	4.6 ± 1.4	4.1 ± 1.4	Pass
Gastric Extractable Lead	mg/kg dry wt	55.4 ± 7.8	56.0 ± 7.9	Pass

Environmental Soils by ICP-MS: 9828.33				
		Replicate 1	**Replicate 2**	**Pass/Fail**
Gastric Extractable Arsenic	mg/kg dry wt	10.9 ± 1.8	10.2 ± 1.7	Pass
Gastric Extractable Lead	mg/kg dry wt	165 ± 24	163 ± 23	Pass

Environmental Soils by ICP-MS: 9828.68				
		Replicate 1	**Replicate 2**	**Pass/Fail**
Gastric Extractable Arsenic	mg/kg dry wt	10.8 ± 1.8	11.1 ± 1.8	Pass
Gastric Extractable Lead	mg/kg dry wt	144 ± 21	145 ± 21	Pass

High Volume Environmental Soils by ICP-MS: 1673.58				
		Replicate 1	**Replicate 2**	**Pass/Fail**
Total Recoverable Arsenic	mg/kg dry wt	9.2 ± 1.9	9.3 ± 2.0	Pass

Environmental Soils by ICP-MS: 9821.58				
		Replicate 1	**Replicate 2**	**Pass/Fail**
Total Recoverable Calcium	mg/kg dry wt	4,880 ± 690	4,960 ± 700	Pass

High Volume Environmental Soils by ICP-MS: 1673.58				
		Replicate 1	**Replicate 2**	**Pass/Fail**
Total Recoverable Chromium	mg/kg dry wt	10.0 ± 2.1	9.3 ± 2.0	Pass
Total Recoverable Copper	mg/kg dry wt	19.4 ± 3.0	18.4 ± 2.9	Pass

Environmental Soils by ICP-MS: 9821.58				
		Replicate 1	**Replicate 2**	**Pass/Fail**
Total Recoverable Iron	mg/kg dry wt	8,060 ± 810	8,100 ± 820	Pass

High Volume Environmental Soils by ICP-MS: 1673.58				
		Replicate 1	**Replicate 2**	**Pass/Fail**
Total Recoverable Lead	mg/kg dry wt	70 ± 11	72 ± 11	Pass

Environmental Soils by ICP-MS: 9821.58				
		Replicate 1	**Replicate 2**	**Pass/Fail**
Total Recoverable Manganese	mg/kg dry wt	87.1 ± 8.8	89.1 ± 9.0	Pass

High Volume Environmental Soils by ICP-MS: 1673.58				
		Replicate 1	**Replicate 2**	**Pass/Fail**
Total Recoverable Nickel	mg/kg dry wt	7.5 ± 1.7	7.2 ± 1.7	Pass

Environmental Soils by ICP-MS: 9821.58				
		Replicate 1	**Replicate 2**	**Pass/Fail**
Total Recoverable Phosphorus	mg/kg dry wt	1,250 ± 130	1,310 ± 140	Pass

Analyst's Comments

[#1] The elevated blank level was noted and due to instrumental carryover from a calibrating standard. The blank was not used in the final calculation of the corresponding analyte.

[#2] Elevated blank levels were observed for this analyte, however the corresponding data was accepted as the blank levels are less than 10% of the sample levels

[#3] Elevated blank levels were observed for this analyte, however the corresponding data was accepted as the blank levels are less than 10% of the sample levels (EPA 200.8, Determination of Trace Elements in Waters and Wastes by ICPMS).

[#4] The sample spike recovery for this analyte was below the acceptable recovery range of the method. The corresponding sample result was accepted because the [Laboratory Control Sample (LCS), Blank] spike recovery was within the expected ranges. This indicates that the low sample spike recovery was due to the matrix of the sample.

[#5] The recovery for this analyte was below the acceptable recovery range of the method. The corresponding sample result was accepted because the other QC recoveries were within the expected ranges.

[#6] Control limits have not been established for this analyte.

[#7] The recovery for this analyte was above the acceptable recovery range of the method. The corresponding sample result was accepted because the other QC recoveries were within the expected ranges.

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ANALYSIS REPORT

Client:	Tasman District Council ENVIRONMENTAL	**Lab No:**	1779955	SPv3
Contact:	Anna MacKenzie	**Date Received:**	23-May-2017	
	C/- Tasman District Council ENVIRONMENTAL	**Date Reported:**	06-Jul-2017	**(Amended)**
	Private Bag 4	**Quote No:**	83731	
	Richmond 7050	**Order No:**	337663	
		Client Reference:		
		Submitted By:	P Sheldon	

Sample Type: Soil

Sample Name:		MA81 A 22-May-2017 1:15 pm	MA81 B 22-May-2017 1:15 pm	MA82 A 22-May-2017 2:15 pm	MA82 B 22-May-2017 2:15 pm	MA83 A 22-May-2017 2:40 pm
Lab Number:		1779955.1	1779955.2	1779955.3	1779955.4	1779955.5
Individual Tests						
Particle size analysis*		-	See attached report	-	See attached report	-
pH*	pH Units	6.6	-	6.5	-	6.6
Heavy Metals with Mercury, Screen Level						
Total Recoverable Arsenic	mg/kg dry wt	24	-	20	-	18
Total Recoverable Cadmium	mg/kg dry wt	0.39	-	0.33	-	0.28
Total Recoverable Chromium	mg/kg dry wt	7	-	7	-	5
Total Recoverable Copper	mg/kg dry wt	51	-	47	-	12
Total Recoverable Lead	mg/kg dry wt	230	-	147	-	172
Total Recoverable Mercury	mg/kg dry wt	0.33	-	0.21	-	< 0.10
Total Recoverable Nickel	mg/kg dry wt	4	-	3	-	< 2
Total Recoverable Zinc	mg/kg dry wt	51	-	43	-	49

Sample Name:		MA83 B 22-May-2017 2:40 pm	MA84 A 22-May-2017 3:00 pm	MA84 B 22-May-2017 3:00 pm	MA85 A 22-May-2017 3:15 pm	MA85 B 22-May-2017 3:15 pm
Lab Number:		1779955.6	1779955.7	1779955.8	1779955.9	1779955.10
Individual Tests						
Particle size analysis*		See attached report	-	See attached report	-	See attached report
pH*	pH Units	-	7.1	-	7.4	-
Heavy Metals with Mercury, Screen Level						
Total Recoverable Arsenic	mg/kg dry wt	-	17	-	13	-
Total Recoverable Cadmium	mg/kg dry wt	-	0.21	-	0.21	-
Total Recoverable Chromium	mg/kg dry wt	-	5	-	5	-
Total Recoverable Copper	mg/kg dry wt	-	10	-	6	-
Total Recoverable Lead	mg/kg dry wt	-	95	-	79	-
Total Recoverable Mercury	mg/kg dry wt	-	< 0.10	-	< 0.10	-
Total Recoverable Nickel	mg/kg dry wt	-	2	-	< 2	-
Total Recoverable Zinc	mg/kg dry wt	-	43	-	33	-

Sample Name:		MA86 A 22-May-2017 3:35 pm	MA86 B 22-May-2017 3:35 pm	MA81 A [<250um Fraction]	MA82 A [<250um Fraction]	MA83 A [<250um Fraction]
Lab Number:		1779955.11	1779955.12	1779955.13	1779955.14	1779955.15
Individual Tests						
Particle size analysis*		-	See attached report	-	-	-
Gastric Extractable Arsenic	mg/kg dry wt	-	-	8.5	6.4	5.8
Total Recoverable Arsenic	mg/kg dry wt	-	-	21	15	15

Sample Type: Soil							
Sample Name:		MA86 A 22-May-2017 3:35 pm	MA86 B 22-May-2017 3:35 pm	MA81 A [<250um Fraction]	MA82 A [<250um Fraction]	MA83 A [<250um Fraction]
Lab Number:		1779955.11	1779955.12	1779955.13	1779955.14	1779955.15
Individual Tests						
Total Recoverable Calcium	mg/kg dry wt	-	-	3,600	3,300	3,500
Total Recoverable Chromium	mg/kg dry wt	-	-	7	8	5
Total Recoverable Copper	mg/kg dry wt	-	-	48	46	11
Total Recoverable Iron	mg/kg dry wt	-	-	5,800	6,400	4,200
Gastric Extractable Lead	mg/kg dry wt	-	-	166	100	122
Total Recoverable Lead	mg/kg dry wt	-	-	210	130	156
Total Recoverable Manganese	mg/kg dry wt	-	-	470	146	68
Total Recoverable Nickel	mg/kg dry wt	-	-	5	4	2
Total Recoverable Phosphorus	mg/kg dry wt	-	-	1,010	910	790
Total Sulphur*	g/100g dry wt	-	-	0.040	0.030	0.040
pH*	pH Units	7.0	-	-	-	-
Total Organic Carbon*	g/100g dry wt	-	-	2.9	3.0	3.4
Heavy Metals with Mercury, Screen Level						
Total Recoverable Arsenic	mg/kg dry wt	19	-	-	-	-
Total Recoverable Cadmium	mg/kg dry wt	0.24	-	-	-	-
Total Recoverable Chromium	mg/kg dry wt	7	-	-	-	-
Total Recoverable Copper	mg/kg dry wt	14	-	-	-	-
Total Recoverable Lead	mg/kg dry wt	127	-	-	-	-
Total Recoverable Mercury	mg/kg dry wt	< 0.10	-	-	-	-
Total Recoverable Nickel	mg/kg dry wt	3	-	-	-	-
Total Recoverable Zinc	mg/kg dry wt	29	-	-	-	-

Sample Name:		MA84 A [<250um Fraction]	MA85 A [<250um Fraction]	MA86 A [<250um Fraction]		
Lab Number:		1779955.16	1779955.17	1779955.18		
Individual Tests						
Gastric Extractable Arsenic	mg/kg dry wt	4.2	2.8	4.9	-	-
Total Recoverable Arsenic	mg/kg dry wt	14	9	14	-	-
Total Recoverable Calcium	mg/kg dry wt	3,100	3,200	2,600	-	-
Total Recoverable Chromium	mg/kg dry wt	5	5	6	-	-
Total Recoverable Copper	mg/kg dry wt	9	6	13	-	-
Total Recoverable Iron	mg/kg dry wt	5,000	4,900	4,900	-	-
Gastric Extractable Lead	mg/kg dry wt	70	58	87	-	-
Total Recoverable Lead	mg/kg dry wt	83	71	119	-	-
Total Recoverable Manganese	mg/kg dry wt	39	43	46	-	-
Total Recoverable Nickel	mg/kg dry wt	3	< 2	< 2	-	-
Total Recoverable Phosphorus	mg/kg dry wt	760	730	900	-	-
Total Sulphur*	g/100g dry wt	0.020	0.020	0.020	-	-
Total Organic Carbon*	g/100g dry wt	2.0	1.70	1.60	-	-

Analyst's Comments

Amended Report: This report replaces an earlier report issued on 28 Jun 2017 at 11:45 am
Reason for amendment: Additional testing has been added at the request of the client.

Appendix No.1 - Particle size Report-1779955

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**	**Sample No**
Sieving through 250 um sieve, no gravimetric result*	<250µm Dry Sieved with no gravimetric determination.	-	1, 3, 5, 7, 9, 11
Soil Prep Dry & Sieve for Agriculture	Air dried at 35°C and sieved, <2mm fraction.	-	1, 3, 5, 7, 9, 11

Sample Type: Soil			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
Heavy Metals with Mercury, Screen Level	Dried sample, < 2mm fraction. Nitric/Hydrochloric acid digestion US EPA 200.2. Complies with NES Regulations. ICP-MS screen level, interference removal by Kinetic Energy Discrimination if required.	0.10 - 4 mg/kg dry wt	1, 3, 5, 7, 9, 11
Gastric Extraction	Simulated gastric extraction using glycine/HCl fluid , pH 1.5. Shaken for 1hr at 37°C. Assessing Oral Bioavailability of Metals in Soil, 2002.	-	13-18
Total Recoverable digestion	Nitric / hydrochloric acid digestion. US EPA 200.2.	-	13-18
Particle size analysis*	Malvern Laser Sizer particle size analysis. Subcontracted to Earth Sciences Department, Waikato University, Hamilton.	-	2, 4, 6, 8, 10, 12
Gastric Extractable Arsenic	Gastric extraction, 37°C, 1hr, ICP-MS, screen level. APHA 3125 B 22nd ed. 2012.	1.0 mg/kg dry wt	13-18
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	13-18
Total Recoverable Calcium	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	100 mg/kg dry wt	13-18
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	13-18
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	13-18
Total Recoverable Iron	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	40 mg/kg dry wt	13-18
Gastric Extractable Lead	Gastric extraction, 37°C, 1hr, ICP-MS, screen level. APHA 3125 B 22nd ed. 2012.	0.2 mg/kg dry wt	13-18
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	13-18
Total Recoverable Manganese	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	1.0 mg/kg dry wt	13-18
Total Recoverable Nickel	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	2 mg/kg dry wt	13-18
Total Recoverable Phosphorus	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	40 mg/kg dry wt	13-18
Total Sulphur (Sub SGS)*	LECO SC32 Sulphur Determinator, high temperature furnace, infra-red detector. Subcontracted to SGS, Waihi. ASTM 4239.	0.005 g/100g dry wt	13-18
pH*	1:2 (v/v) soil : water slurry followed by potentiometric determination of pH.	0.1 pH Units	1, 3, 5, 7, 9, 11
Total Organic Carbon*	Acid pretreatment to remove carbonates present followed by Catalytic Combustion (900°C, O2), separation, Thermal Conductivity Detector [Elementar Analyser].	0.05 g/100g dry wt	13-18

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.

Graham Corban MSc Tech (Hons)
Client Services Manager - Environmental

Analysis - Under

THE UNIVERSITY OF WAIKATO
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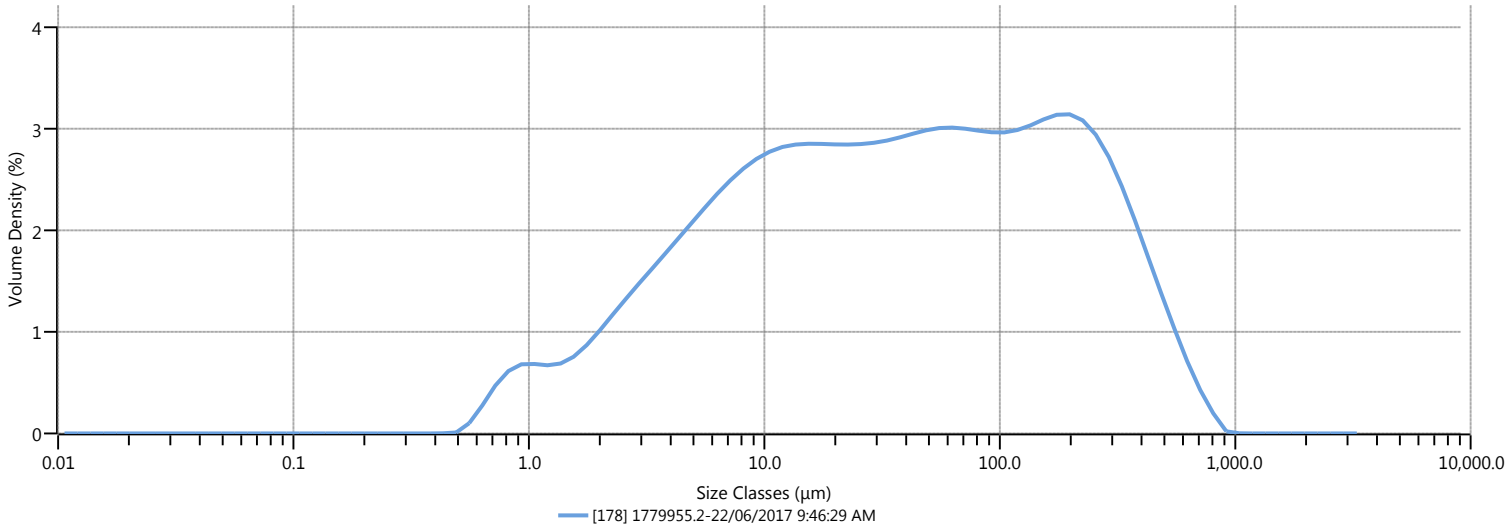
Measurement Details	
Operator Name	rodgers
Sample Name	1779955.2
SOP File Name	Sediment.msop
Lab Number	

Measurement Details	
Analysis Date Time	22/06/2017 9:46:29 AM
Measurement Date Time	22/06/2017 9:46:29 AM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.49 %
Laser Obscuration	22.73 %

Result	
Concentration	0.0308 %
Span	7.553
Uniformity	2.284
Specific Surface Area	663.8 m^2/kg
D [3,2]	9.04 µm
D [4,3]	96.8 µm
Dv (10)	3.44 µm
Dv (50)	36.9 µm
Dv (90)	282 µm

