Characterising arsenic bioaccessibility in legacy gold mine wastes

Technical report

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EPA acknowledges Aboriginal people as the first peoples and Traditional custodians of the land and water on which we live, work, and depend. We pay respect to Aboriginal Elders past and present and recognise the continuing connection to, and aspirations for Country.

Contents

1 Introduction

1.1 Background to the report

Bendigo's gold mining heritage generated mine wastes that are still part of its environment today. These mine wastes can have high levels of arsenic as a result of mining processes. EPA Victoria is undertaking a program of work to better understand the nature and extent of legacy arsenic in soil in the Central Victoria historical gold mining areas. This has included characterisation of the ambient background soil arsenic concentrations across the City of Greater Bendigo (EPA Victoria, 2023). Ambient background arsenic concentrations measuring 14.6 mg/kg were observed to be consistent with national background values of 16.8 mg/kg recorded across Australia (Reimann and de Caritat, 2017). This technical report builds on the background assessment of arsenic concentrations to assess the bioavailability for different types of mine waste present across the City of Greater Bendigo area.

1.2 Purpose and structure of report

These findings provide EPA, Environmental Auditors, and contaminated land consultants with further information to support assessment of arsenic mine tailings in the Goldfields Regions. The information contained in this report will be useful for other parties involved or interested in contaminated land management, including:

- landowners and managers
- planning or responsible authorities and other statutory authorities
- Djaara, in their aspirations and goals for country
- community.

The report provides an overview of the:

- aim, objectives and scope of work undertaken
- background to bioavailability of arsenic in mine waste
- investigation methods
- results and analysis
- findings and recommendations.

2 Background to bioavailability of arsenic in mine waste

2.1 Sources of mine waste in Bendigo

Mine wastes are typically found at sites with historic mining infrastructure, and in areas where it was used for fill purposes in construction and civil projects.

Different ore processing methods have influenced the physical and chemical characteristics of mine waste. They are predominantly in the form of grey sands which is sourced from crushing ore, and calcined sands (red-purple colour) which are sourced from roasting of ore. Other mine wastes are found in operational infrastructure such as tailings ponds, and in areas where alluvial gold mining occurred. These wastes are usually present in the form of pebbles and sediments.

The mobility of arsenic from mine waste is influenced by mineral species, which can contain or host arsenic (Drahota and Filippi, 2009). Arsenic containing minerals include primary minerals such as arsenopyrite and realgar (AsS), and secondary products resulting from processing activities such as scorodite (Savage et al., 2000). Other common secondary minerals that host arsenic include jarosites, iron hydroxides and oxides (Majzlan et al., 2014; Meunier et al., 2010a).

Visual assessment of mine wastes in mining areas typically results in generic categorisation of mine waste as calcined sand (red in colour), grey sands, worked alluvium and mullock (EPA Vic, 2022). Typical concentrations of arsenic in grey sands are in the order of 100 – 3,000 mg/kg, while calcine sands are typically 1,000 – 60,000 mg/kg (Appendix A). Ambient background concentrations are typically below 14 mg/kg (EPA Science, 2023).

2.2 Considering arsenic bioavailability in risk assessment of mine wastes

The National Environment Protection (Assessment of Site Contamination) Measure (National Environment Protection Council, 1999), also known as the NEPM, sets out the assessment framework for contaminated land. It includes health investigation levels (HILs) which are screening levels for assessing soil contamination. Though an exceedance of HILs does not imply risk, it does indicate that further assessment is necessary. In addition, the NEPM provides additional guidance for assessing hot spots of contamination, (identified in regulation 4 of the Environment Protection Regulations 2021 as localised elevated value thresholds), specifying that no single sample should be above 250% of the relevant HIL.

HILs are based on how a person may be exposed to contaminated soils in residential, public open space and commercial settings. The screening criteria reflect the sensitivity of the land use, as shown in Table 1.

Table 1: Summary arsenic Health Investigation Levels

Type	Land Use	Arsenic, HIL, mg/kg
HIL A	Residential land use with home grown fruit and vegetables	100
HIL B	Residential with limited access to soil	500
HIL C	Public Open Space	300
HIL D	Commercial	3000

Arsenic in mine waste can enter a person's body primarily through incidental oral ingestion of soil and dust. This pathway contributes between 72%-86% of a person's exposure with other pathways, including home-grown food or dermal (skin) contact.

Bioavailability is defined as the amount of a substance absorbed by the body. The default HIL values for arsenic assume that all arsenic ingested is absorbed, which assumes that it has a bioavailability of 100%. However, it is rare that metal or metalloid contamination in soil is fully absorbed by the body and bioavailability is typically lower than this.

Where sufficiently justified, the bioavailability used in the calculation of a HIL may be adjusted to account for site-specific bioavailability data. Bioavailability of arsenic in the Bendigo region is specifically addressed in schedule B7 A1 of the NEP(ASC)M (National Environment Protection Council, 1999):

"Available data from Bendigo in Victoria suggests that the bioavailability of arsenic in soil derived from mine tailings in this region commonly ranges from 10-20% and is generally less than 30%. The value of 25% that is adopted by the US EPA would be appropriate in these areas.

With consideration of the above, a range of 25-70% bioavailability may be appropriate for the assessment of arsenic in soil. The range of bioavailabilities considered would need to be based on suitable data in relation to source and site-specific bioavailability (where lower bioavailability values were considered appropriate)."

This assumption is based on unpublished work commissioned by EPA Victoria in 2002. The study measured arsenic *in vitro* bioaccessibility (using the methods set out in Rodriguez et al., 1999) for five samples from Bendigo, with the results ranging from 7 – 16% of the total arsenic concentration (CSIRO, 2002).

The methods used to assess bioaccessibility have been updated, with range of different *in vitro* test methods that mimic conditions in the human gastrointestinal tract. When selecting a method, it is important to ensure it has been validated with *in vivo* data, such as relative bioavailability as measured in swine or mouse models.

The way in which bioavailability is adjusted in a HIL is through estimating relative bioavailability. Relative bioavailability is the ratio of the absorbed fraction from the exposure medium (for example, soil) to the absorbed fraction from the dosing medium used in the critical toxicity study. Bioaccessibility refers to the fraction of arsenic that is soluble in the gastrointestinal tract, to relative bioavailability.

The relationship between bioaccessibility and relative bioavailability for arsenic has been established in Diamond et al., (2016) in the following linear regression equation:

$$Relative\ bioavailability(\%) = 0.79 \times in\ vitro\ bioaccessibility(\%) + 3.0$$

Existing data on bioaccessibility of arsenic in the Goldfields region is available from Environmental Audits conducted between 1995 and 2023 and published research studies. This data featured the following key findings:

- Out of 34 audits, 10 assessments of bioaccessibility were undertaken, with 44 samples tested for *in vitro* bioaccessible arsenic. Results ranged from <1 – 100% of the total arsenic present.
- In 8 research studies conducted in the Goldfields region, 66 samples reported *in vitro* bioaccessible arsenic ranging from 2 – 82% of the total.

Ollson et al., (2016) analysed arsenic bioaccessibility in different mine wastes, and observed a statistically significant difference in *in vitro* bioaccessible arsenic between waste types. These studies cautioned against the adoption of default bioaccessibility values, recommending that site- specific testing be undertaken to improve risk characterisation.

A summary of results from the Environmental Audits and research studies are presented in Appendix A – Tabulated summary of previous studies. Further information from the Environmental Audits and their supporting assessment reports are publicly available on the EPA website.

2.3 Factors that may influence bioaccessibility and bioavailability of arsenic.

While there is data relating to bioaccessibility in the Goldfields region in literature and Environmental Audits, analysis of influencing factors has been limited.

Previous research has highlighted the importance of arsenic mineralogy and soil physicochemical properties on the dissolution of arsenic from contaminated soils. Meunier et al., (2011) reported that the difference in arsenic bioaccessibility in mines waste from six abandoned gold mines was a consequence of differences in arsenic mineralogy (for example., arsenopyrite and realgar) and their propensity for dissolution under low pH gastric conditions. This understanding of mineral speciation and its relationship to *in vitro* bioaccessible arsenic aids our understanding of mine waste in Victoria.

Particle size is an important factor contributing to exposure to arsenic in mine wastes. This is because finer fractions (that is, <250µm) are more likely to adhere to skin and be incidentally ingested. Additionally, particle size may also contribute to exposure via multiple pathways. For example, particles smaller than 10 µm in aerodynamic diameter (PM10) may be inhaled (Kastury et al., 2017). Therefore, < 250 µm-sized particles are more likely to be ingested, and exposure from PM10 may result from both incidental ingestion and inhalation pathways.

Particle size fractions may also play an important role in arsenic bioaccessibility. Reported trends of increasing arsenic concentrations in finer fractions coincide with increased iron content (Smith et al., 2009), an important driver of arsenic mineral speciation (Meunier et al., 2010b).

2.4 Summary

Mine wastes such as calcined sands and grey sands have formed because of industrial processes that influence the minerology and subsequent physical and chemical characteristics of the waste.

Understanding the reliability of visual categorisation is a practical way for community and industry to identify mine waste. This can inform the need for subsequent assessment and management.

Advances in methods for assessing bioaccessibility means that an updated investigation into bioavailability will enable greater understanding to support contaminated land investigations.

Expanding on previous assessments to include consideration of influencing factors such as mineral speciation, particle size will aid greater understanding of drivers for exposure and bioavailability.

3 Purpose and objectives of the study

3.1 Purpose

The purpose of this investigation was to investigate drivers of bioaccessibility and whether there are easily identifiable indicators of high and low bioaccessibility.

The outputs of the investigation are intended to support contaminated land practitioners on how to account for bioavailability of arsenic in mine tailings during site assessment and remediation projects.

3.2 Objectives of the study

The investigation sought to identify key factors in understanding bioaccessibility through:

- characterising mineral speciation of mine waste to validate existing field visual characterisation assumptions
- assessing bioavailability trends to inform whether a default fraction could be identified for use in screening criteria for different waste types
- assessing potential influencing factors such as particle size, co-elemental characteristics, and mineral speciation to better understand drivers of bioavailability that may assist risk assessment and contaminated land management.

The scope of work delivered to support the investigation included:

- Sampling and field characterisation of mine wastes from several different sites across the City of Greater Bendigo municipality.
- Analysis of mine waste samples by the Future Industries Institute, University of South Australia for:
    - total and bioaccessible arsenic concentrations across different particle size fractions
    - total concentrations of other elements (lead, antimony, beryllium, boron, magnesium, aluminum, silica, calcium, scandium, titanium, vanadium, chromium, manganese, iron, cobalt, nickel, copper, zinc, selenium, strontium, yttrium, molybdenum, cadmium, barium, lanthanum, cerium, praseodymium, neodymium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium, lutetium and thorium)
- Semi-quantitative analysis of arsenic species present in a representative sub-set of samples using the X-ray Absorption Spectroscopy (XAS) beamline at the Australian Synchrotron.
- Statistical analysis and interpretation of results to identify trends amongst waste types and drivers of arsenic bioaccessibility.