Frequency (compatible)



Result

Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under
0.0500	0.00	7.80	21.39	88.0	66.92	350	93.60	1410	100.00
0.0600	0.00	15.6	33.92	105	70.34	420	95.99	1680	100.00
0.120	0.00	31.0	46.70	125	73.73	500	97.75	2000	100.00
0.240	0.00	37.0	50.04	149	77.22	590	98.92	2380	100.00
0.490	0.00	44.0	53.36	177	80.72	710	99.66	2830	100.00
0.980	1.74	53.0	56.99	210	84.23	840	99.97	3360	100.00
2.00	5.26	63.0	60.39	250	87.71	1000	100.00		
3.90	11.43	74.0	63.54	300	91.09	1190	100.00		

Analysis - Under

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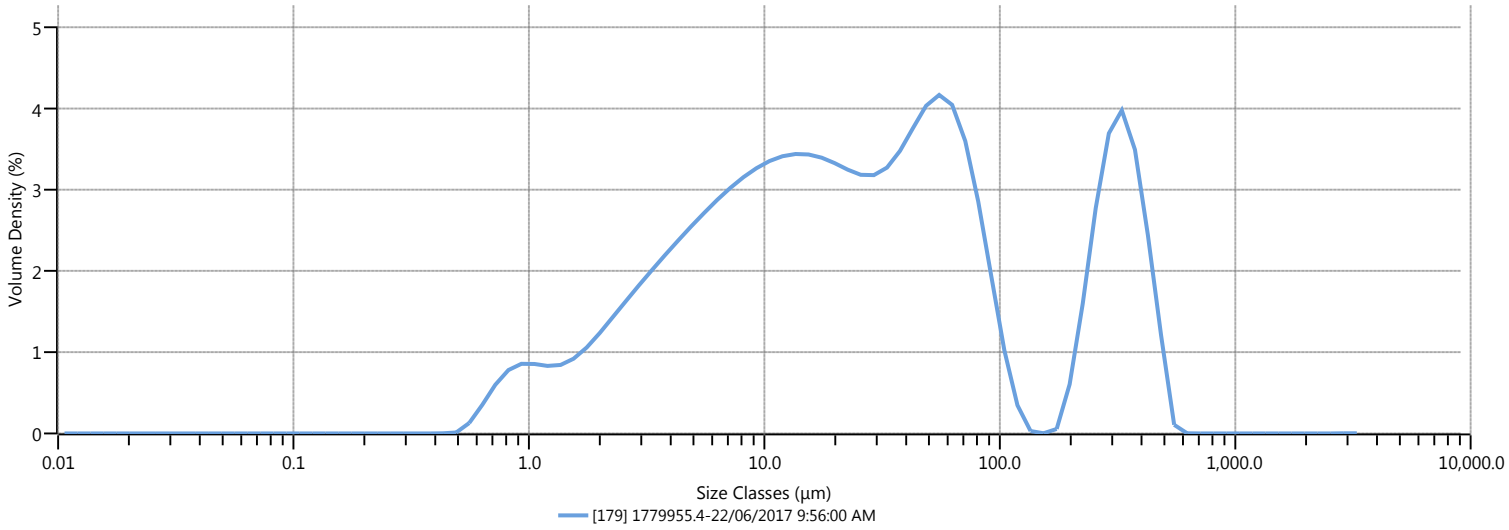
Measurement Details	
Operator Name	rodgers
Sample Name	1779955.4
SOP File Name	Sediment.msop
Lab Number	

Measurement Details	
Analysis Date Time	22/06/2017 9:56:00 AM
Measurement Date Time	22/06/2017 9:56:00 AM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	1.55 %
Laser Obscuration	21.15 %

Result	
Concentration	0.0233 %
Span	12.974
Uniformity	2.945
Specific Surface Area	809.0 m^2/kg
D [3,2]	7.42 µm
D [4,3]	76.5 µm
Dv (10)	2.85 µm
Dv (50)	23.0 µm
Dv (90)	302 µm

Frequency (compatible)



Result

Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under
0.0500	0.00	7.80	26.34	88.0	80.90	350	93.87	1410	100.00
0.0600	0.00	15.6	41.48	105	82.71	420	97.74	1680	100.00
0.120	0.00	31.0	56.17	125	83.34	500	99.75	2000	100.00
0.240	0.00	37.0	60.00	149	83.37	590	100.00	2380	100.00
0.490	0.00	44.0	64.10	177	83.37	710	100.00	2830	100.00
0.980	2.21	53.0	68.97	210	83.83	840	100.00	3360	100.00
2.00	6.53	63.0	73.65	250	85.93	1000	100.00		
3.90	14.14	74.0	77.63	300	89.86	1190	100.00		

Analysis - Under

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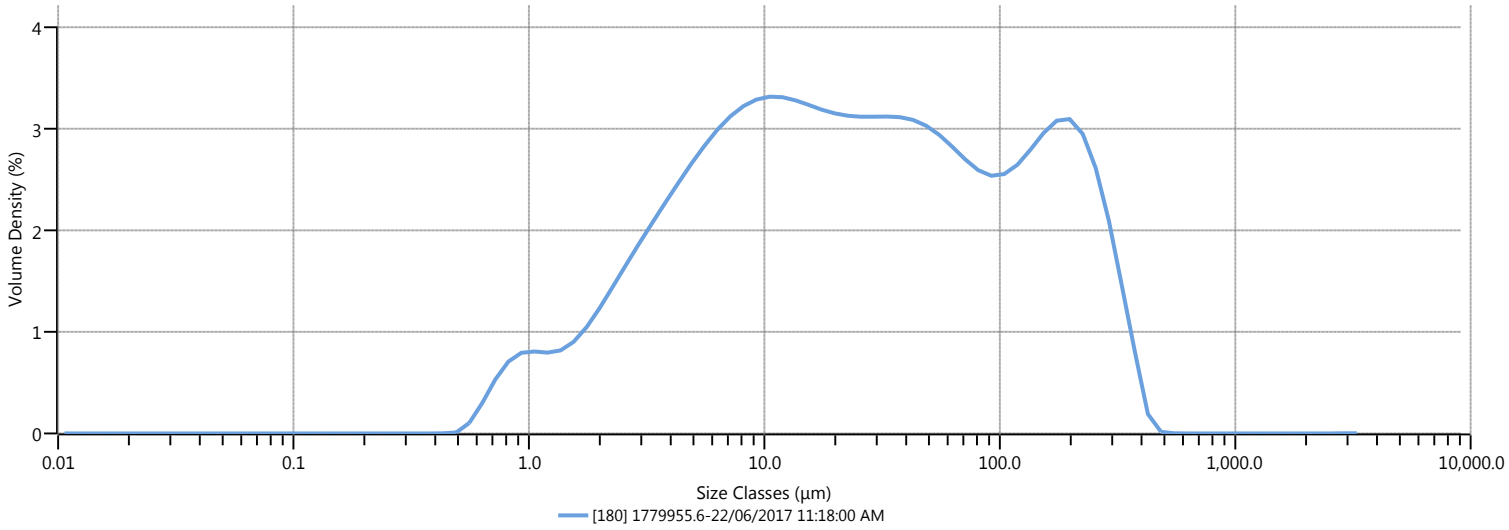
Measurement Details	
Operator Name	rodgers
Sample Name	1779955.6
SOP File Name	Sediment.msop
Lab Number	

Measurement Details	
Analysis Date Time	22/06/2017 11:18:00 AM
Measurement Date Time	22/06/2017 11:18:00 AM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.68 %
Laser Obscuration	17.02 %

Result	
Concentration	0.0187 %
Span	8.165
Uniformity	2.299
Specific Surface Area	788.7 m^2/kg
D [3,2]	7.61 µm
D [4,3]	62.9 µm
Dv (10)	2.92 µm
Dv (50)	23.6 µm
Dv (90)	195 µm

Frequency (compatible)



Result

Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under
0.0500	0.00	7.80	26.62	88.0	75.49	350	99.16	1410	100.00
0.0600	0.00	15.6	41.48	105	78.41	420	99.92	1680	100.00
0.120	0.00	31.0	55.59	125	81.38	500	100.00	2000	100.00
0.240	0.00	37.0	59.20	149	84.61	590	100.00	2380	100.00
0.490	0.00	44.0	62.71	177	88.01	710	100.00	2830	100.00
0.980	1.98	53.0	66.39	210	91.48	840	100.00	3360	100.00
2.00	6.18	63.0	69.66	250	94.76	1000	100.00		
3.90	13.95	74.0	72.55	300	97.56	1190	100.00		

Analysis - Under

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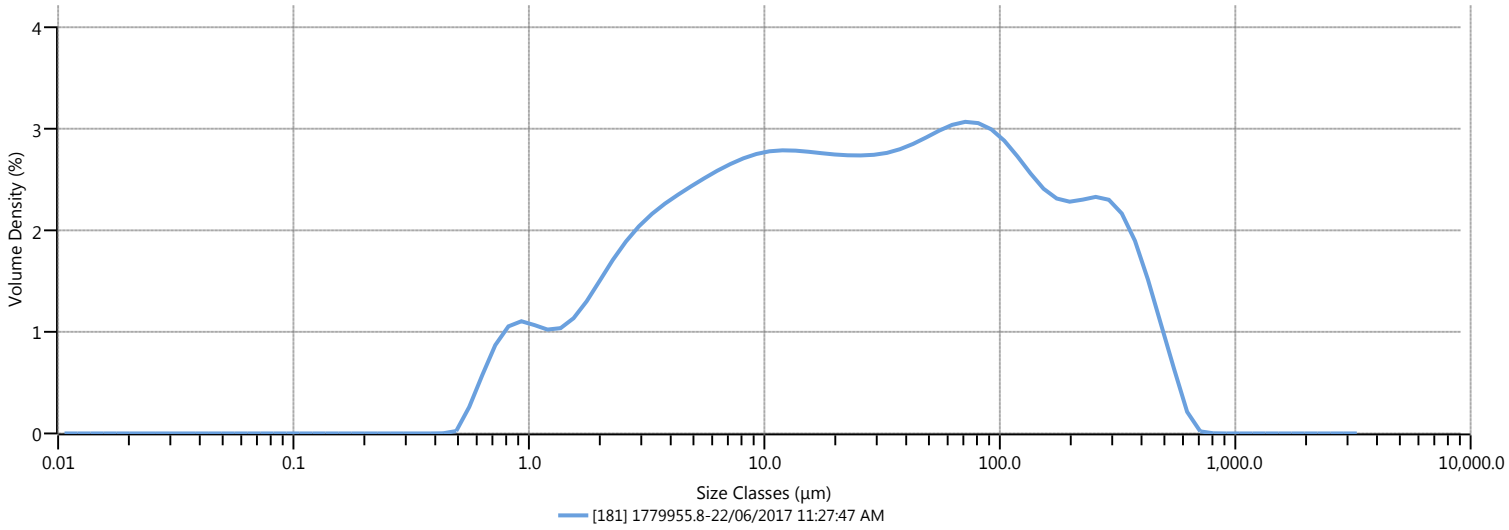
Measurement Details	
Operator Name	rodgers
Sample Name	1779955.8
SOP File Name	Sediment.msop
Lab Number	

Measurement Details	
Analysis Date Time	22/06/2017 11:27:47 AM
Measurement Date Time	22/06/2017 11:27:47 AM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.67 %
Laser Obscuration	19.82 %

Result	
Concentration	0.0194 %
Span	9.227
Uniformity	2.635
Specific Surface Area	921.3 m^2/kg
D [3,2]	6.51 µm
D [4,3]	76.9 µm
Dv (10)	2.31 µm
Dv (50)	26.0 µm
Dv (90)	242 µm

Frequency (compatible)



Result

Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under
0.0500	0.00	7.80	28.34	88.0	73.18	350	95.49	1410	100.00
0.0600	0.00	15.6	40.86	105	76.59	420	97.64	1680	100.00
0.120	0.00	31.0	53.18	125	79.76	500	99.09	2000	100.00
0.240	0.00	37.0	56.38	149	82.67	590	99.85	2380	100.00
0.490	0.00	44.0	59.58	177	85.33	710	100.00	2830	100.00
0.980	3.16	53.0	63.11	210	87.88	840	100.00	3360	100.00
2.00	8.49	63.0	66.51	250	90.51	1000	100.00		
3.90	17.01	74.0	69.72	300	93.27	1190	100.00		

Analysis - Under

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

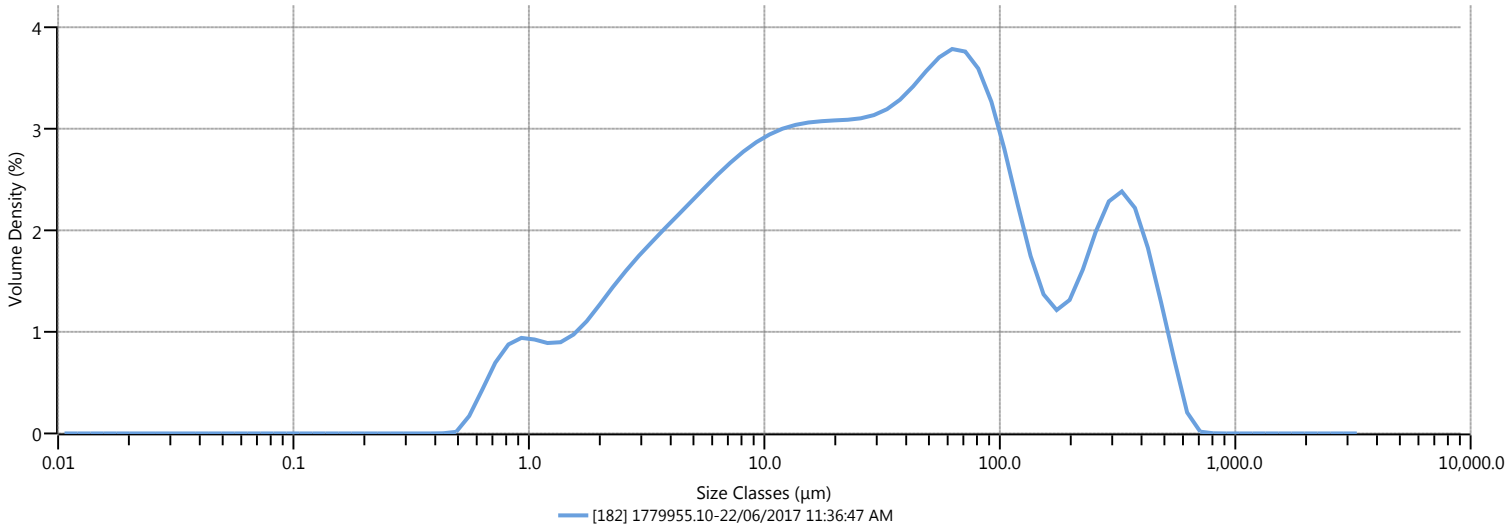
Measurement Details	
Operator Name	rodgers
Sample Name	1779955.10
SOP File Name	Sediment.msop
Lab Number	

Measurement Details	
Analysis Date Time	22/06/2017 11:36:47 AM
Measurement Date Time	22/06/2017 11:36:47 AM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.68 %
Laser Obscuration	18.18 %

Result	
Concentration	0.0197 %
Span	9.229
Uniformity	2.415
Specific Surface Area	818.5 m^2/kg
D [3,2]	7.33 µm
D [4,3]	75.7 µm
Dv (10)	2.70 µm
Dv (50)	27.4 µm
Dv (90)	255 µm

Frequency (compatible)



Result

Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under
0.0500	0.00	7.80	25.34	88.0	76.64	350	94.69	1410	100.00
0.0600	0.00	15.6	38.67	105	80.21	420	97.23	1680	100.00
0.120	0.00	31.0	52.55	125	83.00	500	98.98	2000	100.00
0.240	0.00	37.0	56.26	149	84.95	590	99.86	2380	100.00
0.490	0.00	44.0	60.05	177	86.39	710	100.00	2830	100.00
0.980	2.54	53.0	64.37	210	87.80	840	100.00	3360	100.00
2.00	7.12	63.0	68.60	250	89.73	1000	100.00		
3.90	14.46	74.0	72.57	300	92.29	1190	100.00		

Analysis - Under

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Te Whare Wānanga o Waikato

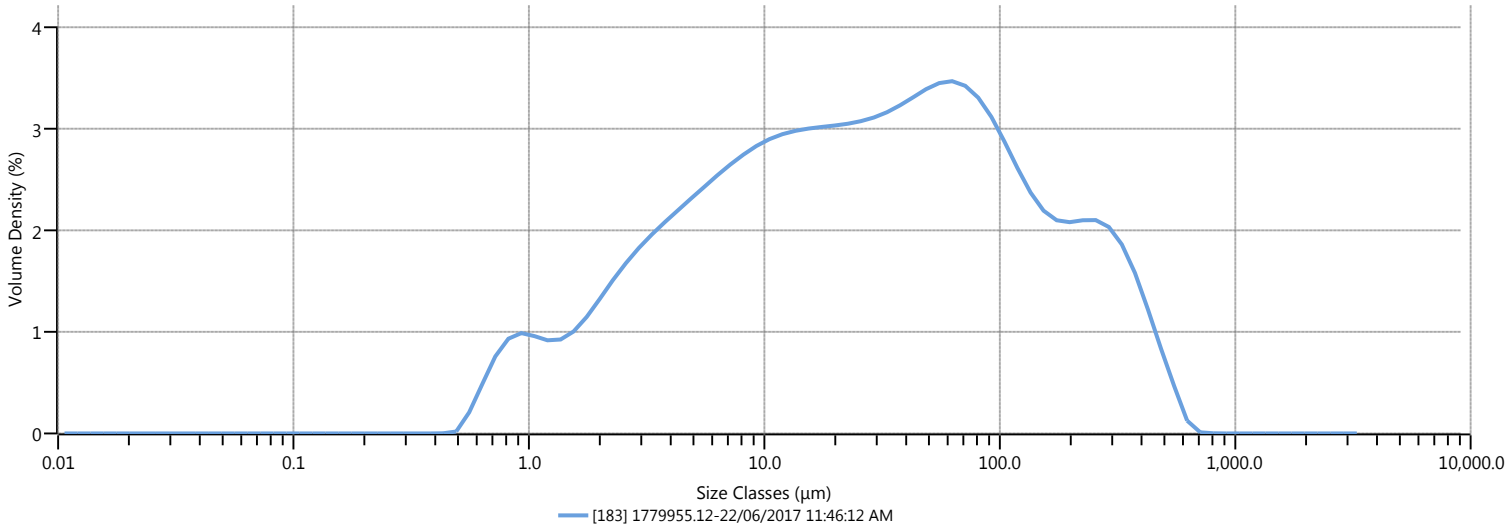
Measurement Details	
Operator Name	rodgers
Sample Name	1779955.12
SOP File Name	Sediment.msop
Lab Number	

Measurement Details	
Analysis Date Time	22/06/2017 11:46:12 AM
Measurement Date Time	22/06/2017 11:46:12 AM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.82 %
Laser Obscuration	21.93 %

Result	
Concentration	0.0235 %
Span	7.919
Uniformity	2.292
Specific Surface Area	848.9 m^2/kg
D [3,2]	7.07 µm
D [4,3]	70.9 µm
Dv (10)	2.58 µm
Dv (50)	26.9 µm
Dv (90)	215 µm

Frequency (compatible)



Result

Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under
0.0500	0.00	7.80	26.08	88.0	75.66	350	96.43	1410	100.00
0.0600	0.00	15.6	39.21	105	79.15	420	98.21	1680	100.00
0.120	0.00	31.0	52.90	125	82.23	500	99.35	2000	100.00
0.240	0.00	37.0	56.57	149	84.92	590	99.92	2380	100.00
0.490	0.00	44.0	60.27	177	87.33	710	100.00	2830	100.00
0.980	2.76	53.0	64.38	210	89.65	840	100.00	3360	100.00
2.00	7.50	63.0	68.29	250	92.04	1000	100.00		
3.90	15.14	74.0	71.91	300	94.51	1190	100.00		

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QUALITY ASSURANCE REPORT

Client:	Tasman District Council ENVIRONMENTAL	**Lab No:**	1779955	QCPv1
Contact:	Anna MacKenzie	**Date Received:**	23-May-2017	
	C/- Tasman District Council ENVIRONMENTAL	**Date Reported:**	06-Jul-2017	
	Private Bag 4	**Quote No:**	83731	
	Richmond 7050	**Order No:**	337663	
		Client Reference:		
		Submitted By:	P Sheldon	

Blank QCs

Digest Blank 1 PrepWS esDig - High Volume Environmental Soils by ICP-MS: 1602.11

		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Arsenic	mg/kg dry wt	< 2	-2.0 – 2.0	No
Total Recoverable Cadmium	mg/kg dry wt	< 0.10	-0.10 – 0.10	No
Total Recoverable Chromium	mg/kg dry wt	< 2	-2.0 – 2.0	No
Total Recoverable Copper	mg/kg dry wt	< 2	-2.0 – 2.0	No
Total Recoverable Lead	mg/kg dry wt	< 0.4	-0.40 – 0.40	No
Total Recoverable Mercury	mg/kg dry wt	< 0.10	-0.10 – 0.10	No
Total Recoverable Nickel	mg/kg dry wt	< 2	-2.0 – 2.0	No
Total Recoverable Zinc	mg/kg dry wt	< 4	-4.0 – 4.0	No

Digest Blank 2 PrepWS esDig - High Volume Environmental Soils by ICP-MS: 1602.37

		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Arsenic	mg/kg dry wt	< 2	-2.0 – 2.0	No
Total Recoverable Cadmium	mg/kg dry wt	< 0.10	-0.10 – 0.10	No
Total Recoverable Chromium	mg/kg dry wt	< 2	-2.0 – 2.0	No
Total Recoverable Copper	mg/kg dry wt	< 2	-2.0 – 2.0	No
Total Recoverable Lead	mg/kg dry wt	< 0.4	-0.40 – 0.40	No
Total Recoverable Mercury	mg/kg dry wt	< 0.10	-0.10 – 0.10	No
Total Recoverable Nickel	mg/kg dry wt	< 2	-2.0 – 2.0	No
Total Recoverable Zinc	mg/kg dry wt	< 4	-4.0 – 4.0	No

Digest Blank 1 PrepWS esDig - High Volume Environmental Soils by ICP-MS: 1603.11

		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Arsenic	mg/kg dry wt	< 2	-2.0 – 2.0	No
Total Recoverable Cadmium	mg/kg dry wt	< 0.10	-0.10 – 0.10	No
Total Recoverable Chromium	mg/kg dry wt	< 2	-2.0 – 2.0	No
Total Recoverable Copper	mg/kg dry wt	< 2	-2.0 – 2.0	No
Total Recoverable Lead	mg/kg dry wt	< 0.4	-0.40 – 0.40	No
Total Recoverable Mercury	mg/kg dry wt	< 0.10	-0.10 – 0.10	No
Total Recoverable Nickel	mg/kg dry wt	< 2	-2.0 – 2.0	No
Total Recoverable Zinc	mg/kg dry wt	< 4	-4.0 – 4.0	No

Digest Blank 2 PrepWS esDig - High Volume Environmental Soils by ICP-MS: 1603.39

		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Arsenic	mg/kg dry wt	< 2	-2.0 – 2.0	No
Total Recoverable Cadmium	mg/kg dry wt	< 0.10	-0.10 – 0.10	No
Total Recoverable Chromium	mg/kg dry wt	< 2	-2.0 – 2.0	No

Digest Blank 2 PrepWS esDig - High Volume Environmental Soils by ICP-MS: 1603.39				
		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Copper	mg/kg dry wt	< 2	-2.0 – 2.0	No
Total Recoverable Lead	mg/kg dry wt	< 0.4	-0.40 – 0.40	No
Total Recoverable Mercury	mg/kg dry wt	< 0.10	-0.10 – 0.10	No
Total Recoverable Nickel	mg/kg dry wt	< 2	-2.0 – 2.0	No
Total Recoverable Zinc	mg/kg dry wt	< 4	-4.0 – 4.0	No

50x Manual Dilution Digest Blank PrepWS esDig - High Volume Environmental Soils by ICP-MS: 1609.61				
		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Mercury	mg/kg dry wt	< 0.10	-0.10 – 0.10	No

Digest Blank 1 PrepWS esDig - High Volume Environmental Soils by ICP-MS: 1684.11				
		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Arsenic	mg/kg dry wt	< 2	-2.0 – 2.0	No
Total Recoverable Chromium	mg/kg dry wt	< 2	-2.0 – 2.0	No
Total Recoverable Copper	mg/kg dry wt	< 2	-2.0 – 2.0	No
Total Recoverable Lead	mg/kg dry wt	< 0.4	-0.40 – 0.40	No
Total Recoverable Nickel	mg/kg dry wt	< 2	-2.0 – 2.0	No

Digest Blank 2 PrepWS esDig - High Volume Environmental Soils by ICP-MS: 1684.35				
		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Arsenic	mg/kg dry wt	< 2	-2.0 – 2.0	No
Total Recoverable Chromium	mg/kg dry wt	< 2	-2.0 – 2.0	No
Total Recoverable Copper	mg/kg dry wt	< 2	-2.0 – 2.0	No
Total Recoverable Lead	mg/kg dry wt	< 0.4	-0.40 – 0.40	No
Total Recoverable Nickel	mg/kg dry wt	< 2	-2.0 – 2.0	No

Digest Blank 1 PrepWS esDig - Environmental Soils by ICP-MS: 9825.11				
		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Calcium	mg/kg dry wt	< 100	-100 – 100	No
Total Recoverable Iron	mg/kg dry wt	< 40	-40 – 40	No
Total Recoverable Manganese	mg/kg dry wt	< 1.0	-1.0 – 1.0	No
Total Recoverable Phosphorus	mg/kg dry wt	< 40	-40 – 40	No

Digest Blank 2 PrepWS esDig - Environmental Soils by ICP-MS: 9825.21				
		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Calcium	mg/kg dry wt	< 100	-100 – 100	No
Total Recoverable Iron	mg/kg dry wt	< 40	-40 – 40	No
Total Recoverable Manganese	mg/kg dry wt	< 1.0	-1.0 – 1.0	No
Total Recoverable Phosphorus	mg/kg dry wt	< 40	-40 – 40	No

Blk - Nitrogen/Carbon by Combustion - ES: 3201.1				
		Results	Control Limits	Outside Limit (Yes/No)
Total Organic Carbon	g/100g dry wt	< 0.05	-0.050 – 0.050	No

Extn Blank 1 PrepWS GastricExtn - Environmental Soils by ICP-MS: 9832.45				
		Results	Control Limits	Outside Limit (Yes/No)
Gastric Extractable Arsenic	mg/kg dry wt	< 1.0	-1.0 – 1.0	No
Gastric Extractable Lead	mg/kg dry wt	< 0.2	-0.20 – 0.20	No

Extn Blank 2 PrepWS GastricExtn - Environmental Soils by ICP-MS: 9832.46				
		Results	Control Limits	Outside Limit (Yes/No)
Gastric Extractable Arsenic	mg/kg dry wt	< 1.0	-1.0 – 1.0	No
Gastric Extractable Lead	mg/kg dry wt	< 0.2	-0.20 – 0.20	No

Sample Spike QCs

Blank Spike PrepWS GastricExtn - Environmental Soils by ICP-MS: 9832.47

		Results	Control Limits	Outside Limit (Yes/No)
Gastric Extractable Arsenic	%	90	80 – 120	No
Gastric Extractable Lead	%	101	80 – 120	No

Spike PrepWS GastricExtn - Environmental Soils by ICP-MS: 9832.66

		Results	Control Limits	Outside Limit (Yes/No)
Gastric Extractable Arsenic	%	91	80 – 120	No
Gastric Extractable Lead	%	105	80 – 120	No

Reference Material QCs

Soil-58 (217988) - Soil Basic: 20626.3

		Results	Control Limits	Outside Limit (Yes/No)
pH	pH Units	5.6	5.5 – 5.8	No

QC A5 PrepWS esDig - High Volume Environmental Soils by ICP-MS: 1602.12

		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Arsenic	mg/kg dry wt	114	82 – 150	No
Total Recoverable Cadmium	mg/kg dry wt	0.31	0.25 – 0.41	No
Total Recoverable Chromium	mg/kg dry wt	34	30 – 41	No
Total Recoverable Copper	mg/kg dry wt	129	110 – 160	No
Total Recoverable Lead	mg/kg dry wt	116	94 – 150	No
Total Recoverable Mercury	mg/kg dry wt	0.44	0.25 – 0.49	No
Total Recoverable Nickel	mg/kg dry wt	27	22 – 31	No
Total Recoverable Zinc	mg/kg dry wt	910	800 – 1100	No

QC A5 PrepWS esDig - High Volume Environmental Soils by ICP-MS: 1602.63

		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Arsenic	mg/kg dry wt	99	82 – 150	No
Total Recoverable Cadmium	mg/kg dry wt	0.31	0.25 – 0.41	No
Total Recoverable Chromium	mg/kg dry wt	35	30 – 41	No
Total Recoverable Copper	mg/kg dry wt	136	110 – 160	No
Total Recoverable Lead	mg/kg dry wt	115	94 – 150	No
Total Recoverable Mercury	mg/kg dry wt	0.40	0.25 – 0.49	No
Total Recoverable Nickel	mg/kg dry wt	27	22 – 31	No
Total Recoverable Zinc	mg/kg dry wt	920	800 – 1100	No

AGAL-10 QC PrepWS esDig - High Volume Environmental Soils by ICP-MS: 1602.64

		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Arsenic	mg/kg dry wt	18.4	15 – 21	No
Total Recoverable Cadmium	mg/kg dry wt	9.5	8.5 – 11	No
Total Recoverable Chromium	mg/kg dry wt	47	37 – 54	No
Total Recoverable Copper	mg/kg dry wt	25	21 – 28	No
Total Recoverable Lead	mg/kg dry wt	45	38 – 47	No
Total Recoverable Mercury	mg/kg dry wt	11.0	9.6 – 13	No
Total Recoverable Nickel	mg/kg dry wt	11.7	9.6 – 14	No
Total Recoverable Zinc	mg/kg dry wt	53	45 – 65	No

QC A5 PrepWS esDig - High Volume Environmental Soils by ICP-MS: 1603.12

		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Arsenic	mg/kg dry wt	118	82 – 150	No
Total Recoverable Cadmium	mg/kg dry wt	0.33	0.25 – 0.41	No

QC A5 PrepWS esDig - High Volume Environmental Soils by ICP-MS: 1603.12				
		Results	**Control Limits**	**Outside Limit (Yes/No)**
Total Recoverable Chromium	mg/kg dry wt	35	30 – 41	No
Total Recoverable Copper	mg/kg dry wt	138	110 – 160	No
Total Recoverable Lead	mg/kg dry wt	129	94 – 150	No
Total Recoverable Mercury	mg/kg dry wt	0.52	0.25 – 0.49	**Yes** [#1]
Total Recoverable Nickel	mg/kg dry wt	27	22 – 31	No
Total Recoverable Zinc	mg/kg dry wt	950	800 – 1100	No

QC A5 PrepWS esDig - High Volume Environmental Soils by ICP-MS: 1603.60				
		Results	**Control Limits**	**Outside Limit (Yes/No)**
Total Recoverable Arsenic	mg/kg dry wt	104	82 – 150	No
Total Recoverable Cadmium	mg/kg dry wt	0.30	0.25 – 0.41	No
Total Recoverable Chromium	mg/kg dry wt	36	30 – 41	No
Total Recoverable Copper	mg/kg dry wt	167	110 – 160	**Yes** [#1]
Total Recoverable Lead	mg/kg dry wt	124	94 – 150	No
Total Recoverable Mercury	mg/kg dry wt	0.39	0.25 – 0.49	No
Total Recoverable Nickel	mg/kg dry wt	26	22 – 31	No
Total Recoverable Zinc	mg/kg dry wt	970	800 – 1100	No

AGAL-10 QC PrepWS esDig - High Volume Environmental Soils by ICP-MS: 1603.61				
		Results	**Control Limits**	**Outside Limit (Yes/No)**
Total Recoverable Arsenic	mg/kg dry wt	19	15 – 21	No
Total Recoverable Cadmium	mg/kg dry wt	9.8	8.5 – 11	No
Total Recoverable Chromium	mg/kg dry wt	45	37 – 54	No
Total Recoverable Copper	mg/kg dry wt	27	21 – 28	No
Total Recoverable Lead	mg/kg dry wt	45	38 – 47	No
Total Recoverable Mercury	mg/kg dry wt	12.4	9.6 – 13	No
Total Recoverable Nickel	mg/kg dry wt	13	9.6 – 14	No
Total Recoverable Zinc	mg/kg dry wt	55	45 – 65	No

QC A5 PrepWS esDig - High Volume Environmental Soils by ICP-MS: 1609.62				
		Results	**Control Limits**	**Outside Limit (Yes/No)**
Total Recoverable Mercury	mg/kg dry wt	0.37	0.25 – 0.49	No