The following limitations should be considered when reading this report:

- Sampling was undertaken on publicly accessible and publicly managed land
- No sampling of residential land was undertaken.
- The spatial extent of mine waste at the sites sampled has not been established.

- Elements in addition to arsenic have been analysed to support characterisation of mine waste types (Section 6.4). They are not reported in detail as broader elemental characterisation goes beyond the specific purpose of this work.

4 Methods

4.1 Overview of methods

This section provides details the sampling and categorisation approach and a summary of laboratory and statistical methods used. Further details are provided in Appendix B – Investigation and analysis methods.

4.2 Sampling Program

4.2.1 Field investigation

Samples were collected from known mine waste sites across the City of Greater Bendigo Local Government Area. Eleven mine waste sites were sampled, comprising of seven grey sands sites, three calcined sands sites, and one alluvial site.

The sampling approach taken did not seek to delineate or map mine waste sites across the Bendigo area. It sought to obtain samples representative of grey sands and calcined sands, which were the predominant types of mine wastes in the area. Minor types of mine wastes, including alluvial material and historic tailings pond samples, were also targeted.

Figure 1: Overview map showing sampling locations by mine waste type.

Surface soils (0-5 cm depth) were collected via a hand grab sample using powder free nitrile gloves, or a hand trowel where required. Subsurface samples were collected by digging a shallow pit using a hand trowel or shovel. At each sampling location, samples were collected at 0.5 m below ground level, or the maximum depth able to be hand-dug before non-penetrable rock was encountered.

At each location, GPS coordinates, time/date, site description, samplers name, photos and additional comments were recorded in Avenza Maps™ (Avenza Systems Inc.). Samples were visually assessed and assigned a mine waste category based on observed characteristics such as colour, structure, and particle characteristics.

Table 2: Sampling and analytical schedule (total number of analytical tests across <2mm, <250 µm, <106 µm, <52 µm fractions)

	Soil samples (no)	**Total concentration (arsenic and other elements)**	**Mineral speciation**	**Arsenic bioaccessibility (excluding 2mm)**
Calcined Sands	11	44	7	33
Grey Sands	35	140	22	105
Mixed material	4	16	3	12
Old tailings	5	16	3	12
Alluvial mine impacted tailings	2	2	-	6
Total	57	222	45	171

4.2.2 Laboratory analytical methods

Mine waste chemical and bioaccessibility analysis was conducted at the Future Industries Institute, University of South Australia. Mine waste was analysed for concentrations of arsenic (Table 1, Appendix C), and other elements (lead, antimony, beryllium, boron, magnesium, aluminum, silica, calcium, scandium, titanium, vanadium, chromium, manganese, iron, cobalt, nickel, copper, zinc, selenium, strontium, yttrium, molybdenum, cadmium, barium, lanthanum, cerium, praseodymium, neodymium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium, lutetium and thorium).

Soil samples were sieved into their 2 mm, 50 µm, 106 µm and 53 µm particle size fractions, after which they were subjected to aqua-regia acid digestions following USEPA Method 3051a (USEPA, 2007a), with quantification of pseudo-total elemental concentrations using US EPA method 6010D (USEPA, 2014a) for ICP-OES and USEPA Method 6020B (USEPA, 2014b) for ICP-MS. Arsenic bioaccessibility was determined using the gastric phase of the SBRC assay as per Ollson et al., (2016), on the 250 µm, 106 µm and 53 µm particle size fractions. This assay has been validated independently with relative bioavailability data (Juhasz et al., 2011).

Mineral speciation analyses of mine wastes were carried out on a sub-set of representative samples on the X-ray Absorption Spectroscopy Beamline ID-12 at the Australian Synchrotron, ANSTO Melbourne. Reference materials were obtained from Museum Victoria, with additional synthetic materials provided by Australian Synchrotron. The beamline instrument was set up for analysis of arsenic using the standard Australian Synchrotron setup protocols described in Appendix B. All samples and reference materials were analysed under cryogenic temperatures ($<$10 K) within a Helium (He) atmosphere.

4.2.3 Quality Assurance and Quality Control Program

The following quality assurance and quality control measures were undertaken:

- All samples were labelled, geolocated and transported under chain of custody to the laboratory.
- For all surface samples, where possible the use of reusable field equipment (for example, nitrile gloves, new sample jars) was avoided to reduce the potential for cross contamination. Triple rinsing of equipment was conducted between sampling locations.
- Collection and analysis of blind duplicates and method replicates.
- Standard reference materials for arsenic (total and bioaccessible concentrations) were included routinely in analysis.

Data quality outcomes are detailed in Appendix B, which shows measurement reliability is acceptable for the purposes of the investigation.

4.3 Statistical and data analytical methods

Key analysis was undertaken using R (version 4.2.1) packages. This included the following:

- General statistics of concentration and bioaccessibility according to particle size, including mean, standard error of mean, minimum, maximum and coefficient of variation, with data grouped according to waste type.
- Tukey box and whisker plots, with results grouped according to waste types. Analysis of difference between medians was conducted using a Kruskal-Wallis test. A pair-wise comparison was then conducted post-hoc Wilcoxon-p.
- Principal coordinates analysis to identify similarities between elemental profiles according to waste types.

- A random forests classification machine learning algorithm was used to identify any elements that could be used as signatures to distinguish the different mine waste categories.

Further details on statistical methods used are presented in Appendix B.

5 Results

5.1 Field observations

Mine wastes were encountered at the surface or in piles at all sites visited.

- Calcined sand – sandy texture with a red to purple-pink colour, noting surface materials were observed to be covered in a green polymer used to minimise erosion. Samples were collected in areas that were not covered by the green polymer.
- Grey sand – sandy texture with a grey colour.
- Alluvial material – pebbles and fine-grained sediments in areas where alluvial gold mining occurred.
- Tailings pond material –collected from a pile thought to be sourced from an old tailings pond that formerly existed in the area. This material comprised of highly stratified layers of sand and silty material.
- Mixed materials were samples that indicated some presence of mine waste but did not otherwise fit in to any of the aforementioned categories.

A sample of field photographs showing material types is displayed in Appendix C.

5.2 Arsenic laboratory analysis results

This section summarises arsenic results. A copy of laboratory results as received from UniSA are shown in Appendix D, with a summary table in Appendix E.

5.2.1 Total arsenic concentration results

Concentrations of arsenic in calcined sands ranged from 4,663 mg/kg to 20,715 mg/kg, with the lowest concentration in the 2 mm fraction and the highest in the 53 µm fraction. Mean concentrations ranged between 10,520 mg/kg (± 8.9 %) and 14,670 mg/kg (± 9.1 %), increasing with decreasing particle size.

In grey sands, the range was 126 mg/kg to 47,069 mg/kg. The concentration of arsenic in grey sands was also lowest in the 2 mm fraction, and highest in the 53 µm fraction. Mean concentrations ranged between 1,322 mg/kg (± 24.7 %) and 4,620 mg/kg (± 30.8 %), similarly increasing with decreasing particle size.

In relation to minor waste types, old tailings ponds samples had remarkably higher arsenic concentrations as compared to calcined and grey sands, with an average of 72,275 mg/kg and a maximum of 231,679 mg/kg in the <2mm fraction. Mixed materials reported a range of 128 mg/kg to 987 mg/kg. However, unlike calcined and grey sands, mix materials reported the highest concentration in the 53 µm fraction. Alluvial materials had an average of 34.3 mg/kg, which is relatively low compared to the other waste types.

5.2.2 Bioaccessibility results

Calcined sands arsenic bioaccessibility ranged from 29 % (53 µm fraction) to 75 % (250 µm fraction). Mean bioaccessibility ranged between 43 % (± 7.0 %) and 45 % (± 6.7 %) across particle size fractions of 250 µm to 53 µm, indicating that there was relatively low variability in the average bioaccessibility of calcined sands.

Grey sands ranged from 2 % (53 µm fraction) to 68 % (250 µm fraction), with mean bioaccessibility ranging between 27 % (± 11.1 %) for the 53 µm fraction, and 31 % (± 9.7 %) for the 250 µm fraction.

For the minor waste types, the tailings ponds samples (250 µm fraction) reported relatively low arsenic bioaccessibility, ranging from 1.1 – 18.5 %, with an average of 6.4%. This indicates that arsenic present in old tailings ponds samples is sparingly soluble within the pH conditions of the bioaccessibility assay. Mix materials ranged from 6% to 46% (both in the 250 µm fraction) and for alluvial samples (<250 µm fraction), arsenic was 10.0 – 10.7 % bioaccessible.

For bioaccessible concentrations, calcined sands ranged from 1,655 mg/kg to 10,045 mg/kg (both in the 53 µm fraction). Mean bioaccessible concentrations ranged between 5,167 mg/kg (± 10.0 %) and 6,169 (± 9.4 %).

Grey sands bioaccessible concentrations ranged from 11 mg/kg (250 µm fraction) to 8,913 mg/kg (53 µm fraction). Mean bioaccessible concentrations ranged between 694 mg/kg (± 28.8 %) for the 250 µm fraction and 1,155 (± 24.7 %) for the 53 µm fraction. The median concentration ranged from 356 mg/kg to 647 mg/kg.

For minor waste types, the tailings ponds samples (250 µm fraction) reported arsenic bioaccessible concentration ranging from 535 – 2,221 mg/kg, with an average of 1,032 mg/kg. Mixed materials range was lower than either grey or calcined sands (min. 27 mg/kg; max 540 mg/kg).

5.3 Mineral speciation results

XAS scans are displayed in Appendix F – Synchrotron XANES scans. Scorodite, a more oxidised form of arsenic, was a major form present in 40 out of 45 samples. Scorodite was the dominant form in all grey sands samples, making up 49-98% of species reported. Calcined sands samples contained greater proportions of arsenic sorbed to iron oxides (natrojarosite and geothite). A break down according to the different mine waste types is shown in Figure 2. Tabulated results for each sample analysed is presented in Appendix E.