QC A5 PrepWS esDig - High Volume Environmental Soils by ICP-MS: 1684.12				
		Results	**Control Limits**	**Outside Limit (Yes/No)**
Total Recoverable Arsenic	mg/kg dry wt	131	82 – 150	No
Total Recoverable Chromium	mg/kg dry wt	37	30 – 41	No
Total Recoverable Copper	mg/kg dry wt	149	110 – 160	No
Total Recoverable Lead	mg/kg dry wt	125	94 – 150	No
Total Recoverable Nickel	mg/kg dry wt	26	22 – 31	No

QC A5 PrepWS esDig - High Volume Environmental Soils by ICP-MS: 1684.53				
		Results	**Control Limits**	**Outside Limit (Yes/No)**
Total Recoverable Arsenic	mg/kg dry wt	110	82 – 150	No
Total Recoverable Chromium	mg/kg dry wt	38	30 – 41	No
Total Recoverable Copper	mg/kg dry wt	134	110 – 160	No
Total Recoverable Lead	mg/kg dry wt	118	94 – 150	No
Total Recoverable Nickel	mg/kg dry wt	28	22 – 31	No

AGAL-10 QC PrepWS esDig - High Volume Environmental Soils by ICP-MS: 1684.54				
		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Arsenic	mg/kg dry wt	19	15 – 21	No
Total Recoverable Chromium	mg/kg dry wt	47	37 – 54	No
Total Recoverable Copper	mg/kg dry wt	28	21 – 28	No
Total Recoverable Lead	mg/kg dry wt	43	38 – 47	No
Total Recoverable Nickel	mg/kg dry wt	12	9.6 – 14	No

QC A5 PrepWS esDig - Environmental Soils by ICP-MS: 9825.12				
		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Calcium	mg/kg dry wt	11000	10000 – 13000	No
Total Recoverable Iron	mg/kg dry wt	27000	24000 – 34000	No
Total Recoverable Manganese	mg/kg dry wt	530	470 – 650	No
Total Recoverable Phosphorus	mg/kg dry wt	1010	820 – 1300	No

QC A5 PrepWS esDig - Environmental Soils by ICP-MS: 9825.22				
		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Calcium	mg/kg dry wt	11200	10000 – 13000	No
Total Recoverable Iron	mg/kg dry wt	27000	24000 – 34000	No
Total Recoverable Manganese	mg/kg dry wt	540	470 – 650	No
Total Recoverable Phosphorus	mg/kg dry wt	1030	820 – 1300	No

AGAL-10 QC PrepWS esDig - Environmental Soils by ICP-MS: 9825.23				
		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Calcium	mg/kg dry wt	2100	1900 – 2400	No
Total Recoverable Iron	mg/kg dry wt	17800	15000 – 22000	No
Total Recoverable Manganese	mg/kg dry wt	250	220 – 280	No
Total Recoverable Phosphorus	mg/kg dry wt	350	280 – 400	No

QC Soil A5 (Acid Treated) - Nitrogen/Carbon by Combustion - ES: 3201.2				
		Results	Control Limits	Outside Limit (Yes/No)
Total Organic Carbon	g/100g dry wt	2.9	2.8 – 2.9	No

QC A3 dup 1 PrepWS GastricExtn - Environmental Soils by ICP-MS: 9832.50				
		Results	Control Limits	Outside Limit (Yes/No)
Gastric Extractable Arsenic	mg/kg dry wt	9.8	7.6 – 16	No
Gastric Extractable Lead	mg/kg dry wt	61	58 – 73	No

QC A5 PrepWS GastricExtn - Environmental Soils by ICP-MS: 9832.69				
		Results	Control Limits	Outside Limit (Yes/No)
Gastric Extractable Arsenic	mg/kg dry wt	5.4	Undefined	N/A [#2]
Gastric Extractable Lead	mg/kg dry wt	85	Undefined	N/A [#2]

QC A5 PrepWS GastricExtn - Environmental Soils by ICP-MS: 9832.70				
		Results	Control Limits	Outside Limit (Yes/No)
Gastric Extractable Arsenic	mg/kg dry wt	5.2	Undefined	N/A [#2]
Gastric Extractable Lead	mg/kg dry wt	91	Undefined	N/A [#2]

QC A3 dup 2 PrepWS GastricExtn - Environmental Soils by ICP-MS: 9832.74				
		Results	Control Limits	Outside Limit (Yes/No)
Gastric Extractable Arsenic	mg/kg dry wt	9.4	7.6 – 16	No
Gastric Extractable Lead	mg/kg dry wt	61	58 – 73	No

2711a Montana II Soil PrepWS GastricExtn - Environmental Soils by ICP-MS: 9832.75				
		Results	Control Limits	Outside Limit (Yes/No)
Gastric Extractable Arsenic	mg/kg dry wt	50	49 – 61	No
Gastric Extractable Lead	mg/kg dry wt	1140	1000 – 1300	No

Replicates

Environmental Soils by ICP-MS: 9832.65

		Replicate 1	Replicate 2	Pass/Fail
Gastric Extractable Lead	mg/kg dry wt	87 ± 13	91 ± 13	Pass
Gastric Extractable Arsenic	mg/kg dry wt	4.9 ± 1.5	5.3 ± 1.5	Pass

Analyst's Comments

#1 The recovery for this analyte was above the acceptable recovery range of the method. The corresponding sample result was accepted because the other QC recoveries were within the expected ranges.

#2 Control limits have not been established for this analyte.

Analysis - Under

THE UNIVERSITY OF WAIKATO
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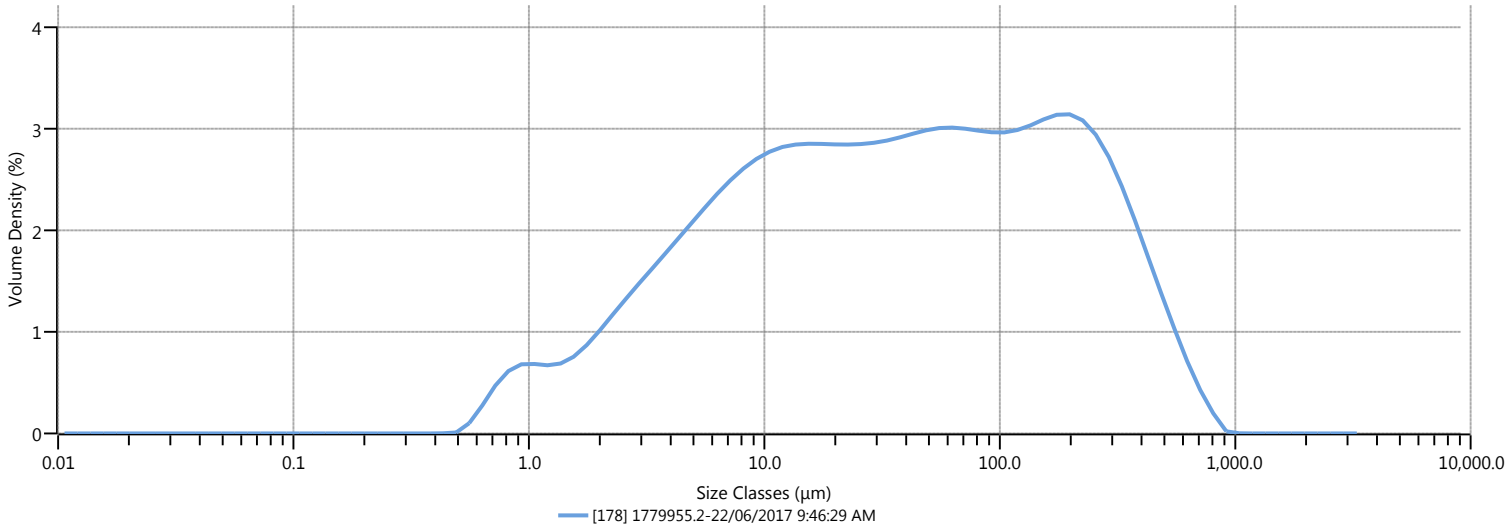
Measurement Details	
Operator Name	rodgers
Sample Name	1779955.2
SOP File Name	Sediment.msop
Lab Number	

Measurement Details	
Analysis Date Time	22/06/2017 9:46:29 AM
Measurement Date Time	22/06/2017 9:46:29 AM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.49 %
Laser Obscuration	22.73 %

Result	
Concentration	0.0308 %
Span	7.553
Uniformity	2.284
Specific Surface Area	663.8 m^2/kg
D [3,2]	9.04 µm
D [4,3]	96.8 µm
Dv (10)	3.44 µm
Dv (50)	36.9 µm
Dv (90)	282 µm

Frequency (compatible)



Result

Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under
0.0500	0.00	7.80	21.39	88.0	66.92	350	93.60	1410	100.00
0.0600	0.00	15.6	33.92	105	70.34	420	95.99	1680	100.00
0.120	0.00	31.0	46.70	125	73.73	500	97.75	2000	100.00
0.240	0.00	37.0	50.04	149	77.22	590	98.92	2380	100.00
0.490	0.00	44.0	53.36	177	80.72	710	99.66	2830	100.00
0.980	1.74	53.0	56.99	210	84.23	840	99.97	3360	100.00
2.00	5.26	63.0	60.39	250	87.71	1000	100.00		
3.90	11.43	74.0	63.54	300	91.09	1190	100.00		

Analysis - Under

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

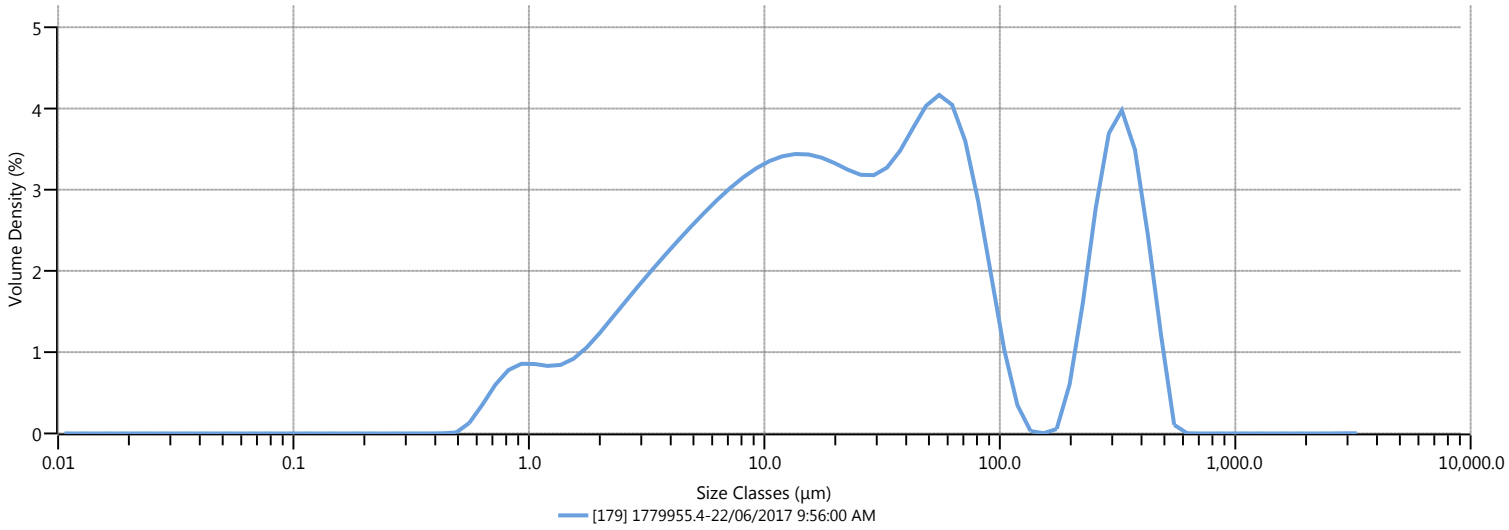
Measurement Details	
Operator Name	rodgers
Sample Name	1779955.4
SOP File Name	Sediment.msop
Lab Number	

Measurement Details	
Analysis Date Time	22/06/2017 9:56:00 AM
Measurement Date Time	22/06/2017 9:56:00 AM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	1.55 %
Laser Obscuration	21.15 %

Result	
Concentration	0.0233 %
Span	12.974
Uniformity	2.945
Specific Surface Area	809.0 m^2/kg
D [3,2]	7.42 µm
D [4,3]	76.5 µm
Dv (10)	2.85 µm
Dv (50)	23.0 µm
Dv (90)	302 µm

Frequency (compatible)



Result

Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under
0.0500	0.00	7.80	26.34	88.0	80.90	350	93.87	1410	100.00
0.0600	0.00	15.6	41.48	105	82.71	420	97.74	1680	100.00
0.120	0.00	31.0	56.17	125	83.34	500	99.75	2000	100.00
0.240	0.00	37.0	60.00	149	83.37	590	100.00	2380	100.00
0.490	0.00	44.0	64.10	177	83.37	710	100.00	2830	100.00
0.980	2.21	53.0	68.97	210	83.83	840	100.00	3360	100.00
2.00	6.53	63.0	73.65	250	85.93	1000	100.00		
3.90	14.14	74.0	77.63	300	89.86	1190	100.00		

Analysis - Under

THE UNIVERSITY OF WAIKATO
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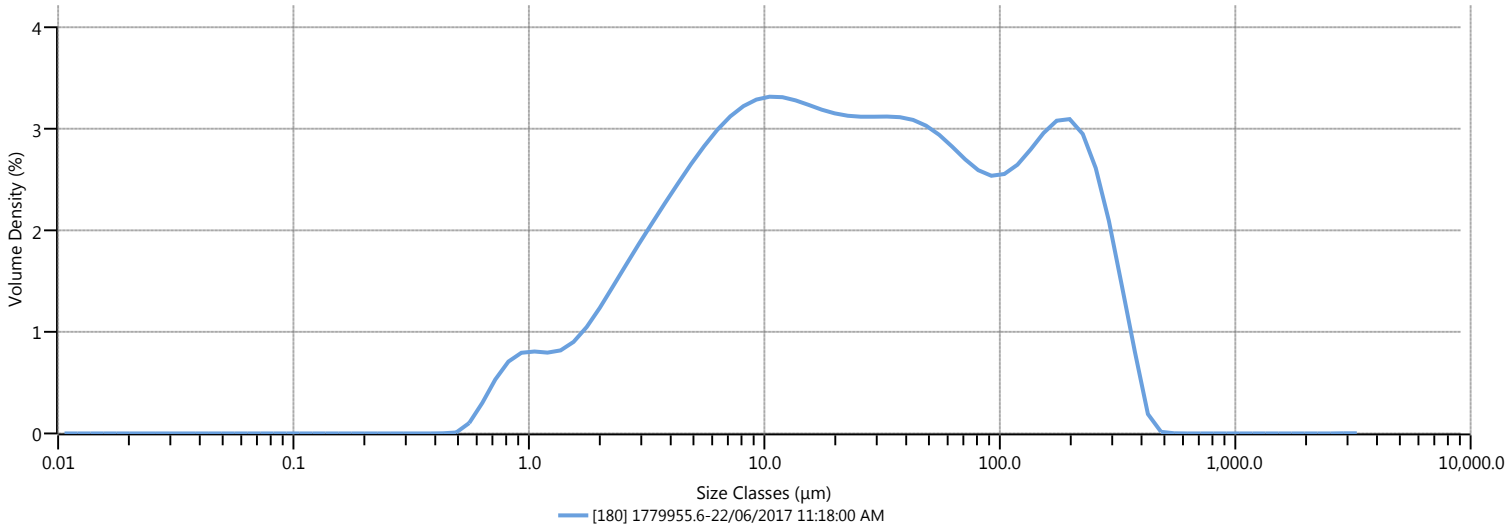
Measurement Details	
Operator Name	rodgers
Sample Name	1779955.6
SOP File Name	Sediment.msop
Lab Number	

Measurement Details	
Analysis Date Time	22/06/2017 11:18:00 AM
Measurement Date Time	22/06/2017 11:18:00 AM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.68 %
Laser Obscuration	17.02 %

Result	
Concentration	0.0187 %
Span	8.165
Uniformity	2.299
Specific Surface Area	788.7 m^2/kg
D [3,2]	7.61 µm
D [4,3]	62.9 µm
Dv (10)	2.92 µm
Dv (50)	23.6 µm
Dv (90)	195 µm

Frequency (compatible)



Result

Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under
0.0500	0.00	7.80	26.62	88.0	75.49	350	99.16	1410	100.00
0.0600	0.00	15.6	41.48	105	78.41	420	99.92	1680	100.00
0.120	0.00	31.0	55.59	125	81.38	500	100.00	2000	100.00
0.240	0.00	37.0	59.20	149	84.61	590	100.00	2380	100.00
0.490	0.00	44.0	62.71	177	88.01	710	100.00	2830	100.00
0.980	1.98	53.0	66.39	210	91.48	840	100.00	3360	100.00
2.00	6.18	63.0	69.66	250	94.76	1000	100.00		
3.90	13.95	74.0	72.55	300	97.56	1190	100.00		