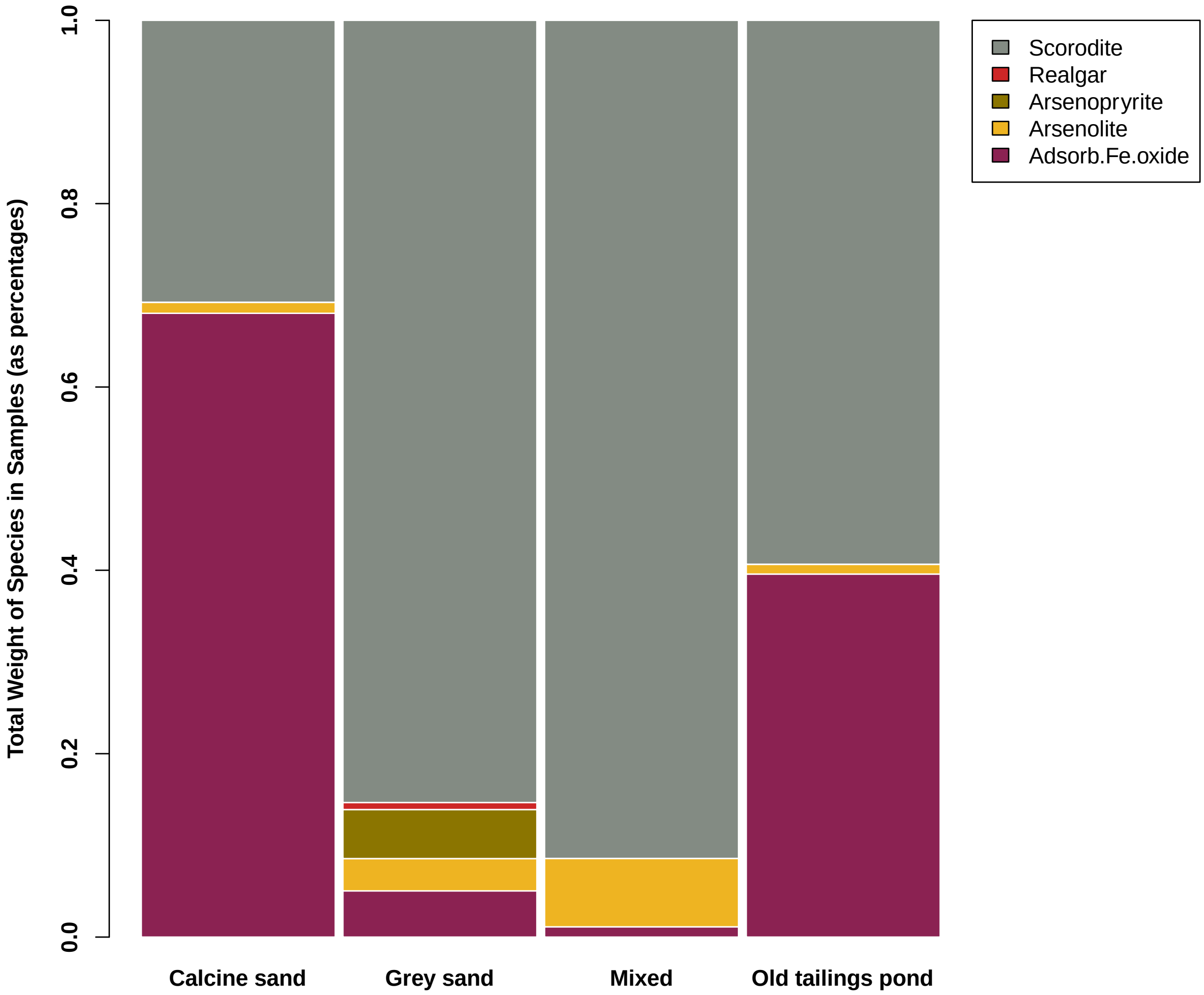

Figure 2: Total weight of arsenic species across five soil sampling site categories (calcined sand (n = 7), grey sand (n = 32), Mixed (n = 3) and Old tailing pond (n = 3)). Alluvial samples were not analysed due to low arsenic concentrations. Note: percentage weights have been forced to sum to 100%.

6 Data interpretation

6.1 Overview of data interpretation

This section presents the analysis undertaken to characterise arsenic in mine wastes to address the study objectives. Comparative analysis was undertaken for:

- total arsenic and bioaccessibility within different waste types and particle size fractions
- variability in arsenic bioaccessibility between different waste types
- adequacy of visual characterisation through comparative analysis of elemental indicators, mineral speciation and bioaccessibility of arsenic for different waste types.

6.2 Results according to waste types and particle size fractions

The first set of analysis aimed to understand if there are significant differences in the distribution of arsenic for different waste types and particle size fractions. Analysis was undertaken for calcine sands, grey sands, and mixed materials. Minor waste types of tailings pond material and alluvial material are not presented due to the low number of samples. Box-plots of arsenic results grouped by waste type and particle size fraction were generated to present the distribution visually. Analysis of differences between waste types were assessed using Kruskal-Wallis and Wilcoxon pair wise analyses, which are also displayed on the box-plots in Figure 3, Figure 4 and Figure 5 and summarised in the following paragraphs.

Kruskall-Wallis P values indicate whether there is a statistically significant ($p < 0.05$) difference between the median values of the three waste types. Unpaired two-sample Wilcoxon tests with Bonferroni corrections are indicated by horizontal bars (α = 0.05). This test was undertaken to identify which waste types were significantly different statistically from one another.

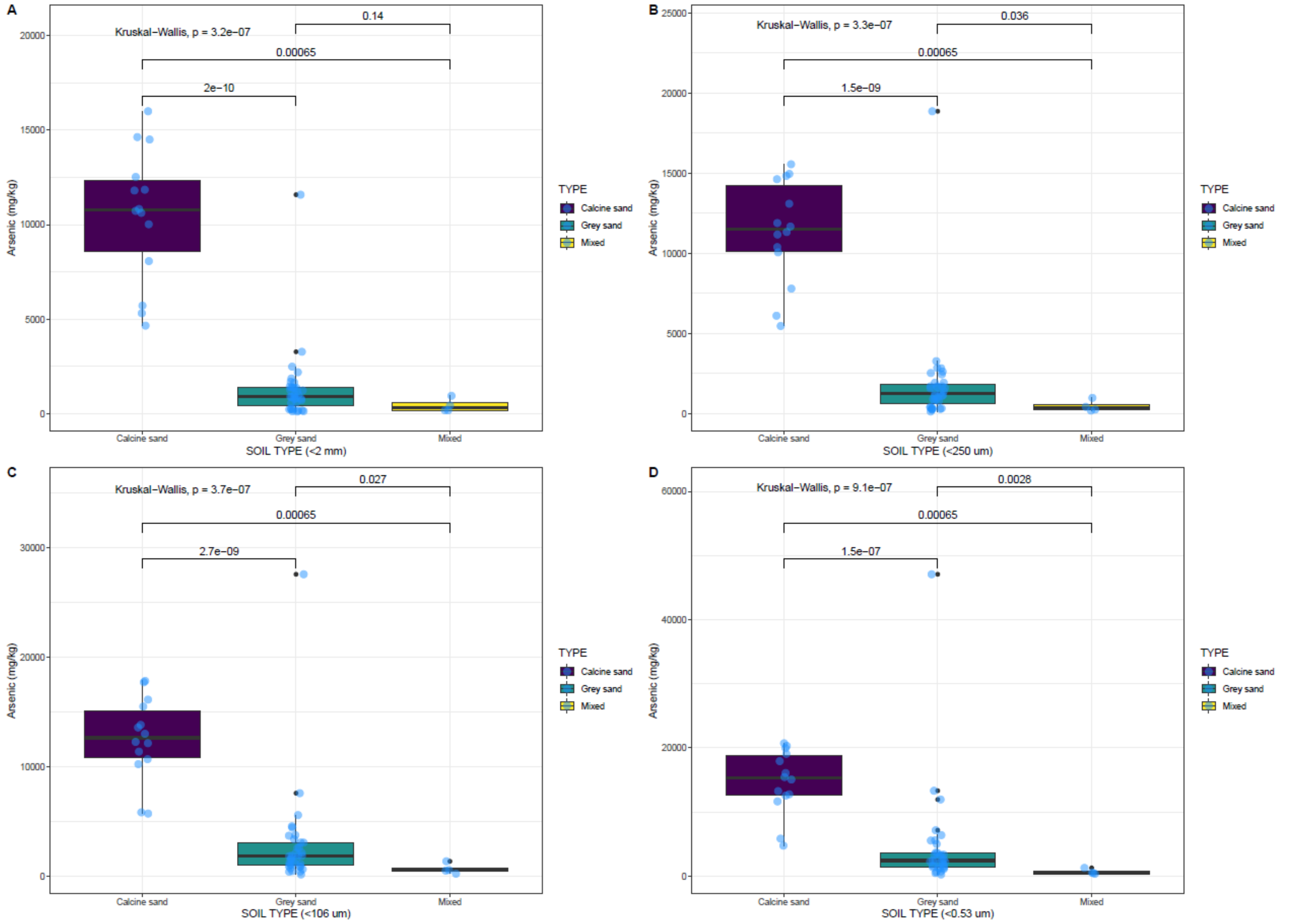

Figure 3: Arsenic concentrations (mg/kg) as box and whisker plots. Comparisons of arsenic in different size fractions of calcined sand, grey sand, and mix material. The plots are arranged by fraction. (A) <2 mm fraction. (B) <250 µm fraction. (C) <106 µm fraction. (D) <53 µm fraction.