Analysis - Under

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

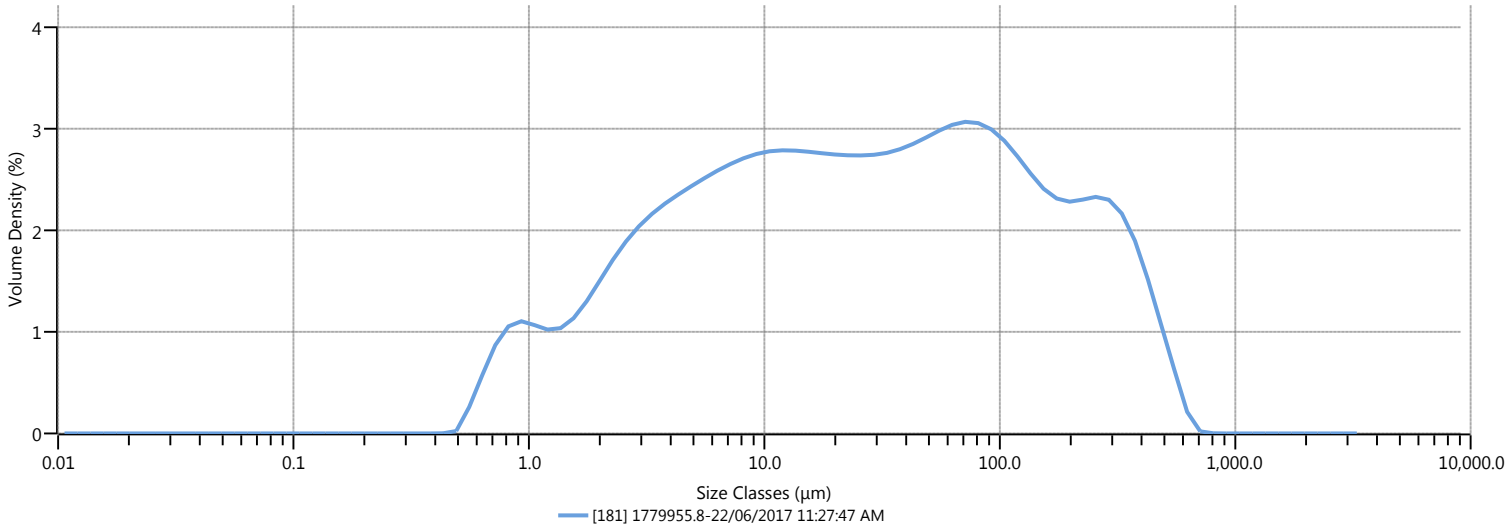
Measurement Details	
Operator Name	rodgers
Sample Name	1779955.8
SOP File Name	Sediment.msop
Lab Number	

Measurement Details	
Analysis Date Time	22/06/2017 11:27:47 AM
Measurement Date Time	22/06/2017 11:27:47 AM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.67 %
Laser Obscuration	19.82 %

Result	
Concentration	0.0194 %
Span	9.227
Uniformity	2.635
Specific Surface Area	921.3 m^2/kg
D [3,2]	6.51 µm
D [4,3]	76.9 µm
Dv (10)	2.31 µm
Dv (50)	26.0 µm
Dv (90)	242 µm

Frequency (compatible)



Result

Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under
0.0500	0.00	7.80	28.34	88.0	73.18	350	95.49	1410	100.00
0.0600	0.00	15.6	40.86	105	76.59	420	97.64	1680	100.00
0.120	0.00	31.0	53.18	125	79.76	500	99.09	2000	100.00
0.240	0.00	37.0	56.38	149	82.67	590	99.85	2380	100.00
0.490	0.00	44.0	59.58	177	85.33	710	100.00	2830	100.00
0.980	3.16	53.0	63.11	210	87.88	840	100.00	3360	100.00
2.00	8.49	63.0	66.51	250	90.51	1000	100.00		
3.90	17.01	74.0	69.72	300	93.27	1190	100.00		

Analysis - Under

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Te Whare Wānanga o Waikato

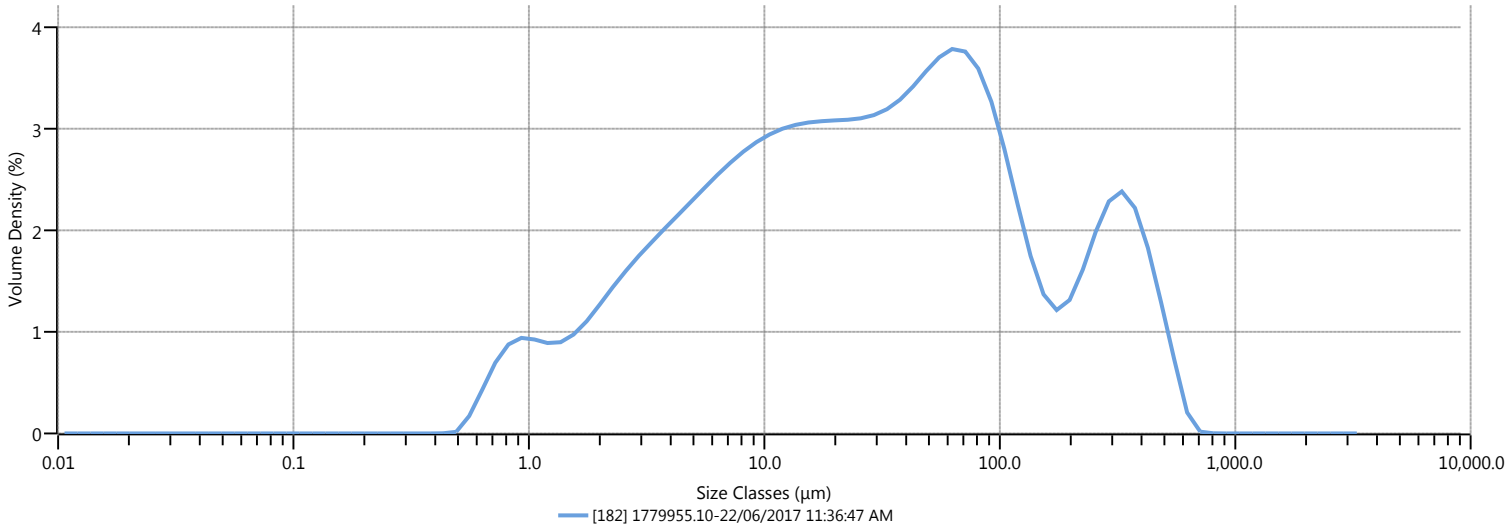
Measurement Details	
Operator Name	rodgers
Sample Name	1779955.10
SOP File Name	Sediment.msop
Lab Number	

Measurement Details	
Analysis Date Time	22/06/2017 11:36:47 AM
Measurement Date Time	22/06/2017 11:36:47 AM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.68 %
Laser Obscuration	18.18 %

Result	
Concentration	0.0197 %
Span	9.229
Uniformity	2.415
Specific Surface Area	818.5 m^2/kg
D [3,2]	7.33 µm
D [4,3]	75.7 µm
Dv (10)	2.70 µm
Dv (50)	27.4 µm
Dv (90)	255 µm

Frequency (compatible)



Result

Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under
0.0500	0.00	7.80	25.34	88.0	76.64	350	94.69	1410	100.00
0.0600	0.00	15.6	38.67	105	80.21	420	97.23	1680	100.00
0.120	0.00	31.0	52.55	125	83.00	500	98.98	2000	100.00
0.240	0.00	37.0	56.26	149	84.95	590	99.86	2380	100.00
0.490	0.00	44.0	60.05	177	86.39	710	100.00	2830	100.00
0.980	2.54	53.0	64.37	210	87.80	840	100.00	3360	100.00
2.00	7.12	63.0	68.60	250	89.73	1000	100.00		
3.90	14.46	74.0	72.57	300	92.29	1190	100.00		

Analysis - Under

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Te Whare Wānanga o Waikato

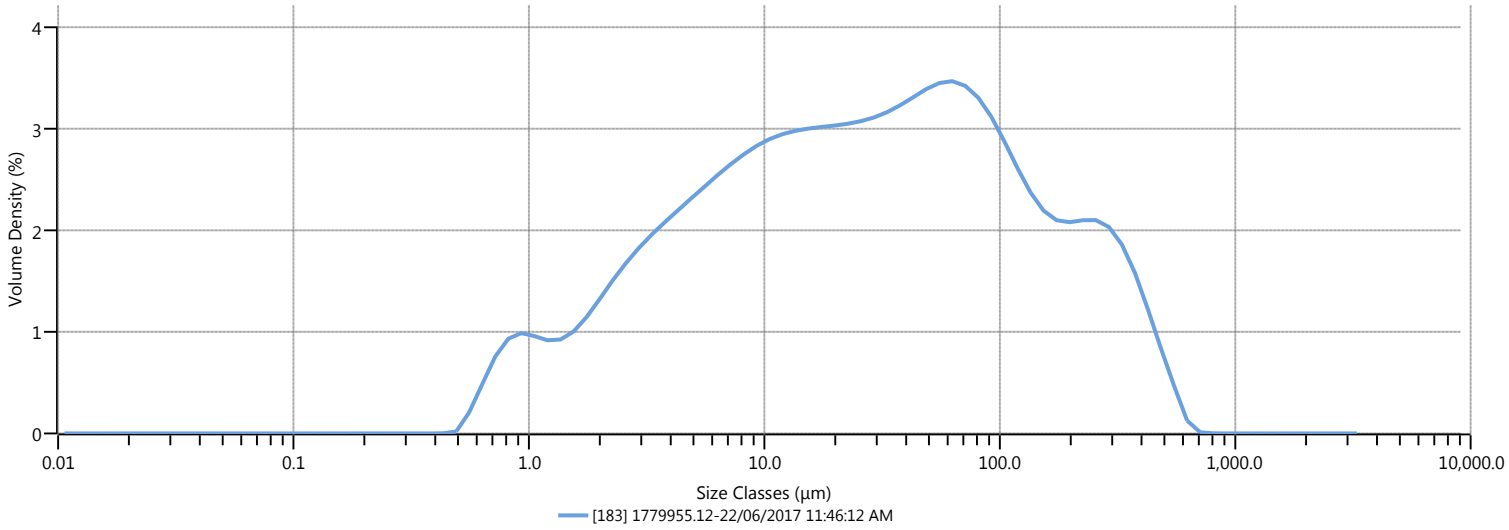
Measurement Details	
Operator Name	rodgers
Sample Name	1779955.12
SOP File Name	Sediment.msop
Lab Number	

Measurement Details	
Analysis Date Time	22/06/2017 11:46:12 AM
Measurement Date Time	22/06/2017 11:46:12 AM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.82 %
Laser Obscuration	21.93 %

Result	
Concentration	0.0235 %
Span	7.919
Uniformity	2.292
Specific Surface Area	848.9 m^2/kg
D [3,2]	7.07 µm
D [4,3]	70.9 µm
Dv (10)	2.58 µm
Dv (50)	26.9 µm
Dv (90)	215 µm

Frequency (compatible)



Result

Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under
0.0500	0.00	7.80	26.08	88.0	75.66	350	96.43	1410	100.00
0.0600	0.00	15.6	39.21	105	79.15	420	98.21	1680	100.00
0.120	0.00	31.0	52.90	125	82.23	500	99.35	2000	100.00
0.240	0.00	37.0	56.57	149	84.92	590	99.92	2380	100.00
0.490	0.00	44.0	60.27	177	87.33	710	100.00	2830	100.00
0.980	2.76	53.0	64.38	210	89.65	840	100.00	3360	100.00
2.00	7.50	63.0	68.29	250	92.04	1000	100.00		
3.90	15.14	74.0	71.91	300	94.51	1190	100.00		

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ANALYSIS REPORT

Client:	Hail Environmental	**Lab No:**	1798552	SPv2
Contact:	Dave Bull	**Date Received:**	27-Jun-2017	
	C/- Hail Environmental	**Date Reported:**	24-Jul-2017	**(Amended)**
	PO Box 13113	**Quote No:**	86260	
	Tauranga Central	**Order No:**		
	Tauranga 3141	**Client Reference:**	1018	
		Submitted By:	Dave Bull	

Sample Type: Soil

Sample Name:		BF7 26-Jun-2017 1:30 pm	BF8 26-Jun-2017	BF9 26-Jun-2017 1:50 pm	BF10 26-Jun-2017 1:52 pm	BF11 26-Jun-2017 1:54 pm
Lab Number:		1798552.1	1798552.2	1798552.3	1798552.4	1798552.5
Individual Tests						
Dry Matter	g/100g as rcvd	87	81	87	89	94
TCLP Weight of Sample Taken	g	-	-	100	100	-
TCLP Initial Sample pH	pH Units	-	-	8.7	9.0	-
TCLP Acid Adjusted Sample pH	pH Units	-	-	1.7	1.6	-
TCLP Extractant Type*		-	-	NaOH/Acetic acid at pH 4.93 +/- 0.05	NaOH/Acetic acid at pH 4.93 +/- 0.05	-
TCLP Extraction Fluid pH	pH Units	-	-	5.0	5.0	-
TCLP Post Extraction Sample pH	pH Units	-	-	5.2	5.1	-
Total Recoverable Arsenic	mg/kg dry wt	6	6	5	7	9
Total Recoverable Cadmium	mg/kg dry wt	< 0.10	< 0.10	0.18	0.12	< 0.10
Total Recoverable Chromium	mg/kg dry wt	19	19	18	18	20
Total Recoverable Copper	mg/kg dry wt	20	25	29	36	25
Total Recoverable Lead	mg/kg dry wt	125	90	490	240	50
Total Recoverable Zinc	mg/kg dry wt	103	97	240	194	97
Polycyclic Aromatic Hydrocarbons Screening in Soil						
1-Methylnaphthalene	mg/kg dry wt	< 0.012	< 0.013	0.144	< 0.011	< 0.011
2-Methylnaphthalene	mg/kg dry wt	< 0.012	< 0.013	0.165	< 0.011	< 0.011
Perylene	mg/kg dry wt	0.153	0.033	6.7	0.043	0.019
Acenaphthylene	mg/kg dry wt	0.052	< 0.013	1.83	0.029	< 0.011
Acenaphthene	mg/kg dry wt	< 0.012	< 0.013	0.137	< 0.011	< 0.011
Anthracene	mg/kg dry wt	0.063	0.013	7.9	0.020	< 0.011
Benzo[a]anthracene	mg/kg dry wt	0.34	0.076	19.5	0.078	0.059
Benzo[a]pyrene (BAP)	mg/kg dry wt	0.52	0.109	24	0.129	0.072
Benzo[b]fluoranthene + Benzo[j] fluoranthene	mg/kg dry wt	0.56	0.128	25	0.159	0.087
Benzo[e]pyrene	mg/kg dry wt	0.32	0.072	14.5	0.086	0.046
Benzo[g,h,i]perylene	mg/kg dry wt	0.34	0.074	14.8	0.091	0.051
Benzo[k]fluoranthene	mg/kg dry wt	0.24	0.055	10.8	0.061	0.037
Chrysene	mg/kg dry wt	0.30	0.070	15.9	0.065	0.051
Dibenzo[a,h]anthracene	mg/kg dry wt	0.060	0.016	2.4	0.019	< 0.011
Fluoranthene	mg/kg dry wt	0.62	0.119	41	0.122	0.103
Fluorene	mg/kg dry wt	< 0.012	< 0.013	0.39	< 0.011	< 0.011
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	0.46	0.109	18.5	0.134	0.068
Naphthalene	mg/kg dry wt	< 0.06	< 0.07	0.57	< 0.06	< 0.06
Phenanthrene	mg/kg dry wt	0.093	0.025	8.4	0.023	0.011
Pyrene	mg/kg dry wt	0.72	0.135	46	0.129	0.109

Sample Type: Soil							
Sample Name:		BF12 26-Jun-2017 1:52 pm					
Lab Number:		1798552.6					
Individual Tests							
Dry Matter	g/100g as rcvd	92	-	-	-	-	
Total Recoverable Arsenic	mg/kg dry wt	5	-	-	-	-	
Total Recoverable Cadmium	mg/kg dry wt	0.12	-	-	-	-	
Total Recoverable Chromium	mg/kg dry wt	16	-	-	-	-	
Total Recoverable Copper	mg/kg dry wt	28	-	-	-	-	
Total Recoverable Lead	mg/kg dry wt	230	-	-	-	-	
Total Recoverable Zinc	mg/kg dry wt	196	-	-	-	-	
Polycyclic Aromatic Hydrocarbons Screening in Soil							
1-Methylnaphthalene	mg/kg dry wt	< 0.011	-	-	-	-	
2-Methylnaphthalene	mg/kg dry wt	< 0.011	-	-	-	-	
Perylene	mg/kg dry wt	0.175	-	-	-	-	
Acenaphthylene	mg/kg dry wt	0.144	-	-	-	-	
Acenaphthene	mg/kg dry wt	< 0.011	-	-	-	-	
Anthracene	mg/kg dry wt	0.075	-	-	-	-	
Benzo[a]anthracene	mg/kg dry wt	0.23	-	-	-	-	
Benzo[a]pyrene (BAP)	mg/kg dry wt	0.54	-	-	-	-	
Benzo[b]fluoranthene + Benzo[j] fluoranthene	mg/kg dry wt	0.66	-	-	-	-	
Benzo[e]pyrene	mg/kg dry wt	0.35	-	-	-	-	
Benzo[g,h,i]perylene	mg/kg dry wt	0.38	-	-	-	-	
Benzo[k]fluoranthene	mg/kg dry wt	0.28	-	-	-	-	
Chrysene	mg/kg dry wt	0.21	-	-	-	-	
Dibenzo[a,h]anthracene	mg/kg dry wt	0.082	-	-	-	-	
Fluoranthene	mg/kg dry wt	0.26	-	-	-	-	
Fluorene	mg/kg dry wt	< 0.011	-	-	-	-	
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	0.59	-	-	-	-	
Naphthalene	mg/kg dry wt	< 0.06	-	-	-	-	
Phenanthrene	mg/kg dry wt	0.036	-	-	-	-	
Pyrene	mg/kg dry wt	0.33	-	-	-	-	

Sample Type: Aqueous						
Sample Name:		BF9 [TCLP extract]	BF10 [TCLP extract]			
Lab Number:		1798552.7	1798552.8			
Heavy metals, totals, screen As,Cd,Cr,Cu,Ni,Pb,Zn						
Total Arsenic	g/m³	< 0.021	< 0.021	-	-	-
Total Cadmium	g/m³	< 0.0011	< 0.0011	-	-	-
Total Chromium	g/m³	< 0.011	< 0.011	-	-	-
Total Copper	g/m³	< 0.011	0.011	-	-	-
Total Lead	g/m³	0.067	0.072	-	-	-
Total Nickel	g/m³	< 0.011	< 0.011	-	-	-
Total Zinc	g/m³	0.087	0.23	-	-	-

Analyst's Comments

Amended Report: This report replaces an earlier report issued on 30 Jun 2017 at 5:02 pm
Reason for amendment: At the client's request, TCLPs for heavy metals have been added to samples BF9 & BF10.

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**	**Sample No**
Individual Tests			
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%.	-	1-6

Sample Type: Soil			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
Dry Matter (Env)	Dried at 103°C for 4-22hr (removes 3-5% more water than air dry) , gravimetry. (Free water removed before analysis, non-soil objects such as sticks, leaves, grass and stones also removed). US EPA 3550.	0.10 g/100g as rcvd	1-6
Total Recoverable digestion	Nitric / hydrochloric acid digestion. US EPA 200.2.	-	1-6
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	1-6
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	1-6
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	1-6
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	1-6
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	1-6
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	1-6
1-Methylnaphthalene	Sonication extraction, SPE cleanup, GC-MS SIM analysis. Modified US EPA 8270.	0.010 mg/kg dry wt	1-6
2-Methylnaphthalene	Sonication extraction, SPE cleanup, GC-MS SIM analysis. Modified US EPA 8270.	0.010 mg/kg dry wt	1-6
Perylene	Sonication extraction, SPE cleanup, GC-MS SIM analysis. Modified US EPA 8270.	0.010 mg/kg dry wt	1-6
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. [KBIs:5786,2805,2695]	0.010 - 0.05 mg/kg dry wt	1-6
TCLP Profile*	Extraction at 30 +/- 2 rpm for 18 +/- 2 hours, (Ratio 1g sample : 20g extraction fluid). US EPA 1311	-	3-4
TCLP Profile			
TCLP Weight of Sample Taken	Gravimetric. US EPA 1311.	0.1 g	3-4
TCLP Initial Sample pH	pH meter. US EPA 1311.	0.1 pH Units	3-4
TCLP Acid Adjusted Sample pH	pH meter. US EPA 1311.	0.1 pH Units	3-4
TCLP Extractant Type*	US EPA 1311.	-	3-4
TCLP Extraction Fluid pH	pH meter. US EPA 1311.	0.1 pH Units	3-4
TCLP Post Extraction Sample pH	pH meter. US EPA 1311.	0.1 pH Units	3-4

Sample Type: Aqueous			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
Individual Tests			
Total Digestion of Extracted Samples*	Nitric acid digestion. APHA 3030 E 22nd ed. 2012 (modified).	-	7-8
Heavy metals, totals, screen As,Cd,Cr,Cu,Ni,Pb,Zn	Nitric acid digestion, ICP-MS, screen level. APHA 3125 B 22nd ed. 2012.	0.0011 - 0.021 g/m^3	7-8

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

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W www.hill-laboratories.com

ANALYSIS REPORT

Client:	Tasman District Council ENVIRONMENTAL	**Lab No:**	1806362	SPv1
Contact:	Anna MacKenzie	**Date Received:**	10-Jul-2017	
	C/- Tasman District Council ENVIRONMENTAL	**Date Reported:**	08-Aug-2017	
	Private Bag 4	**Quote No:**	83731	
	Richmond 7050	**Order No:**	337657	
		Client Reference:		
		Submitted By:	P Sheldon	

Sample Type: Soil

Sample Name:		RNZ01 A 19-Apr-2017 10:00 am	RNZ12 A 19-Apr-2017	MA5A1 C 12-May-2017 10:20 am	MA5A1 C 12-May-2017 10:20 am	MA3A1 A 12-May-2017 2:40 pm
Lab Number:		1806362.1	1806362.2	1806362.3	1806362.4	1806362.5
Dry Matter	g/100g as rcvd	83	82	80	79	70
Acid Soluble Sulphide*	mg/kg as rcvd	8	< 3	4	< 3	3
Acid Insoluble Sulphide*	mg/kg as rcvd	11	16	14	10	4

Sample Name:		MA21 A 13-May-2017 9:30 am	MA71 A 13-May-2017 11:00 am			
Lab Number:		1806362.6	1806362.7			
Dry Matter	g/100g as rcvd	73	73	-	-	-
Acid Soluble Sulphide*	mg/kg as rcvd	11 #1	5	-	-	-
Acid Insoluble Sulphide*	mg/kg as rcvd	9 #1	7	-	-	-

Analyst's Comments

#1 It has been noted that the result for the acid soluble fraction was greater than that for the acid insoluble fraction, but within analytical variation of the methods.

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	Sample No
Dry Matter (Env)	Dried at 103°C for 4-22hr (removes 3-5% more water than air dry) , gravimetry. (Free water removed before analysis, non-soil objects such as sticks, leaves, grass and stones also removed). US EPA 3550.	0.10 g/100g as rcvd	1-7
Acid Soluble Sulphide*	Acidify with c.H_2SO_4, distill under N_2 at 70°C, trap in Zn Acetate, iodometric titration. US EPA 9030B then 9034.	3 mg/kg as rcvd	1-7
Acid Insoluble Sulphide*	Acidify with c.HCl, distill under N_2 at 100°C with SnCl, trap in Zn Acetate, iodometric titration. US EPA 9030B then 9034.	3 mg/kg as rcvd	1-7

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.

Graham Corban MSc Tech (Hons)
Client Services Manager - Environmental

Appendix C: X-ray Fluorescence Data

Reading #	Date	Time	Sample ID	Latitude	Longitude	Mg	Al	Si
19	19/04/2017	10:08:49	rnz01	-41.3666	173.149		92380	241670
20	19/04/2017	10:09:43	rnz01	-41.3666	173.149			
21	19/04/2017	10:09:51	rnz01	-41.3666	173.149		89866	229443
22	19/04/2017	10:10:45	rnz01	-41.3666	173.149		81936	217889
23	19/04/2017	10:21:34	rnz02	-41.3669	173.149	30030	89752	227093
24	19/04/2017	10:29:42	rnz03	-41.3667	173.148	0	76827	201690
25	19/04/2017	10:46:51	rnz04	-41.3661	173.149	0	88658	234634
26	19/04/2017	10:54:37	rnz05	-41.3656	173.148	0	83264	210791
27	19/04/2017	11:08:23	rnz06	-41.3657	173.149	40283	90050	217741
29	19/04/2017	11:34:47	rnz11	-41.3673	173.148	0	83733	212573
30	19/04/2017	11:48:42	rnz12	-41.3677	173.147		87035	203571
31	19/04/2017	11:54:06	rnz12	-41.3677	173.147		84468	214272
32	19/04/2017	11:54:58	rnz12	-41.3677	173.147	24493	91643	227284
33	19/04/2017	12:03:32	rnz13	-41.3678	173.146	22509	97134	234367
34	19/04/2017	12:14:42	rnz14	-41.3668	173.148	20962	110637	263306
35	19/04/2017	12:23:28	rnz15	-41.3663	173.147	0	90322	207267
36	19/04/2017	12:28:37	rnz16	-41.3668	173.146	0	86073	205833
37	19/04/2017	13:34:09	rnz21	-41.3665	173.136	0	71690	174888
38	19/04/2017	13:36:30	rnz21	-41.3665	173.136	22004	71391	157260
39	19/04/2017	13:46:58	rnz22	-41.3659	173.136	0	83861	194399
40	19/04/2017	13:48:15	rnz22	-41.3659	173.136	24652	79200	184709
41	19/04/2017	13:50:26	rnz22	-41.3662	173.136	0	84420	184025
42	19/04/2017	13:54:11	rnz22	-41.367	173.137	0	87788	219175
43	19/04/2017	13:56:18	rnz22	-41.3667	173.137	0	78388	182298
44	19/04/2017	14:08:27	rnz22	-41.366	173.136			
45	19/04/2017	14:09:53	rnz22	-41.3663	173.137	0	64949	138597
46	19/04/2017	14:11:58	rnz22	-41.3669	173.138	0	58853	129040
47	19/04/2017	14:15:37	rnz22	-41.3673	173.137	0	60043	140123
48	19/04/2017	14:18:39	rnz22	-41.3668	173.136	0	78666	186422
51	19/04/2017	14:45:41	rnz31	-41.3644	173.141	0	69097	168610
52	19/04/2017	14:49:09	rnz31	-41.3651	173.142	24785	65665	159068
53	19/04/2017	14:51:36	rnz31	-41.3655	173.141	0	71748	180339
54	19/04/2017	14:53:52	rnz31	-41.366	173.14	24434	76689	193017
56	19/04/2017	14:59:51	rnz31	-41.365	173.139	0	57102	131929
57	19/04/2017	15:29:17	rnz41			0	46153	101109
58	19/04/2017	15:32:51	rnz41	-41.3459	173.146	0	85891	201944
59	19/04/2017	15:36:22	rnz41	-41.3455	173.146	0	79937	199923
60	19/04/2017	15:37:18	rnz41	-41.3455	173.146	18529	75115	188224
61	19/04/2017	15:40:40	rnz41	-41.3456	173.146	24316	90277	228323
62	19/04/2017	15:42:30	rnz41	-41.3456	173.146	0	66038	152312
63	19/04/2017	16:10:24	rnz51	-41.3463	173.151	21841	92803	222652
64	19/04/2017	16:16:51	rnz51	-41.3467	173.15	18835	90270	210280
65	19/04/2017	16:19:18	rnz51	-41.3472	173.15	25526	102315	265007
66	19/04/2017	16:20:31	rnz51	-41.3471	173.15	0	99243	245550
67	19/04/2017	16:22:34	rnz51	-41.3473	173.149	0	115390	217123
68	19/04/2017	16:24:51	rnz51	-41.3473	173.149	17625	96364	237638
69	19/04/2017	16:27:15	rnz51	-41.3471	173.149	21514	97117	229232

70	19/04/2017	16:28:45	rnz51	-41.3471	173.15	39076	105033	256940
71	19/04/2017	16:31:21	rnz51	-41.3471	173.15	26338	111408	265188
72	19/04/2017	16:33:48	rnz51	-41.3468	173.151	21229	93087	212280
73	19/04/2017	17:06:58	rnz61	-41.3379	173.137	0	93012	212178
74	19/04/2017	17:09:28	rnz61	-41.3374	173.137	0	80417	185655
75	19/04/2017	17:14:21	rnz61	-41.3386	173.138	20952	98741	239566
77	19/04/2017	17:19:41	rnz61	-41.3384	173.137	24581	66403	137653
78	19/04/2017	17:38:48	rnz71	-41.362	173.15	20870	101510	247260

Reading #	Date	Time	Sample ID	Latitude	Longitude	Mg	Al	Si
1	18/04/2017	19:05:45	sio2					
2	18/04/2017	19:06:27	sio2			0	0	437351
3	18/04/2017	19:08:04	nist2710a			0	0	436502
4	18/04/2017	19:09:44	nist2711a			0	11611	16906
5	18/04/2017	19:16:33	nist2711a			0	72832	296273
6	18/04/2017	19:20:18	nist2710a			0	76372	299621
7	18/04/2017	19:25:16	nist2710a			0	72372	303295
8	18/04/2017	19:28:13	nist2711a			0	77120	295491
1	19/04/2017	7:11:49	sio2			0	0	442943
2	19/04/2017	7:13:24	2710a			0	68517	299908
3	19/04/2017	7:15:12	2711a			0	73979	303055
50	19/04/2017	14:25:59	nist2711a			0	73000	288792
18	19/04/2017	9:48:39	survey	-41.3666	173.149	0	28473	58372
49	19/04/2017	14:20:22	rnz22	-41.3664	173.136	0	42934	79131
55	19/04/2017	14:55:26	rnz31	-41.3661	173.14	26972	44938	90874
76	19/04/2017	17:16:28	rnz61	-41.3386	173.138	0	78383	185232

P	S	S Error 1s	K	Ca	Ti	V	Cr	Mn	
	1736		236	5866	11433	4217	66	672	1104
						3919		893	826
	1674		243	5998	10305	3884	76	1161	991
	1530		259	5771	9721	3902	77	831	1001
								889.25	
	1919	0	208	5666	10427	3826	66	385	908
	1970	0	255	5590	9597	3676	55	1005	963
	1837	0	223	5921	10533	3891	69	517	1029
	1821	0	234	5712	10247	3835	83	534	1041
	2365	0	216	5830	10041	3986	54	523	927
	2477	0	217	6637	10678	3673	65	592	862
	3348		240	5780	9533	3522	83	611	973
	3625		221	6089	10234	3625	44	557	1099
	3252		238	6085	11272	3760	50	608	908
								592	
	3807	0	193	6873	10864	3804	62	598	1030
	3877	0	179	6725	10568	3954	66	599	1035
	2808	0	243	5968	10413	3647	66	989	1026
	3199	0	236	5901	10026	3466	77	678	1088
	1699	429	63	4698	8814	2744	48	730	763
	1955	452	59	4285	8301	2327	51	429	726
	2563	460	67	5091	10282	3101	49	658	998
	2384	348	69	4831	10741	2987	0	617	997
	2217	0	329	5487	8680	2766	63	708	789
	2122	0	233	5299	9111	3165	49	508	1019
	1881	0	247	4682	9177	2287	60	473	724
						2276	34	537	681
	1615	459	56	3441	6806	1498	0	427	448
	2831	2025	72	5018	8425	1011	0	156	468
	1616	415	59	4206	7206	2191	31	466	682
	2066	387	73	5043	8365	3035	45	618	796
	1291	0	293	3845	8782	2336	38	459	663
	1227	302	66	4592	9342	2381	33	622	761
	1664	0	293	4635	9469	2887	55	1101	814
	1360	0	253	5287	11434	3008	58	804	1008
	1182	676	64	3849	11424	1993	26	482	602
	1211	1311	66	3545	6534	1499	0	221	435
	1408	0	226	4425	7231	3303	46	509	871
	1252	0	227	4470	6984	2966	53	510	727
	1889	302	60	4284	6969	2541	35	356	607
	2175	0	208	5357	8504	3577	44	649	948
	1484	336	51	3862	7982	2480	0	320	552
	3581	697	70	6497	16958	3619	33	909	976
	3118	969	62	5839	12544	2981	48	775	751
	3635	866	82	6979	13595	4030	61	960	894
	3164	583	83	6296	13568	4066	64	1007	966
	2701	483	70	5403	11332	2941	50	721	776
	2616	594	66	6028	11270	2995	47	847	850
	2745	206	66	5564	10241	3518	55	932	896

3192	394	89	7013	12732	3699	41	1053	1089
3214	560	96	7067	14354	3833	43	868	978
2835	467	65	5673	12966	3330	55	1132	859
2289	0	348	5643	10744	3184	0	814	714
2541	318	82	4504	10241	3226	43	482	824
3236	222	70	6641	12199	3817	60	565	858
1607	293	55	4427	8187	3494	60	399	725
3435	404	73	6669	13603	3744	37	383	786