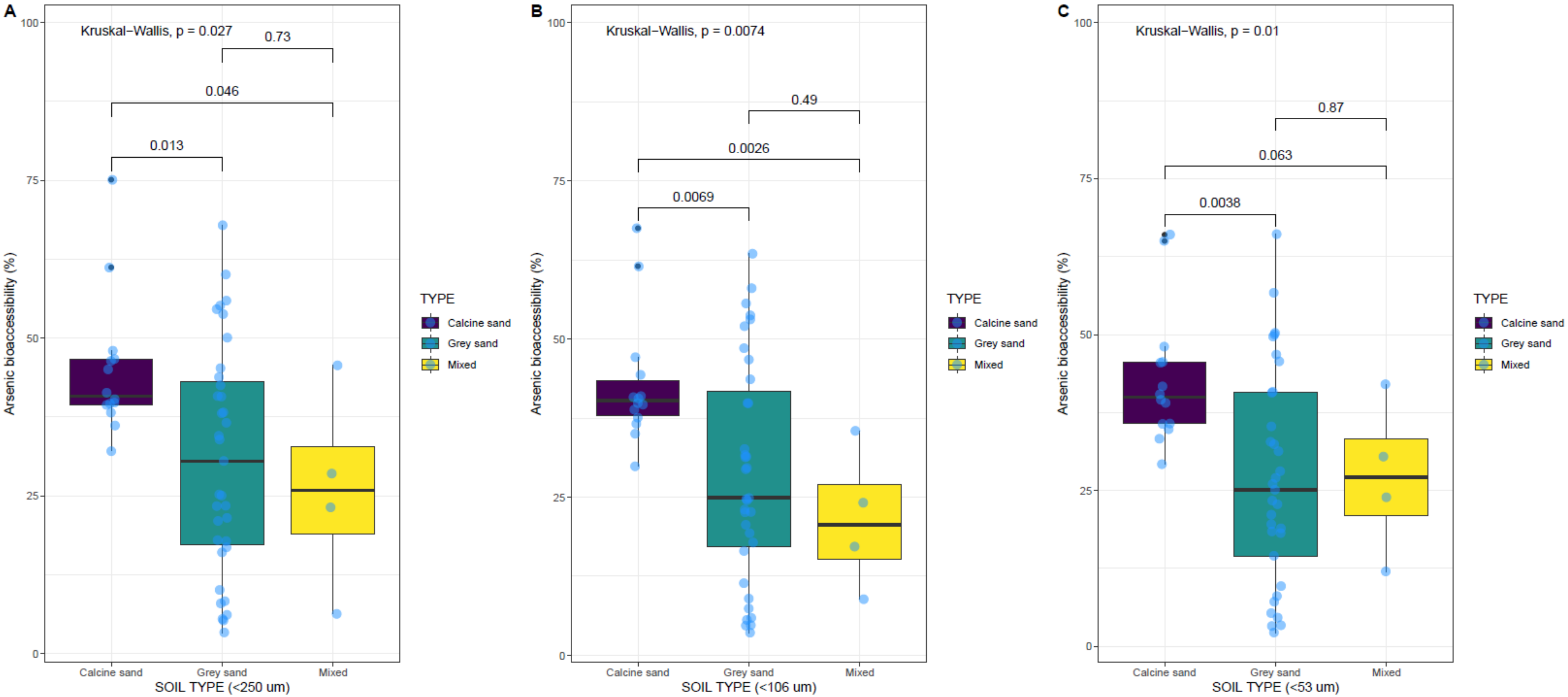

Figure 4: Arsenic bioaccessibility (%) as box and whisker plots. Comparisons are for calcined sand, grey sand, and mix material. The plots are arranged by fraction. (A) <250 µm fraction. (B) <106 µm fraction. (C) <53 µm fraction. The < 2 mm fraction was excluded because the larger soil grain sizes are less likely to adhere to skin, food or eating surfaces, and so are less likely to be accidentally ingested.

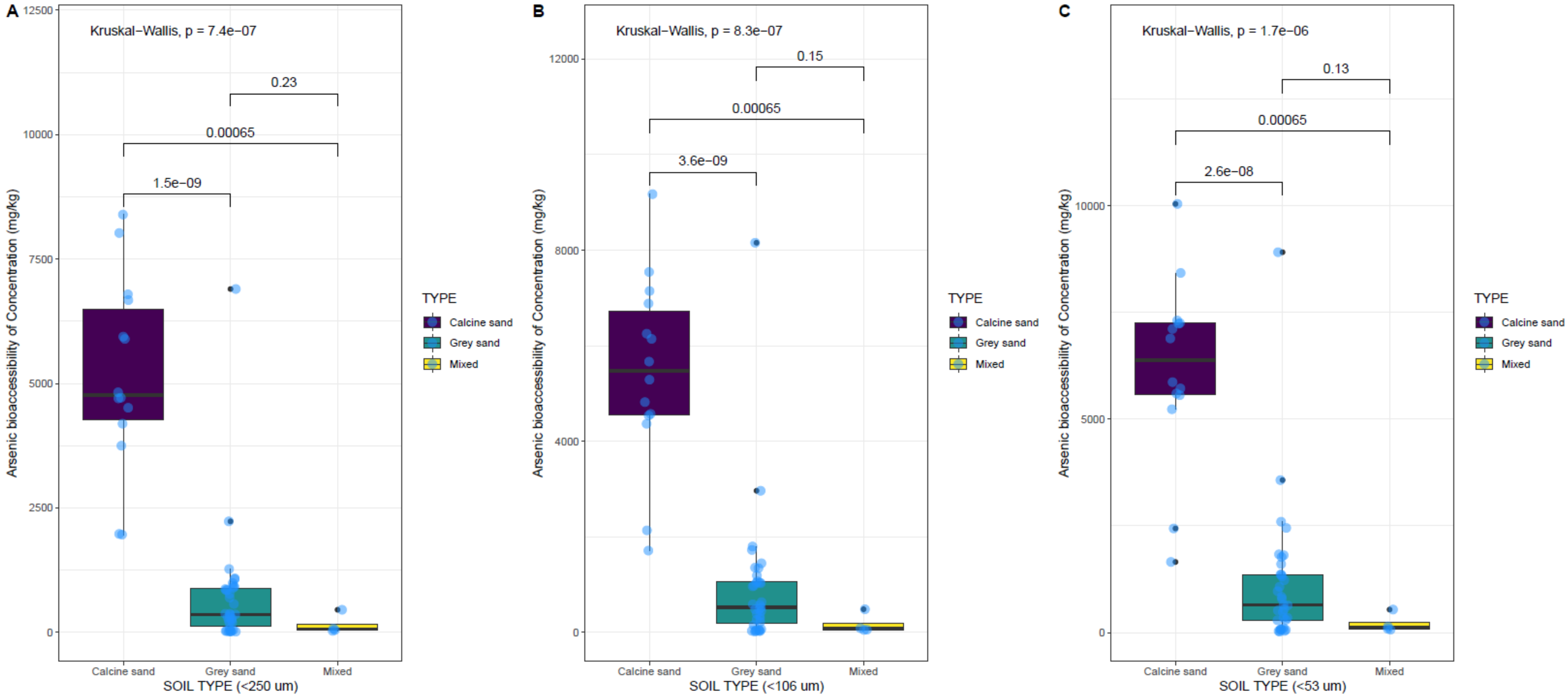

Figure 5: Arsenic bioaccessible concentration (mg/kg) as box and whisker plots. These values are derived by multiplying the sample concentrations by each respective percent accessible. Comparisons are for calcined sand, grey sand, and mix material. The plots are arranged by fraction. (A) <250 µm fraction. (B) <106 µm fraction. (C) <53 µm fraction. The < 2 mm fraction was excluded because the larger soil grain sizes are less likely to adhere to skin, food or eating surfaces, and so are less likely to be accidentally ingested.

Total arsenic concentration (As) (mg/kg) was significantly higher in calcined sands than in grey sands (all $P < 0.001$) and mix materials (all $P < 0.001$), shown in Figure 3. Grey sands had significantly higher arsenic concentration than mix materials, but only for the <106 μm and <53 μm fractions (both $P < 0.027$).

Arsenic bioaccessibility (%) was examined for the <250 μm, <106 μm and <53 μm fractions (Figure 4). Bioaccessibility was always higher in calcined sands than grey sands (all $P < 0.013$) while grey sands and mix materials were not significantly different (all $P > 0.490$). Calcined sands had a higher bioaccessibility than mix materials in the <250 μm and <106 μm fractions, but not for the <53 μm fraction.

The arsenic bioaccessible concentration (mg/kg) was examined for the <250 μm, <106 μm and <53 μm fractions (Figure 5). Arsenic bioaccessible concentration was always higher in calcined sands than grey sands (all $P < 0.013$). Calcined sands had a higher bioavailable concentration than mix materials in all fractions (all $P < 0.001$). Grey sands and mix materials were not different in terms of arsenic bioaccessibility (all $P > 0.130$).

The results described above are consistent with Martin et al., (2016), who reported that arsenic concentration increased from 14,800 mg/kg in the 100 - 250 μm particle size fractions to 15,600 mg/kg in the < 53 μm particle size fraction (1.05 fold). Similarly, arsenic concentration in grey, brown, and yellow battery sand increased from 307 - 980, 750 - 1,050 and 371 – 1,270 mg/kg, corresponding to 3.19-, 1.40- and 3.42-fold enrichment, respectively (Martin et al, 2016).

The influence of particle size on total and bioaccessible arsenic was further assessed using Kendalls Tau correlation test (measure of the strength of the relationship between two variables), as shown in Figure 6. For calcined sands, arsenic concentrations increased as the particle size decreased (tau = -0.314, $P = 0.002$), but there was no significant association between fraction size and arsenic bioaccessibility (tau = +0.097, $P = 0.426$) or bioaccessible concentration (tau = +0.191, $P = 0.117$).

For grey sands, arsenic concentrations increased as the particle size decreased (tau = -0.333, $P < 0.001$) and bioaccessible concentration increased (tau = -0.163, $P = 0.034$). There was no association with bioaccessibility (tau = +0.072, $P = 0.351$).

For mixed materials, arsenic concentration (tau = -0.298, $P = 0.135$), bioaccessibility (tau = -0.071, $P =0.770$) and bioaccessible concentration (tau = -0.391, $P = 0.107$) were not significantly associated with grain size in mix material samples. However, some effect sizes (tau) were quite pronounced, and sample sizes were relatively small, which may warrant further investigation.

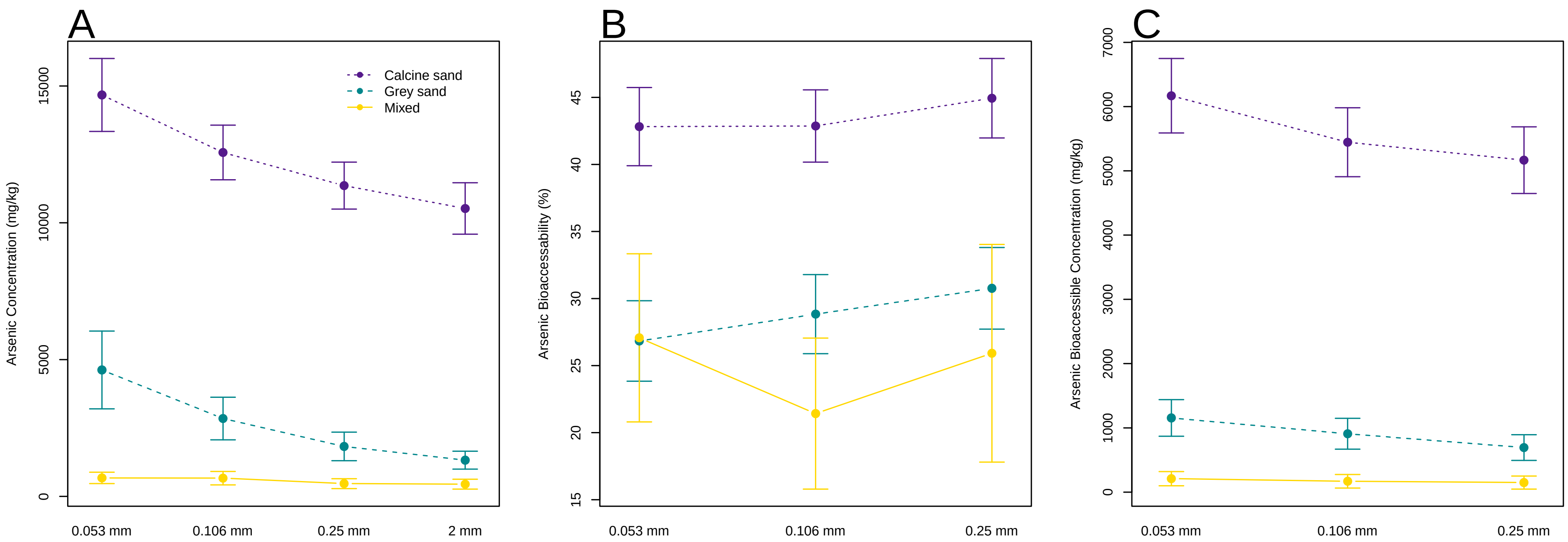

Figure 6: Arsenic concentrations (mg/kg), bioaccessibility (%), and bioaccessible concentration (mg/kg) as functions of the fractionated grain sizes. (A) concentration (mg/kg). (B) Bioaccessibility (%). (C) Bioaccessible concentration (mg/kg). Significant associations (P < 0.05) with grain size were Calcine and Grey sands concentrations (A: purple and blue-grey lines), and grey sands bioaccessible concentration (C): blue-grey line

6.3 Bioaccessibility variability

Multimodality analysis was undertaken to assess whether there are multiple bioaccessibility profiles within each waste type.