P	S	S Error 1s	K	Ca	Ti	V	Cr	Mn	
						0	0	0	0
0	0	135	0	0	0	0	0	0	0
0	0	134	0	0	0	0	0	0	0
0	1058	72	1764	49095	0	0	0	0	0
751	1016	95	23958	22207	3420	85	59	650	
527	841	93	23752	22257	3468	86	65	661	
816	16946	209	22837	5874	3407	75	0	2107	
1052	1144	97	23428	22216	3240	84	63	654	
0	0	133	0	0	0	0	0	0	
1273	17524	211	22859	5973	3492	80	0	2076	
687	1130	94	24554	22234	3580	115	67	644	
945	811	91	22306	21308	3377	102	71	699	
2393	1869	61	3105	2108	0	0	9647	357	
2312	2841	70	2553	2134	0	0	13257	208	
2663	2915	84	2268	3227	0	0	7393	385	
2485	470	58	4478	7956	1624	0	4444	455	

Fe	Fe Error 1s	Ni	Cu	Zn	As	As Error 1s	Cd	Pb
49939	226	199	150	98	18	2		53
37428	1271	203	182	89	34	11		
47241	217	217	138	105	16	2		51
49683	227	225	153	103	23	2		55
		211	155.75	98.75	22.75			53
45943	359	209	122	94	20	2	0	40
45961	203	197	92	108	43	2	0	120
49715	220	252	97	96	28	2	0	84
48972	212	190	78	104	31	2	0	96
47595	399	195	62	96	30	2	0	86
43232	180	164	108	86	16	2	0	62
44328	193	186	181	105	29	2		86
45311	192	186	181	100	26	2		77
41471	369	158	161	87	25	2		67
		176.6667	174.3333	97.33333	26.66667			76.66667
46833	347	210	169	105	27	2	0	70
48658	369	220	124	99	33	2	0	98
45901	202	179	39	103	47	3	0	135
42893	186	146	37	99	48	3	0	149
36561	151	150	142	130	22	1	0	7
33472	249	127	148	121	21	1	0	7
40461	168	158	284	114	6	1	0	14
40511	334	152	316	112	4	1	0	16
38783	192	172	240	112	5	1	0	8
41355	180	183	110	137	13	1	0	9
34698	146	125	142	116	6	1	0	8
34193	223	123	205	95	0	14	0	13
21232	90	79	87	77	2	1	14	3
16100	73	65	55	50	0	7	0	3
35559	146	253	63	86	4	1	0	9
48438	211	261	74	89	7	1	0	6
32183	142	147	27	125	4	1	0	10
36113	307	160	25	226	5	1	0	17
38780	178	175	30	208	6	1	0	11
41479	355	183	28	201	7	1	0	15
28461	123	109	203	135	3	1	0	7
21974	96	81	35	60	3	1	18	3
40718	172	177	58	82	0	9	0	12
37998	155	160	49	84	4	1	0	6
33065	238	124	39	72	3	1	0	5
42856	327	171	57	86	5	1	0	9
28586	111	102	52	384	16	1	20	61
42694	307	152	162	335	6	1	0	10
34950	222	120	85	243	4	1	0	9
44451	339	161	111	267	10	1	0	34
47565	207	165	113	266	9	1	0	11
37421	164	139	72	215	4	1	0	11
38454	257	171	75	181	6	1	0	10
42201	306	172	86	236	6	1	0	8

44417	404	169	114	337	8	1	0	11
42639	394	138	131	288	5	1	0	14
41488	294	131	45	194	5	1	0	10
38968	218	141	110	94	5	1	0	9
38041	183	139	119	85	4	1	0	6
44447	328	167	116	94	4	1	0	8
40589	306	179	131	99	5	1	0	8
39722	296	119	94	98	3	1	0	6

Fe	Fe Error 1s	Ni	Cu	Zn	As	As Error 1s	Cd	Pb
80	8	0	0	0	0	8	0	0
60	7	0	0	0	0	8	0	0
57	7	0	0	0	0	8	0	0
1309	19	0	63	118	11	3	22	356
27288	134	23	150	441	45	7	44	1470
27332	134	22	150	435	45	7	47	1464
42267	197	18	3666	4362	1448	18	0	5616
26828	132	27	151	423	57	7	41	1433
42	6	0	0	0	0	8	0	0
41850	195	0	3648	4428	1396	18	0	5585
27415	132	26	157	443	51	7	47	1484
27606	134	23	145	428	35	7	44	1451
1483	15	0	4069	253	5345	19	17	0
2626	21	0	6328	57	7328	27	18	0
1842	24	0	4783	609	5494	48	24	0
18458	80	44	2401	338	2986	12	14	0

Pb Error 1s	Bi	LE	LE Error 1s
2	23	590076	2001
302		956096	1551
2	15	608505	2022
2	17	626786	2012
2	25	583193	4272
3	18	651797	1917
2	13	602317	1961
2	24	632854	1894
2	22	579830	4595
2	26	634727	1804
2	23	640301	1891
2	16	629772	1845
2	20	588326	4909
2	25	571201	3972
3	28	528687	3814
3	22	630753	1923
3	23	639961	1872
1	26	696232	1741
1	26	696697	4670
1	29	657199	1791
1	13	647140	4918
1	0	671300	2130
1	14	629700	1888
1	15	684716	1766
2	15	961520	261
1	21	760107	1627
1	8	775762	1630
1	23	746841	1659
1	23	665440	1905
1	13	712161	1806
1	13	694433	5402
1	19	687820	1928
1	14	640708	5078
1	13	761614	1687
1	0	815663	1594
1	23	653041	1818
1	28	664625	1730
1	24	667619	4317
1	18	592376	4202
2	28	735233	1540
1	25	585783	3911
1	31	617950	3543
2	27	530799	3834
1	12	577097	1913
1	0	605002	1959
1	25	583955	3586
1	23	584982	3938

1	0	524430	4574
2	0	522684	4614
1	14	603964	3944
2	0	631825	2419
1	20	673093	2043
1	24	568005	3918
1	31	710876	4847
1	0	560948	3895

Pb Error 1s	Bi	LE	LE Error 1s
36	0	999920	8
33	0	562589	1450
32	0	563441	1448
4	0	917452	1365
11	0	548540	1879
10	0	542149	1880
29	61	513923	1968
10	0	545855	1894
33	0	557015	1435
29	60	520485	1961
10	0	539568	1838
10	0	558118	1885
25	0	882401	1323
24	9	838160	1448
28	0	805501	6552
28	0	690125	1619

Sample ID	Date	Time	Latitude	Longitude	Al	Si	P	S
ma5a1	12/05/2017	10:31:53	-41.20360184	173.0709991	32516	161931	864	391
ma5a1	12/05/2017	10:32:53	-41.20360184	173.0709991	28420	140929	660	
ma5a1	12/05/2017	10:33:54	-41.20360184	173.0709991	38650	190768	644	
ma5a2	12/05/2017	10:48:17	-41.20330048	173.0709991	31328	134999	505	370
ma5a3	12/05/2017	10:54:39	-41.20320129	173.0709991	40337	192723	1128	374
ma5a6	12/05/2017	11:02:21	-41.2030983	173.0720062	28625	139945	630	499
ma5a5	12/05/2017	11:11:23	-41.20320129	173.0720062	41076	212468	857	1062
ma5a4	12/05/2017	11:16:11	-41.20339966	173.0720062	54055	227705	920	653
ma11	12/05/2017	13:30:27	-41.20399857	173.0639954	46678	207635	341	658
ma11	12/05/2017	13:31:51	-41.20410156	173.0639954	49744	213183	561	673
ma11	12/05/2017	13:33:22	-41.20429993	173.0639954	51190	219146	378	807
ma12	12/05/2017	13:38:47	-41.20439911	173.0639954	50156	198146	293	517
ma13	12/05/2017	13:46:37	-41.20410156	173.0639954	47160	181324	0	564
ma3a1	12/05/2017	14:47:49	-41.21030045	173.0659943	35268	146174	0	590
ma3a1	12/05/2017	14:48:39	-41.21030045	173.0659943	32873	154513	0	655
ma3a2	12/05/2017	14:54:39	-41.21020126	173.0659943	34278	137903	0	520
ma3a4	12/05/2017	15:06:57	-41.2098999	173.0659943	42111	178493	0	670
ma3a6	12/05/2017	15:12:25	-41.20959854	173.0659943	48902	202206	0	529
ma3a5	12/05/2017	15:18:25	-41.20970154	173.0670013	40938	161993	0	358
ma3a3	12/05/2017	15:29:50	-41.21009827	173.0670013	57909	248031	435	622
ma41	12/05/2017	16:42:38	-41.21450043	173.0650024	121572	615360	2562	635
ma42	12/05/2017	17:02:07	-41.21500015	173.0650024	106328	491942	2208	436
ma21	13/05/2017	9:26:14	-41.21229935	173.0570068	61108	268685	1129	372
ma21	13/05/2017	9:37:34	-41.21220016	173.0570068	63010	263831	1254	271
ma21	13/05/2017	9:38:25	-41.21220016	173.0570068	62224	255844	1020	421
ma22	13/05/2017	9:47:36	-41.21239853	173.0570068	48056	206125	1065	962
ma23	13/05/2017	10:03:15	-41.21289825	173.0579987	58423	274709	1320	474
ma24	13/05/2017	10:10:39	-41.2132988	173.0570068	58504	235883	1130	559
ma25	13/05/2017	10:22:52	-41.21289825	173.0570068	60671	236251	1280	609
ma26	13/05/2017	10:27:39	-41.21250153	173.0570068	57524	252706	929	545
ma71	13/05/2017	11:09:11	-41.2118988	173.0829926	52171	226431		250
ma71	13/05/2017	11:17:08	-41.21179962	173.0829926	56560	262157		
ma71	13/05/2017	11:17:57	-41.21179962	173.0829926	59604	279100	463	
ma72	13/05/2017	11:26:48	-41.2120018	173.0820007	70095	300165	1092	0
ma73	13/05/2017	11:33:10	-41.21179962	173.0829926	70003	280648	688	0

Sample ID	Date	Time	Latitude	Longitude	Al	Si	P	S
test	12/05/2017	9:15:46			67284	286403	996	17040
test	12/05/2017	9:17:40	-41.31309891	173.2180023	69307	289131	940	956
test	12/05/2017	9:19:15	-41.31309891	173.2180023	0	441299	0	0
test	12/05/2017	17:14:23	-41.21480179	173.0630035	49264	194974	0	674
test	12/05/2017	17:15:19	-41.21480179	173.0630035	31886	134098	0	4449
test	12/05/2017	17:16:40	-41.21480179	173.0630035	7145	297800	0	0
test	13/05/2017	8:27:18			84053	380229	998	967
test	13/05/2017	8:28:23			76576	371910	1458	13901
test	13/05/2017	8:29:26			26273	468062	0	0
test	13/05/2017	12:34:43	-41.3132019	173.2180023	85682	351893	509	408
test	13/05/2017	12:35:44	-41.3132019	173.2180023	86480	377167	702	11886

test	13/05/2017	12:36:41	-41.3132019	173.2180023	43645	449521	0	0

S Error 1s	K	Ca	Cr	Mn	Fe	Fe Error 1s	Cu	Zn	As	As Error 1s	Cd
74	5801	1498		101	8959	55	25	26	39	2	
649	6231	1267		116	11068	78	25	30	45	3	
388	7070	1100		129	10760	67	23	28	32	3	
68	6008	1586	0	53	7328	46	18	27	17	2	17
66	6844	973	32	55	8115	48	21	27	26	2	0
56	3452	1655	0	51	4372	30	10	24	7	2	0
88	7756	1710	0	75	7649	51	14	27	15	2	0
67	6497	978	32	74	7215	43	10	23	13	2	0
65	7399	1607		130	7106	42	10	27	6	1	
69	7746	1761		125	7835	46	16	29	11	2	16
74	8024	1895	51	148	7993	49	18	32	7	2	
64	7083	1594	43	133	7350	43	17	38	8	2	0
58	6368	1498	44	119	6492	38	13	32	5	1	0
59	5511	1771	0	123	6003	37	18	41	0	17	0
66	5943	2027	42	107	6647	41	20	49	0	18	0
57	5516	1961	0	112	7393	41	19	39	5	2	16
67	6275	2036	32	142	9692	53	14	52	15	1	15
68	6462	1777	0	137	9066	52	23	46	9	2	0
51	4895	1442	0	104	5717	33	13	34	0	16	12
71	6701	1447	33	155	8637	50	23	43	0	21	0
119	12147	0	0	277	13814	80	45	53	16	2	0
92	8894	0	0	192	10461	61	32	48	12	2	18
74	7411	1348		100	11049	61	17	31	16	2	
66	6803	1292		90	8765	49	7	28	11	1	
61	6582	1751	30	61	8856	47	9	30	11	1	
85	11606	1450	0	100	8972	57	10	40	10	2	0
84	7834	2670	49	109	10481	63	21	61	6	2	0
75	5785	2079	0	81	10602	60	12	42	9	1	0
69	5441	2274	0	75	9579	53	10	51	9	1	0
88	5872	1968	0	112	11203	68	15	49	9	2	0
83	6105	627		171	8367	55	24	22	13	2	
216	5538		34	134	7508	47	16	21	11	2	
204	5728		37	136	7858	49	16	21	16	2	
179	7597	282	0	143	10100	57	22	24	11	2	0
189	6981	1012	0	195	10858	59	17	62	11	2	0

S Error 1s	K	Ca	Cr	Mn	Fe	Fe Error 1s	Cu	Zn	As	As Error 1s	Cd
208	21757	5678	0	2009	40781	193	3595	4274	1365	17	0
94	23733	22409	59	675	26920	133	153	425	47	7	50
127	0	0	0	0	0	22	0	0	0	8	0
87	15078	12905	0	479	21512	115	126	370	0	71	48
137	8034	1987	0	1458	30575	168	2847	3461	1111	15	0
242	408	0	0	0	1009	17	0	4	0	9	0
102	21863	17855	62	608	26077	127	147	391	30	7	46
192	20089	3831	0	1962	39462	177	3348	4022	1245	16	0
124	0	0	0	0	1109	18	0	0	0	9	0
95	19267	14197	0	629	25034	124	141	393	33	7	51
187	18646	3061	0	1846	38156	176	3187	3822	1172	16	0

123	1245	0	0	52	2002	24	0	7	0	9	0	

Pb	Pb Error 1s	Bi	LE	LE Error 1s
191	3		785702	1717
237	4		808592	2119
203	3		748346	1898
248	3	0	815809	1662
232	3	0	747126	1636
139	2	18	819264	1417
182	3	0	725068	1818
159	2	19	699817	1607
83	2	20	726242	1578
84	2		716010	1640
113	2	13	707878	1704
104	2	17	732467	1612
97	2	23	754402	1522
96	2	20	802914	1506
100	2	14	795282	1576
119	2	19	810609	1485
76	2	20	758433	1626
125	2	11	728785	1668
94	2	17	783103	1421
131	2	0	673752	1663
106	3	0	229645	1101
93	2	0	376443	1401
86	2		646094	1694
72	2	19	652428	1605
73	2	16	661039	1527
59	2	0	719790	1824
59	2	0	641611	1800
63	2	0	683218	1724
44	1	11	682031	1642
90	2	0	666818	1866
118	2		703527	1873
111	2		665789	1691
118	2	12	644771	1692
96	2	11	608245	1665
75	2	0	627234	1676

Pb	Pb Error 1s	Bi	LE	LE Error 1s
5465	29	56	538981	1981
1458	11	0	559480	1889
0	34	0	558701	1426
1297	10	0	699952	1944
4811	28	45	772258	2141
0	34	0	693385	1602
1404	10	14	461099	1765
5249	26	57	452632	1821
0	35	0	504252	1503
1345	10	0	495986	1834
5142	26	62	444320	1863

4	1	0	502741	1567

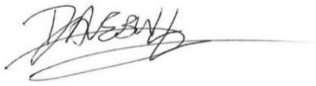
Appendix D: Site-Specific Soil Guideline Value Calculation

TIER II SITE-SPECIFIC RISK ASSESSMENT INCLUDING ORAL BIOAVAILABILITY FOR **ARSENIC**

Site Identification: **Former pipfruit orchards on Ranzau soils, Tasman District**

Risk Assessor: **Dr. Dave Bull CEnvP:CLS CChem**

Signature:



For Supporting Details See *Arsenic bioavailability assessment: former pipfruit orchards on Mapua and Ranzau Soils, Tasman District.* Report 1014 for Massey University and Tasman District Council. HAIL Environmental Ltd. Wellington.