Results for grey sands indicated there was no evidence for more than one bioaccessibility profile in grey sands for any of the four particle size fractions assessed (all $P > 0.332$). There was also no evidence for multimodality (more than one 'type') in calcined sands in the <250 µm, <106 µm or <53 µm fractions (all $P > 0.357$).

Small peaks are visually present in modality distributions, as shown in Figure 7. However, these were not statistically supported and may be attributable to outliers or differences in historic processing.

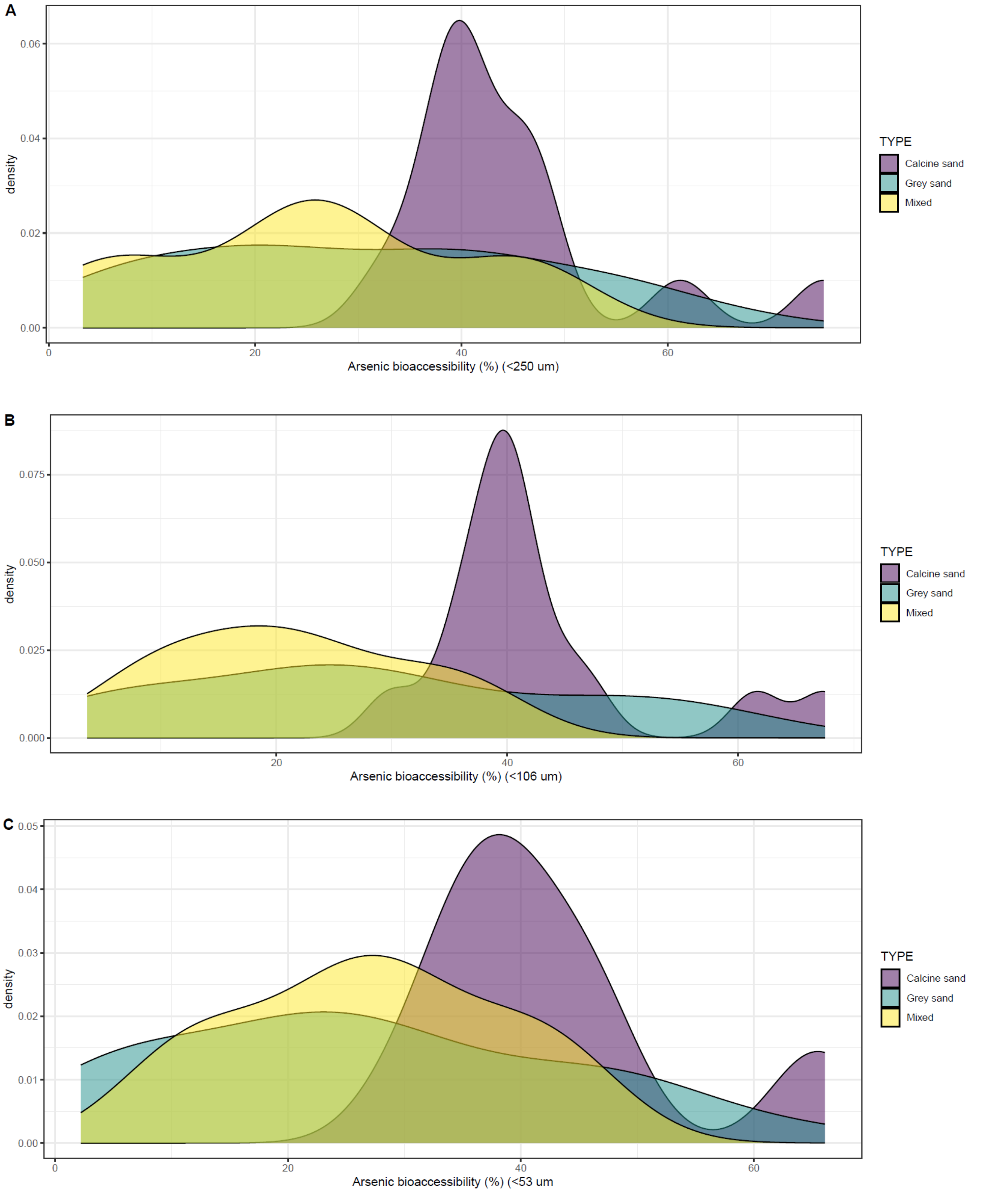

Figure 7: Arsenic bioaccessible percentages (mg/kg) as kernel density plots. Distributions are for calcined sand, grey sand, and mix material. (A) <250 µm, (B) < 105 µm and (C) <53 µm

6.4 Elemental indicators of waste type

A random forests machine learning algorithm was used to identify any elements that could be used as signatures to distinguish the different mine waste categories. For signifying elements Ni, Cd and Pb, conditional inference trees showing the splits in concentrations associated with each mine waste types can be found in Appendix G – Random Forests analysis results.

Nickel (Ni) was the most strongly diagnostic element. All calcined sands samples had nickel concentrations > 130 mg/kg Ni, while mix samples were ≤ 81 mg/kg Ni and 99.99% of grey sands were ≤ 102 mg/kg Ni. One grey sand fraction sample (<0.053 mm) returned a nickel concentration of 133mg/kg Ni. Cadmium may also be used to distinguish calcined sands from grey sands and mix samples, where a concentration of >2 mg/kg cadmium is indicative of calcined sands. Similarly, materials with lead > 308 mg/kg may be indicative of calcined sands.

Principal coordinate analysis (PCoA) of 43 elements strongly supports a clear demarcation between calcined sands and the other two mine waste types (Figure 8). Grey sand and mixed materials showed overlapping, indicating they shared some of their elemental components but also a moderate degree of separation. Dimension 1 explained 40.1% of variance, whilst Dimension 2 explained 9.7% of variance.

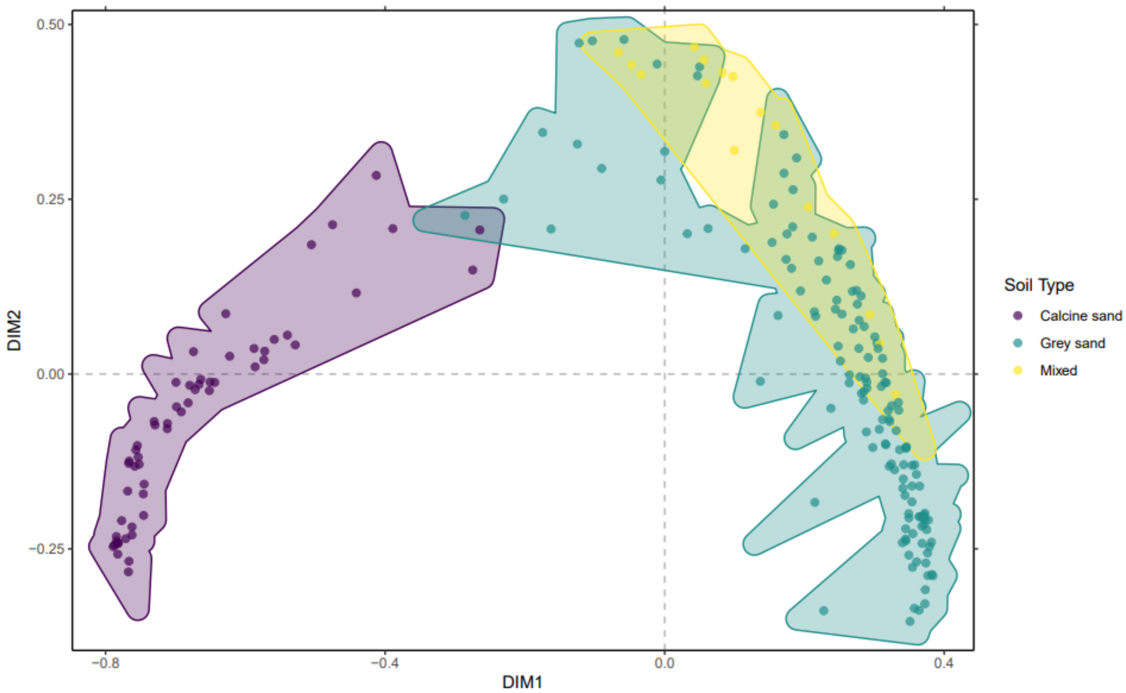

Figure 8: Ordinations based on Principal Coordinates Analysis of 43 element concentrations. Concave ordihulls showing the distribution of element patterns in Calcine sands (purple), Grey sands (blue-grey) and Mixed (yellow). Note: calcined sands are separated from grey sand and mix materials, but grey sand and mix materials overlap. PCoA Dimension 1 = 40.1% of variance explained. PCoA Dimension 2 = 9.7% of variance explained

6.5 Relationship between arsenic bioaccessibility and mineral speciation

A Kruskal-Wallis pairwise comparison of arsenic species present in calcined sands and grey sands identified a statistically significant ($p<0.05$) difference based on arsenic sorbed to iron oxides. Calcined sands samples contained greater proportions of arsenic sorbed to iron oxides (natrojarosite and geothite) compared to grey sands, which had a higher contribution from scorodite. This difference in arsenic bearing phases may explain the colour difference, with the red and grey colours for calcined and grey sands respectively corresponding to the colour of dominant mineral phases present.

A statistically significant difference between calcined sands and grey sands was also evident from the bioaccessibility results. This is most pronounced when considering the bioaccessible concentration, with the median in calcined sands (4,767 mg/kg in <250 µm) being more than an order of magnitude higher than the grey sands (356 mg/kg in <250 µm). These findings are consistent with previous studies , which indicate that mineral speciation can have an impact on bioaccessibility. Meunier et al., (2010) proposed that high arsenic bioaccessibility may be linked with the presence of Ca-Fe arsenates, while low arsenic bioaccessibility may be attributed to the presence of scorodite and arsenopyrite. Meunier et al. (2010) also suggested that predominance of amorphous Fe arsenates and arsenic bearing Fe(oxy)hydroxides, may result in intermediate arsenic bioaccessibility, which was also observed in this study. Arsenic bioaccessibility in grey sands was found to be more variable than calcined sands, most likely due to more mixed and minor mineral phases of arsenic that were present.

When the mineralogical characteristics of arsenic bearing phases were taken together with total arsenic concentration and outcomes from bioaccessibility assays results indicate that mine waste type may strongly influence arsenic bioaccessibility.