Bioaccessibility Test Protocol Used: Solubility and Bioavailability Research Consortium

Sample ID	Total Arsenic (mg/kg)	Bioaccessible Arsenic (mg/kg)	*In Vitro* Bioaccessibility	*In Vivo* Bioavailability
RNZ01 A 19-Apr-2017 10:00 am	21	1.8	9%	10%
RNZ01 C 19-Apr-2017 10:00 am	21	2.9	14%	14%
RNZ02 A 19-Apr-2017	18	1.9	11%	12%
RNZ03 A 19-Apr-2017	45	5.8	13%	13%
RNZ04 A 19-Apr-2017 10:35 am	28	3.7	13%	13%
RNZ05 A 19-Apr-2017	33	4.2	13%	13%
RNZ06 A 19-Apr-2017	35	4.4	13%	13%
RNZ11 A 19-Apr-2017 11:30 am	25	2.8	11%	12%
RNZ12 A 19-Apr-2017	31	4.1	13%	13%
RNZ12 C 19-Apr-2017 11:55 am	31	4.6	15%	15%
RNZ13 A 19-Apr-2017	27	3.7	14%	14%
RNZ14 A 19-Apr-2017	36	5.2	14%	14%
RNZ15 A 19-Apr-2017	50	8	16%	16%
RNZ16 A 19-Apr-2017	**63**	8.7	14%	14%

Calculate Non-Detects as	1	× LOD		
Proportion of Non-Detects > 25%?	**Pass**			**Pass**
Shapiro-Wilk Test (for normality)	**Pass**			**Pass**
Grubbs Test (for high outliers)	**REVIEW**			**Pass**
Minimum	**18**	mg/kg	9%	**10%**
Maximum	**63**	mg/kg	16%	**16%**
Arithmetic Mean	**33**	mg/kg	13%	**13%**
Standard Deviation	**12**	mg/kg	2%	**1%**
UCL_{95}	**39**	mg/kg	14%	**14%**
Averaging Areas Within Site:	Multiple		Results tightly grouped?	**Pass**

Data Quality Objectives:	
Representativeness - samples adequately cover site soils	**No**
Accuracy - bioaccessibility standard in acceptable range	Yes
Repeatability - duplicate root mean square error < 30 %	Yes
Reproducibility - interlaboratory duplicate RMSE < 30 %	

Supporting Lines of Evidence: Low for an applied pesticide, but within existing range of results for orchards. Consistent with moderately high iron content in this soil type. No positive identification of arsenic-containing minerals, also consistent with adsorption to iron oxides.

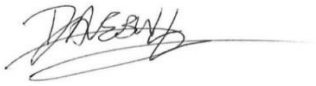
Exposure Scenario	**Residential**	**Site SGV**	**68**	mg/kg
ASSESSMENT RESULT				

TIER II SITE-SPECIFIC RISK ASSESSMENT INCLUDING ORAL BIOAVAILABILITY FOR **ARSENIC**

Site Identification: **Former pipfruit orchards on Mapua soils, Tasman District**

Risk Assessor: **Dr. Dave Bull CEnvP:CLS CChem**

Signature:



For Supporting Details See *Arsenic bioavailability assessment: former pipfruit orchards on Mapua and Ranzau Soils, Tasman District.* Report 1014 for Massey University and Tasman District Council. HAIL Environmental Ltd. Wellington.

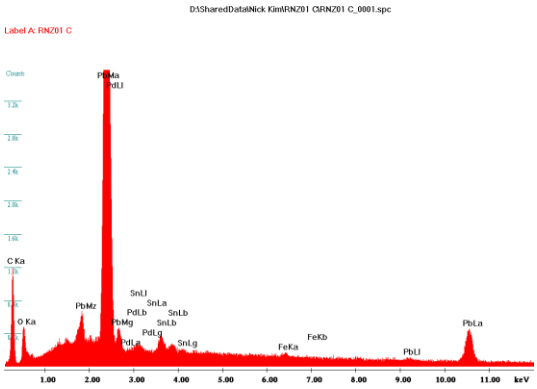
Bioaccessibility Test Protocol Used: Solubility and Bioavailability Research Consortium

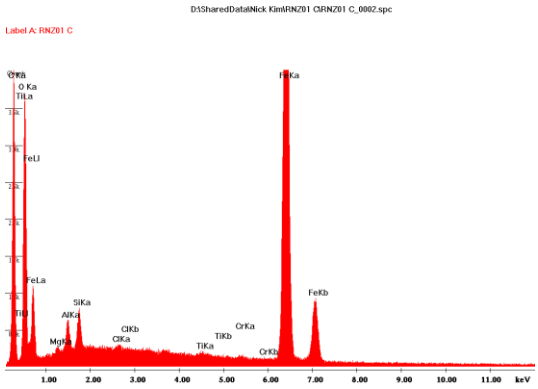
Sample ID	Total Arsenic (mg/kg)	Bioaccessible Arsenic (mg/kg)	*In Vitro* Bioaccessibility	*In Vivo* Bioavailability
MA5A1 A 12-May-2017 10:20 am	47	21.0	45%	39%
MA5A1 C 12-May-2017 10:20 am	40	19.6	49%	42%
MA5A2 A 12-May-2017	40	17.1	43%	37%
MA5A3 A 12-May-2017	33	18.2	55%	46%
MA5A4 A 12-May-2017	23	10.6	46%	39%
MA5A5 A 12-May-2017	26	11.6	45%	39%
MA5A6 A 12-May-2017	15	7.7	51%	43%
MA3A1 A 12-May-2017 2:40 pm	15	8.0	53%	45%
MA3A1 C 12-May-2017 2:40 pm	15	7.1	47%	40%
MA3A2 A 12-May-2017	21	10.9	52%	44%
MA3A3 A 12-May-2017	16	6.6	41%	35%
MA3A4 A 12-May-2017	20	7.1	36%	31%
MA3A5 A 12-May-2017	24	12.8	53%	45%
MA3A6 A 12-May-2017	20	10.9	55%	46%
MA71 A 13-May-2017 11:00 am	21	5.5	26%	24%
MA71 C 13-May-2017 11:00 am	21	6.4	30%	27%
MA72 A 13-May-2017	17	5.5	32%	28%
Unlabelled [A-500]	19	2.8	15%	15%
MA11 A 12-May-2017 1:35 pm	22	9.1	41%	35%
MA12 A 12-May-2017	22	7.7	35%	31%
MA13 A 12-May-2017	22	10.8	49%	42%
MA21 A 13-May-2017 9:30 am	20	9.6	48%	41%
MA21 C 13-May-2017 9:30 am	21	8.5	40%	35%
MA22 A 13-May-2017	12	5.0	42%	36%
MA23 A 13-May-2017	9	3.5	39%	34%
MA24 A 13-May-2017	13	4.8	37%	32%
MA25 A 13-May-2017	11	4.5	41%	35%
MA26 A 13-May-2017	14	5.4	39%	34%
MA81 A 22-May-2017 1:15 pm	21	8.5	40%	35%
MA82 A 22-May-2017 2:15 pm	15	6.4	43%	37%
MA83 A 22-May-2017 2:40 pm	15	5.8	39%	34%
MA84 A 22-May-2017 3:00 pm	14	4.2	30%	27%
MA85 A 22-May-2017 3:15 pm	9	2.8	31%	27%
MA86 A 22-May-2017 3:35 pm	14	4.9	35%	31%
Calculate Non-Detects as	1	× LOD		
Proportion of Non-Detects > 25%?	**Pass**			**Pass**
Shapiro-Wilk Test (for normality)	**REVIEW**			**Pass**
Grubbs Test (for high outliers)	**REVIEW**			**Pass**
Minimum	**9**	mg/kg	15%	**15%**
Maximum	**47**	mg/kg	55%	**46%**
Arithmetic Mean	**20**	mg/kg	41%	**36%**
Standard Deviation	**9**	mg/kg	9%	**7%**
UCL_{95}	**23**	mg/kg	44%	**38%**
Averaging Areas Within Site:	Multiple		Results tightly grouped?	**Pass**

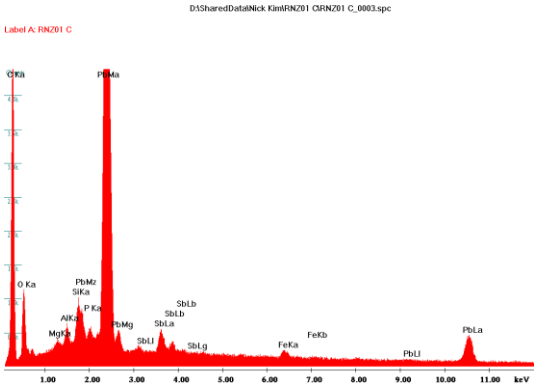
Data Quality Objectives:	
Representativeness - samples adequately cover site soils	Yes
Accuracy - bioaccessibility standard in acceptable range	Yes
Repeatability - duplicate root mean square error < 30 %	Yes
Reproducibility - interlaboratory duplicate RMSE < 30 %	

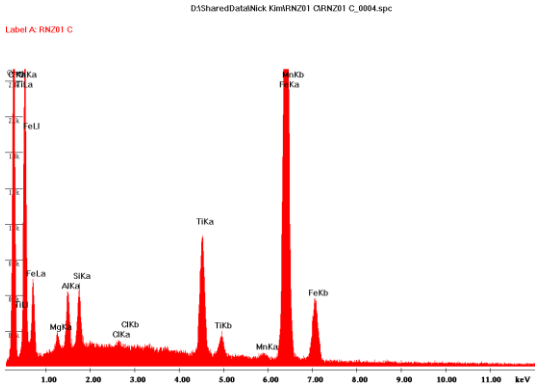
Supporting Lines of Evidence:	Low for an applied pesticide, but within existing range of results for orchards. Consistent with moderately high iron content in this soil type. No positive identification of arsenic-containing minerals, also consistent with adsorption to iron oxides.			
Exposure Scenario	**Residential**	**Site SGV**	**40**	mg/kg
ASSESSMENT RESULT				

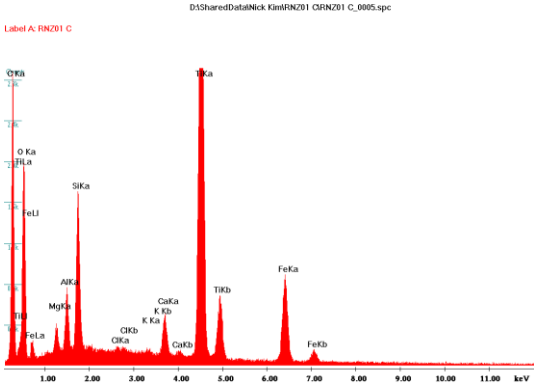
Appendix E: SEM-EDAX Spectra

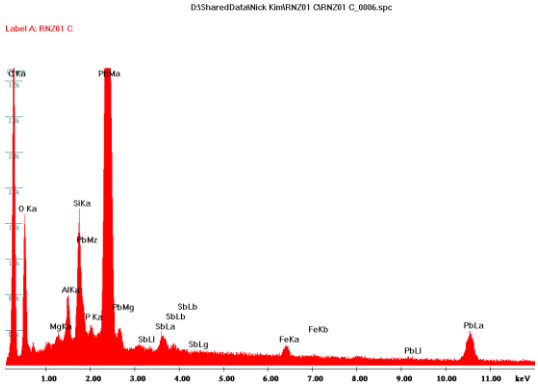


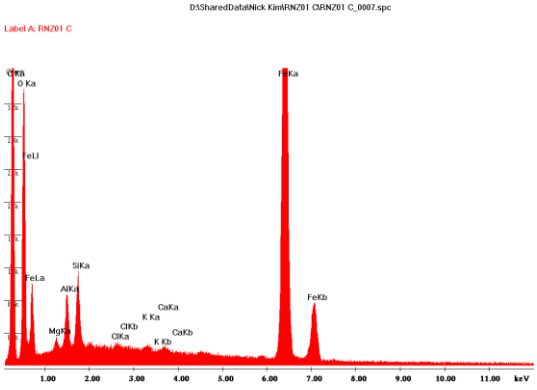


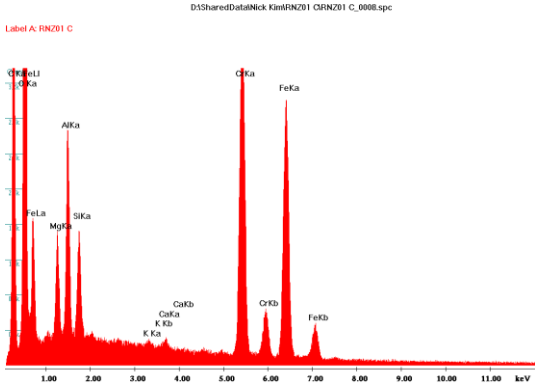












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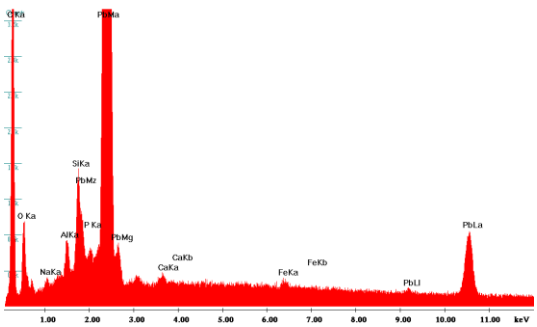

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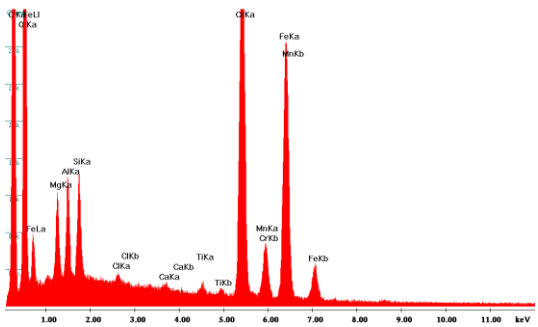

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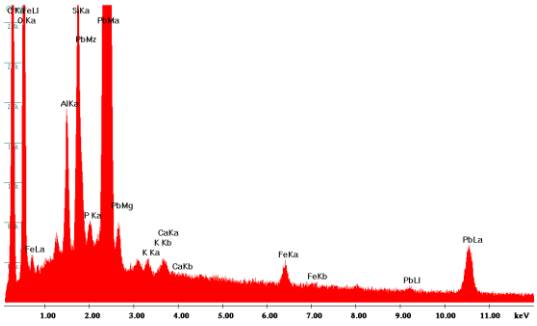

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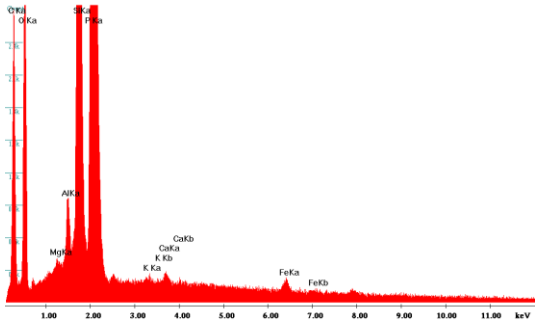

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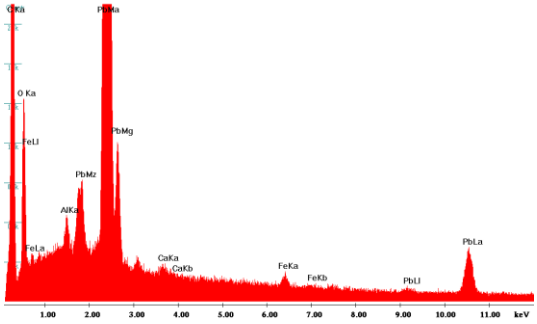

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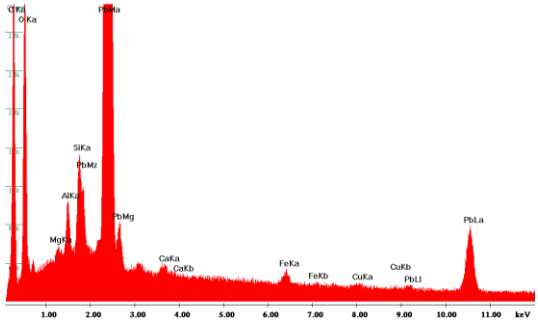

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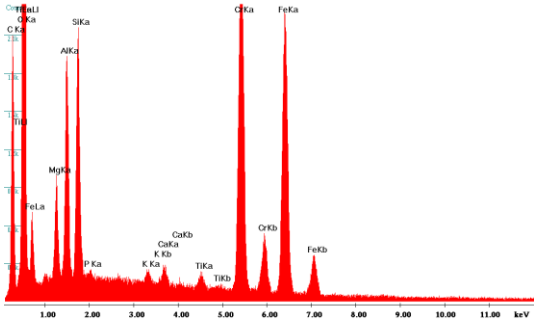

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