7 Contaminated land implications

As set out in Section 35 of the EP Act 2017, and further clarified in EPA Publication 1940, with respect to arsenic in soil, land is considered contaminated where the concentration exceeds background levels and creates a risk of harm to human health or the environment. With respect to the term 'creates a risk of harm', EPA Publication 1940 describes this expression to be akin to the word 'hazard' – that is, presence of a chemical substance or waste that has an inherent characteristic capable of causing harm. For the purposes of Section 35 of the EP Act, Publication 1940 suggests that the lowest of default ecological investigation level (EIL), which is used to assess risks to terrestrial ecosystems, and health investigation level (HIL) set out in the National Environment Protection (Assessment of Site Contamination) 1999 (as amended 2013) be used as thresholds for 'creates a risk of harm' when determining the status of contaminated land at a site.

The bioaccessibility study undertaken relates to potential bioavailability of arsenic to humans so the outputs are relevant to human health only. As noted in Section 2.2, the HILs are conservative screening levels for a range of land uses, to be applied at the first stage of an investigation.

In assessing mine tailings at a site, consideration is typically given to the distribution of elevated concentrations of arsenic across the site with localised areas of contamination identified as those above 250 % of the investigation level.

The findings of the study provided further information around drivers of the bioavailability of arsenic in mine tailings that can aid contaminated site assessments:

- Visual characterisation of calcine and grey sands remains appropriate, as mineral speciation and co-elemental investigation reported significant differences between these mine wastes.
- The key influencing factors driving bioaccessibility were waste type, particle size and mineral speciation (which is related to waste type).
- Bioaccessibility of arsenic was statistically higher in calcined sands compared to grey sands. This indicates that the presence of these sands at a contaminated site is likely to require management to reduce risk of harm.
- Bioaccessibility of grey sands is highly variable, therefore it is not possible to identify a default or regionally specific bioavailability factor.
- Bioaccessible concentrations ranged between 11 mg/kg to 6,898 mg/kg with a median concentration of 356 mg/kg.
- This indicates that while most bioaccessible concentrations were above the HIL A of 100 mg/kg (or 250 mg/kg where the sands are identified in localised hotspots), there can be scenarios where grey sands at a site are below these levels.
- Median bioaccessible concentrations were below HIL B and marginally above HIL C.

It is important to understand both the distribution of these sands across the site and the bioavailability to determine whether they have potential to pose a risk of harm. Where contaminated site investigations and remediation projects seek to modify investigation levels for bioavailability, a site-specific assessment will be necessary.

8 Summary and recommendations

8.1 Characterisation of mine waste types.

Mine waste is identified as calcined sands, grey sands or alluvials during contaminated site investigations based on field observations of colour and texture.

The study identified that grey and calcined sands are the predominant type of mine waste present in the Bendigo environment. Visual characterisation based on observations of colour and appearance was found to be supported by geochemical patterns observed, with concentrations of signifying elements nickel, cadmium and lead being predictors of whether a given sample should be categorised as grey or calcined sand.

Mineral speciation analysis also provided an additional line of evidence to support the splitting of mine wastes into different types, with grey sands dominated by scorodite (an arsenate mineral consistent with gold containing ore). Arsenic in calcined sands was associated as being sorbed to iron oxide minerals such as natrojarosite and geothite, which may be explained by weathering, processing and roasting during mining activities.

8.2 Bioaccessibility assessment

The investigation did not identify a waste-specific bioaccessible fraction that could support development of default regional investigation criteria. This is because:

- bioaccessible concentrations in calcine sands were consistently above health investigation levels and would require management. In addition, arsenic bioaccessibility in the <250 µm fraction ranged from 32-75%, with moderate variability (CV=25%) and a median of 45% meaning a default fraction is unlikely to be useful.
- Variability in grey sands bioaccessibility was even higher, ranging from 3-68%, with high variability (CV=59%) and a median of 31%. The distribution of results for grey sands arsenic bioaccessibility fraction shows a median peak at around 30-40%, though the distribution is noticeably uniform compared to calcine sands or mix materials.

  This uniform distribution means that values falling well above and well below the average are significant, and that the 'average' is not a reliable guide to the probable bioaccessibility of any given grey sand sample. As a result, a default fraction to set regional investigation criteria could not be identified.

8.3 Factors that influence bioaccessibility

The key factors that influence bioaccessibility assessed in this study are waste type, particle size and mineral speciation.

- Arsenic bioaccessibility was statistically different ($p < 0.05$) between major waste types. It was recorded as being higher in calcined sands than in grey sands, which is consistent with previous work (Ollson et al. 2016).
- Particle size also influenced bioaccessibility with higher levels in smaller fractions, with wastes with higher levels of fines more likely to have higher bioaccessible concentrations.
- Mineral speciation presented as a reliable indicator of arsenic bioaccessibility. Greater proportions of more bioaccessible mineral phases (arsenic sorbed to iron oxides) were observed in calcined sands compared to grey sands, with higher arsenic bioaccessibility observed in calcined sands compared to grey sands.

8.4 Recommendations

Where a potentially contaminated site is being assessed for mine-contaminated arsenic-rich mine waste, no assumptions regarding arsenic bioaccessibility should be made without site-specific evidence.

Where adjustments to the default health investigation level are being considered, site- and material-specific sampling and analysis is required. The guidance provided in NEP(ASC)M (1999) should be considered, including but not limited to the following criteria:

- Development of a sampling plan, based on a conceptual site model.
- Understanding of site and material related factors that may affect bioaccessibility (for example, different soil or waste types, site management practices (mulching, fertilising, and other methods).
- The number of samples collected and analysed should seek to be representative, considering exposure areas, characteristics and distribution of waste and soil type(s) present, and potential for high variability that may require more than one sample for a single waste type.
- Quality assurance and quality control measures for sampling and analyses.

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Appendix A – Tabulated summary of previous studies

Appendix A – Table 1: summary of previous literature studies

Authors	Region	Sample	n	Arsenic (mg/kg)		
				Range	Median	Mean
DMID, (1991) (reported in Hinwood et al., (1998))	Victorian goldfields	Ballarat	20	< - 383		
		Bendigo A	173	1 - 3,106		
		Chewton	18	28 - 10,190		
		Eaglehawk	21	< 5 - 710		
		Maldon	1	59		
		Mt Egerton	2	145 - 300		
		Swifts Creek	5	1300 - 15,000		
Hinwood et al. (1998)	Victorian goldfields	Kaniva	6	4.1 - 10	6.40	No data
		Lillimur	5	3.8 - 5.2	4.10	
		Maldon	13	9.1 - 160	58.0	
		Merino	19	3.4 - 30	9.10	
		Nhill - Household sample	10	2.2 - 13	3.20 - 4.60	
		Swifts Creek - Household sample	12	4.7 - 290	9.00	
		Wandilingong - Household sample	32	7.4 - 1,600	29.0	
		Woodend - Household sample	26	1.7 - 80	3.30	
		Soils (background)	33	2.5 - 19	No data	8
		Soils (regionally contaminated)	16	20 - 158		55
		Soils (strongly contaminated)	14	191 – 38,600		9320
Sultan., (2007)	Victorian goldfields	Creswick-Ballarat soils	85	7.44 - 396	28.4	39.0
Juhasz et al., (2007)	Victorian goldfields	Gold mining site soils	8	577 - 12,781	4081	5653
Smith et al., (2014)	Victorian goldfields	Roasting site sample	2	577 - 807	NA	
Smith et al., (2009)	Victorian goldfields	Gold mining site soils	11	142 - 12,781	807	4195
Ollson et al., (2016)	Victorian goldfields	Tailings	35	29.8 - 3,160	505	711
		Calcinated materials	10	736 - 47,100	10,900	14,100
		Grey slimes	5	1370 - 2,310	1,540	1,760
Martin et al., (2016)	Victorian goldfields	Red calcine sand	1	8,600		
		Grey battery sand	1	211		
		Brown battery sand	1	632		
		Yellow battery sand	1	37		

Appendix A – Table 2: summary of previous environmental audit reports

Audit	Completion date	Site address	arsenic range, mg/kg	Bioaccessibility testing	Number of samples tested	As range tested, mg/kg	Bioaccessibility, %
EA001376	4/06/2023	24 Mccoll Street	602 - 4410	No			

Audit	Completion date	Site address	arsenic range, mg/kg	Bioaccessibility testing	Number of samples tested	As range tested, mg/kg	Bioaccessibility, %
EA001375	13/04/2023	31-33 Anderson Street	28 - 509	No			
EA001374	31/03/2023	16 Redan Street	182 - 1990	No			
EA001373	24/03/2023	13 Hustlers Road	385 - 3340	No			
0008006499	09/07/2021	Clay Gully, Maiden Gully	11 – 18,000	Yes	3	3,550 – 9,850	34 - 70
0008006748	12/05/2021	195-221 Marong Rd, Maiden Gully	8 – 24,500	Yes	4	93 – 18,500	11 - 37
0008006498	30/06/2021	Leggo's Pyrite Works, California Gully	<LOR - 19,400	Yes	3 (same samples as Audit 8006499)	3,550 – 9,850	34 - 70
0008006892	7/06/2021	188 Hargreaves Street, Bendigo, Vic	<LOR - 1370	No			
0008005361	10/08/2018	100 Arnold Street, Bendigo, Vic	<LOR - 1440	No			
0008005644	29/06/2018	Woodvale Evaporation Ponds Complex, Dalys Road, Woodvale, Victoria		Yes	5	526 – 1,210	76 - 100
0008005291	22/06/2017	13 Arthur Street, Bendigo Vic	17 - 317	No			
0008005020	5/04/2017	Bendigo Hospital redevelopment	<LOR – 1,750	No, Regional HIL adopted but no bioaccessibility testing			
0008003162	4/04/2016	Former Bendigo Gasworks Weeroona Ave	<LOR – 410	No			
0008004769	20/01/2016	47 Lansell Street, Bendigo	3 to 2020	No			
0008004061	26/03/2015	Bendigo Hospital redevelopment	<LOR – 1,700	No, Regional HIL adopted but no bioaccessibility testing			
0008004063	2/09/2014	Bendigo Hospital redevelopment	<LOR – 1,235	No, Regional HIL adopted but no bioaccessibility testing			

Audit	Completion date	Site address	arsenic range, mg/kg	Bioaccessibility testing	Number of samples tested	As range tested, mg/kg	Bioaccessibility, %
0008004062	31/03/2014	Bendigo Hospital redevelopment	<LOR - 320	No, Regional HIL adopted but no bioaccessibility testing			
0008002378	30/09/2013	Parts of former Bendigo Psychiatric Hospital Holdsworth road	3.4-5,000	Yes	5	160-8800	<1 - 32
				Yes	2	16750-23000	36 – 52.3
8003127	25/06/2013	Former Psychiatric Hospital 28A Holdworth Road		Yes	5	160-8800	<1 - 32
8002835	21/12/2012	71-75 Bridge Street	6 - 308	No			
8002544	24/10/2012	Golden Square Fortuna, 22 – 48 Chum Street	<1 – 5,800	Yes	15	52 - 2400	6.1 – 41.5
8002867	23/03/2012	Liddells Calcine Sands, Derwent Gully Road	10 – 53,350	Yes	4	706 - 53350	22.8 – 54.8
8002495	11/12/2009	Bendigo Market Place Shopping Centre, Garsed Street	<LOR – 8,000	No			
8001817	12/09/2007	Former Mobil Bendigo Service Station, 1 Bridge Street	<LOR – 1,200	No			
8002020	15/12/2006	7-15 McLaren Street	7 -1,100	No			
8001930	27/03/2006	113-133 Mollison Street	<LOR - 770	No			
8001912	20/02/2006	NOS.1,2,3 & 4 Cheviot Place NOS.1,2,3 & 4 Lincoln Place and NO.16 Hyde Street	180-460	Yes	Data not available in audit register		
8001213	8/12/2005	47 Lansell Road	Max = 2020	No			
8001848	11/06/2004	2 ,9 Acacia Street	35 – 1,200	No			
8001763	3/12/2003	71 Bright Street,	<5 – 1,300	Yes	6	130 – 1,300	
8001408	26/02/2002	22 Vine Street, 20 Vine Street	97 - 450	No			
8001004	12/10/1999	Corner of Miller & Wolstencroft Streets	10 - 175	No			

Audit	Completion date	Site address	arsenic range, mg/kg	Bioaccessibility testing	Number of samples tested	As range tested, mg/kg	Bioaccessibility, %
8000697	16/02/1999	Cnr View and Rowan Streets	33 - 680	No			
8000575	9/01/1998	Former Saleyards, cnr Charleston Road, Lansell Road	38 - 760	No			
8000359	18/03/1996	141-143 Mitchell Street	-	No			
8000372	25/10/1995	Bendigo Market Place, Mitchell Street	3.6-1,700	No			

Appendix A – Table 3: summary of previous literature studies testing bioaccessibility

Authors	Region	Sample (n)	Particle size fraction	Assay type	IVBA gastric phase (%)			
					Assay conditions	Range	Median	Mean
Laird et al. (2007)	Nova Scotia, Canada	Goldenville – tailings (1)	Bulk	Static SHIME	No data			
			< 38 µm					
		Lower Seal Harbour hardpan (1)	Bulk					
			< 38 µm					
		Montague – roasting and tailing (1)	Bulk					
			< 38 µm					
Juhasz et al. (2007b)	Victorian goldfields, Australia	Mine sites (8)	< 250 µm	SBET / SBRC	pH 1.5, S/L = 1:100, 1 h	5.00 - 36.0	24.5	23.5
Juhasz et al. (2009)	Victorian goldfields, Australia	Roasting site sample # 33 (1)	< 250 µm	SBRC	pH 1.5, S/L = 1:100, 1 h	39.9 ± 0.25		
				PBET	pH 2.5, S/L = 1:100, 1 h	11.5 ± 0.03		
				IVG	pH 1.8, S/L = 1:150, 1 h	9.23 ± 0.26		
				DIN	pH 2.0, S/L = 1:50, 1 h	7.71 ± 0.31		
		Roasting site sample # 34 (1)		SBRC	pH 1.5, S/L = 1:100, 1 h	3.81 ± 0.05		
				PBET	pH 2.5, S/L = 1:100, 1 h	2.30 ± 0.11		
				IVG	pH 1.8, S/L = 1:150, 1 h	2.62 ± 0.06		
				DIN	pH 2.0, S/L = 1:50, 1 h	2.69 ± 0.03		
Smith et al. (2009)	Victorian goldfields, Australia	Gold mining (11)	< 250 µm	SBET/ SBRC	pH 1.5, S/L = 1:100, 1 h	25.0 ± 16.0		
			< 150 µm			33 ± 22		
			< 10 µm			42 ± 23		
Meunier et al. (2010a)	Nova Scotia, Canada	Caribou (5)	< 150 µm	PBET	pH = 1.8, S/L= 1:100, 1 h	0.50 - 3.90	2.1	2.00
		Montague (5)				1.80 - 11.0	2.1	3.88
		Goldenville (5)				0.13 - 47.0	1.6	10.5
		Oldham (1)				4.2		
		Whiteburn (1)				8.3		

Authors	Region	Sample (n)	Particle size fraction	Assay type	IVBA gastric phase (%)			
					Assay conditions	Range	Median	Mean
		North Brookfield (12)				0.48 - 31.0	0.48	15.3
Meunier et al. (2010b)	Nova Scotia, Canada	Soils and tailings (14), reference materials (3), Arsenopyrite (solid matrix, 1), Ironite (commercial fertilizer, 1)	< 150 µm	PBET	pH = 1.8, S/L = 1:100, 1 h	0.13 - 47.0	3.90	13.5
					pH = 1.8, S/L = 1:2000, 1 h	0.05 - 47.0	6.0	12.8
				SBRC (0.4 M glycine)	pH = 1.5, S/L = 1:100, 1 h	0.13 - 44.0	7.80	14.4
					pH = 1.5, S/L = 1:2000, 1 h	0.24 - 79.0	10.0	21.7
				SBRC (0.2 M glycine)	pH = 1.5, S/L = 1:100, 1 h	0.22 - 48.0	3.50	15.9
Meunier et al. (2011a)	Nova Scotia, Canada	Soils and tailings (26)	< 250 µm	SBRC	pH = 1.5, S/L = 1:100, 1 h	4.19 - 48.3	10.9	14.4
				PBET	pH = 1.8, S/L = 1:100, 1 h	1.21 - 25.9	9.28	11.1
			< 150 µm	SBRC	pH = 1.5, S/L = 1:100, 1 h	2.79 - 45.3	11.6	14.7
				PBET	pH = 1.8, S/L = 1:100, 1 h	1.05 - 33.3	7.22	9..37
			< 45 µm	SBRC	pH = 1.5, S/L = 1:100, 1 h	4.04 - 44.1	8.83	13.4
				PBET	pH = 1.8, S/L = 1:100, 1 h	3.10 - 25.0	6.88	9.29
Ono et al. (2012)	Paracatu, Minas Gerais, Brazil	Overburden dump (1)	< 150 µm	IVG	pH : 1.8, S/L = 1:150, 1 h	2.46 ± 1.04		
		Smelting waste (1)				2.68 ± 1.53		
		B2 tailings (1)				0.88 ± 0.17		
Toujaguez et al. (2013)	Delita gold mine, Cuba	Surface Tailing samples (4)	< 150 µm	IVG	pH : 1.8, S/L = 1:150, 1 h	0.55 - 34.5	7.03	12.3
Smith et al., (2014)	Victorian goldfields, Australia	Gold mining # 33 (1)	< 250 µm	SBRC	pH = 1.5, S:L = 1:100, 1 h	40.0 ± 1.0		
				PBET		12.0 ± 1.0		
		Gold mining # 34 (1)		SBRC		4.00 ± 1.0		
				PBET		2.3 ± 0.10		
Ollson et al. (2016)	Victorian goldfields, Australia	Tailings (35)	< 250 µm	SBRC	pH = 1.5, S:L = 1:100, 1 h	4 - 70	No data	30
		Calcinated materials (10)				25 - 84		48

Authors	Region	Sample (n)	Particle size fraction	Assay type	IVBA gastric phase (%)			
					Assay conditions	Range	Median	Mean
		Grey slimes (5)				70 - 90		82
Whitacre et al. (2017)	USA	Residential area near gold mining (3)	< 250 µm	CAB	pH = 1.5, S/L ratio = 1:150, 2 h	5.10 - 73.6	31.6	16.1
				IVG	pH = 1.8, S/L ratio = 1:150, 1 h	1.92 - 35.2	13.4	3.0
		Gold mining (16)		CAB	pH = 1.5, S/L ratio = 1:150, 2 h	2.86 - 50.1	23.6	45.5
				IVG	pH = 1.8, S/L ratio = 1:150, 1 h	1.52 - 52.3	9.4	4.24
Bromstad et al. (2017)	Yellowknife, Canada	Outcrop samples (3)	< 250 µm	SBRC	pH = 1.5, S/L = 1:100, 1 h	29.0 - 40.0	33.0	34.0
Kastury et al. (2018a)	Victorian goldfields, Australia	Calcinated mine waste (1)	< 10 µm	SBRC	pH = 1.5, S/L = 1:100, 1 h	44.0		
Kastury et al. (2018b)	Victorian goldfields, Australia	Calcinated mine waste (1)	< 2.5 µm	SBRC	pH = 1.5, S/L = 1:100, 1 h	60.6		

Appendix B – Investigation and analysis methods

Sample collection

Soil sampling was conducted in general accordance with AS4482.1-2005. Surface soil (0-5cm depth) samples were collected using a hand trowel and sealed in labelled zip-lock bags. Subsurface samples were collected by digging a shallow pit (maximum 1 m deep) using a hand trowel or shovel. Trowels used for soil sampling were triple-rinsed in between sampling locations to avoid cross-contamination.

GPS coordinates, time/date, site description, samplers name, photos and additional comments were also recorded at each location.

Analytic methods

Sample analysis for concentration and bioaccessibility of arsenic and other trace elements was conducted at the Future Industries Institute, University of South Australia.

Concentration

Samples were oven-dried and sieved to two particle size fractions: <2mm, <250 µm <106 µm and <53 µm. In accordance with aqua-regia soil digestion method 3051A (USEPA, 2007), samples from the four different particle size fractions were weighed, with a subsample comprising 0.25 g placed in teflon digestion tubes. Inside a fume hood, 5 mL of aqua-regia [3:1 v/v 37% hydrochloric acid (HCl): 70% nitric acid (HNO_3)] was pumped into digestion tubes and left overnight to pre-digest the samples (Kastury et al., 2021). Samples were digested with a Mars6 microwave (CEM) using US EPA method 3051A (USEPA, 2007b). The digestion method requires that the acidified sample temperature increases to 175˚C over 10 minutes, holds temperature 175˚C for 10 minutes, then cools for 20 minutes.

Following digestion, the supernatant was decanted into 50 mL centrifuge tubes and diluted up to 50 mL using Milli-Q water, then syringe-filtered (0.45 µm, cellulose acetate) to separate undigested solids from the solution containing dissolved elements. The digested samples were stored at room temperature until analysis. Quantification of pseudo-total elemental concentrations was conducted using US EPA method 6010D (USEPA, 2014a) for ICP-OES and 6020B (USEPA, 2014b) for ICP-MS.

Arsenic bioaccessibility was determined in the mine wastes using the 250µm, 106 µm and 53 µm particle size fractions and the gastric phase of the SBRC assay as per Ollson et al., (2016). The 2mm fraction was not tested for arsenic bioaccessibility as this fraction is less relevant to exposure through incidental or accidental ingestion. Mine wastes were combined with gastric phase solution (30.03 g/L glycine adjusted to pH 1.5 using concentrated HCl) to achieve a soil:solution ratio of 1:100. Samples were incubated at 37°C, 40 rpm on a Ratek suspension mixer for 1 h at pH 1.5. After gastric phase extraction, samples (10 ml) were collected and filtered through 0.45 µm filters for analysis by ICP-MS or OES. Arsenic bioaccessibility was calculated by dividing the gastric phase extractable arsenic by the total soil As concentration (Eq. 1).

Arsenic bioaccessibility (%) = *In vitro* bioaccessible arsenic / Total arsenic × 100

where: *in vitro* arsenic = As (mg) extracted from soil following gastric (SBRC-G) phase treatment. Total arsenic = As (mg) present in the mine waste sample added to the *in vitro* assay.

Quality control results for each of the above methods are summarised in the following table:

Study component	Quality control measure	Description	Data quality objective
Pseudo-total arsenic	Analysis of duplicate samples	48 duplicate samples were analysed for total arsenic, at a rate of 22% of total samples, with a mean difference of 2.9%.	Relative percentage difference of less than 30%
	Analysis of replicate ICP-MS	Sixteen extractions were analysed in replicate, with a mean difference of 0.3%	Relative percentage difference of less than 30%
	Analysis of standard reference materials	Certified reference material National Institute of Standards and Technology (NIST) 2710a Montana 1 soil (certified to contain 1540 mg/kg arsenic) was analysed 8 times with a mean recovery of 107.5%.	Recovery of 70 – 130% for inorganics/metals
In vitro bioaccessible arsenic	Analysis of duplicate samples	Replicate *in vitro* arsenic extractions were conducted on 19 samples (11% of total samples), with	Relative percentage difference of less than 30%

Study component	Quality control measure	Description	Data quality objective
		a mean difference of 2.3%.	
	Analysis of replicate ICP-MS	Duplicate analysis of extracts by ICP-MS was conducted on 10 samples with a mean difference of 1.8%.	Relative percentage difference of less than 30%
	Analysis of standard reference materials	United States Geological Survey reference material for bioavailability (considered to contain 148.5 ± 13.6 mg/kg bioaccessible arsenic) was analysed 8 times with average recovery of 150.8 ± 7.3 mg/kg.	Recovery of 70 – 130% for inorganics/metals

Arsenic speciation

To determine arsenic speciation, mine waste samples were ground in an agate mortar and pestle, diluted with cellulose where required (to bring them within a concentration range suitable for fluorescence measurements, ideally <1000ppm), then manually pressed into an opening cut within Perspex sample holders. Kapton tape sealed the sample within the holder on both sides.

Radiation hardness testing was conducted in the cryostat environment on a test sample received earlier for mercury speciation feasibility tests (Marong-02). Short, repeat XAS scans of both soils indicated the samples were sufficiently impervious to X-ray exposure over a timeframe representative of an XAS scan.

For speciation work, the following reference materials were obtained from Museum Victoria:

- Arsenopyrite (FeAsS)
- Realgar (AsS)
- Arsenolite (As_2O_3)
- Scorodite ($Fe(AsO_4)\bullet 2(H_2O)$)
- Natrojarosite ($NaFe_3(SO_4)_2(OH)_6$)
- Goethite (FeOOH)

In addition, the following synthetic materials were provided by Australian Synchrotron:

- Jarosite ($KFe_3(SO_4)_2(OH)_6$)
- As(V) as As_2O_5
- As(III) as As_2O_3

Standard minerals were prepared in the same way as samples, by first grinding in a mortar and pestle, dilution with cellulose, then pressing manually into XAS Perspex sample holders.

Arsenic solid speciation analyses were carried out at the X-ray Absorption Spectroscopy Beamline ID-12 at the Australian Synchrotron, ANSTO Melbourne. The beamline instrument was set up for analysis of arsenic using the following set up protocols.

For the acquisition of XAS spectra, the photon energy delivered to the sample was calibrated using a gold metal foil (Kraft et al., 1996). The gold foil was chosen as it exhibits an absorption edge close to that of As. All samples and reference materials were analysed under cryogenic temperatures (<10 K) under a He atmosphere.

Spectra were recorded at the As-K absorption edge in fluorescence mode using an 18-element solid state HP-Ge detector (Mirion, France). The energy was scanned from 11.700 to 11.850 keV with a dwell time of 0.3 seconds per step in 3 eV steps, then the step size was decreased to 0.25 eV over the absorption edge from 11.850 to 11.916 keV.

In the post-edge range, the step size was increased to units of 0.07 $Å^{-1}$, to a maximum of k = 10 $Å^{-1}$ (12.250 keV), maintaining a dwell time of 0.3 seconds per step. Fluorescence XAS data were pre-processed using in-house software to sum the spectra collected from each detector element. All XAS data were then processed using ATHENA (freeware) for background subtraction, normalisation, principle component analysis (PCA), and least squares linear combination fitting (LCA) (Ravel and Newville, 2005).

PCA showed that four components accounted for 99% of the cumulative variance in the sample set. Target transformation analysis of reference materials with up to four components resulted in a good fit for goethite, and moderately reasonable fits for scorodite, geothite, arsenopyrite, natrojarosite. Mineralogical information and results from Ollson et al (2016) were also used to inform which mineral phases to use in linear combination fits. Linear combination fitting was performed in ATHENA with a maximum of four components in each simulated combination.

Statistical methods

A principal coordinates analysis (PCoA) was used to apply an ordination to the measured concentrations of 39 element concentrations measured (R; 'cmdscale' in 'stats'; Bray-Curtiss dissimilarity matrix). PCoA axes 1 and 2 were plotted to visually assess differentiation among the three soil types of interest: calcined sand, grey sand, and mix materials.

To explore which elements are the best indicators of a soil class, we applied a random forests analysis (R: 'cforest' in 'party') to examine the relative importance of the elements for classifying the soil types. The most important elements were then further examined using conditional inference trees (R: 'ctree' in 'party').

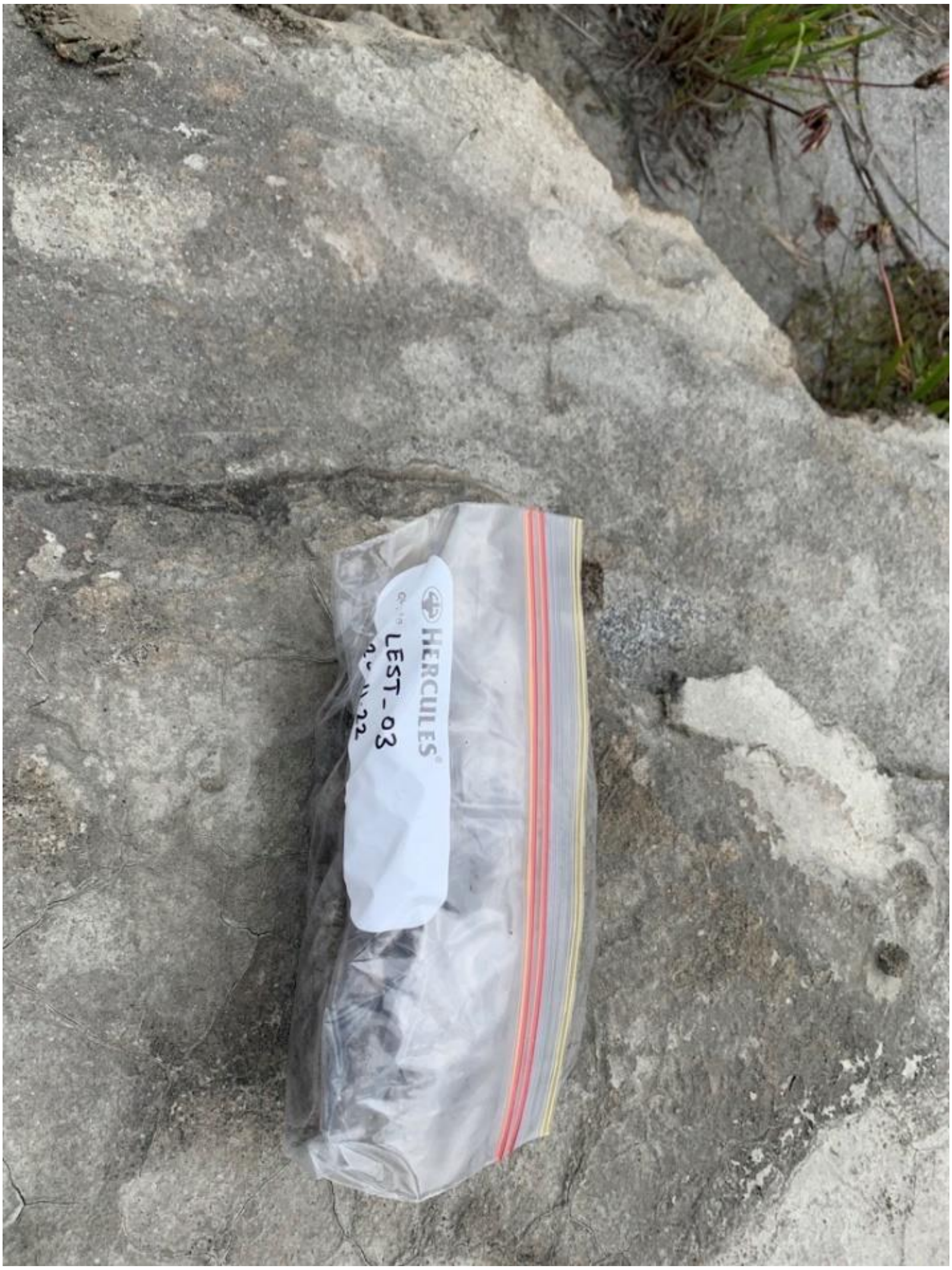
Non-parametric Kruskall-Wallis tests were used to test for overall differences among the arsenic and lead median values in the three soil types. *Post-hoc* pairwise testing was performed with Wilcoxon (Mann-Whitney *U*) unpaired non-parametric tests, with a Bonferroni correction. Tests were calculated and applied directly to box and whisker figures using R: 'stat_compare_means' in 'ggpubr'. All $\alpha = 0.05$.

To test for uni- versus multimodality, an iterative bootstrapping method was used (R: 'modetest' in 'multimode'; 1000 iterations). The null hypothesis was for a single mode (peak) in the distribution. All $\alpha = 0.05$.

A test of 'enrichment' at smaller fraction grain sizes was conducted by applying Kendall's tau correlation tests, comparing concentration, bioaccessibility, and bioavailable concentration with grain sizes for arsenic and lead in the three soil types (calcined sands, grey sands, mix materials). Non-parametric correlation tau values are reported.

Repeatability (a bootstrapped reliability measure) of replicated concentrations for arsenic and lead was checked using 'rpt' in 'rptR'.

Appendix C – Field Photographs



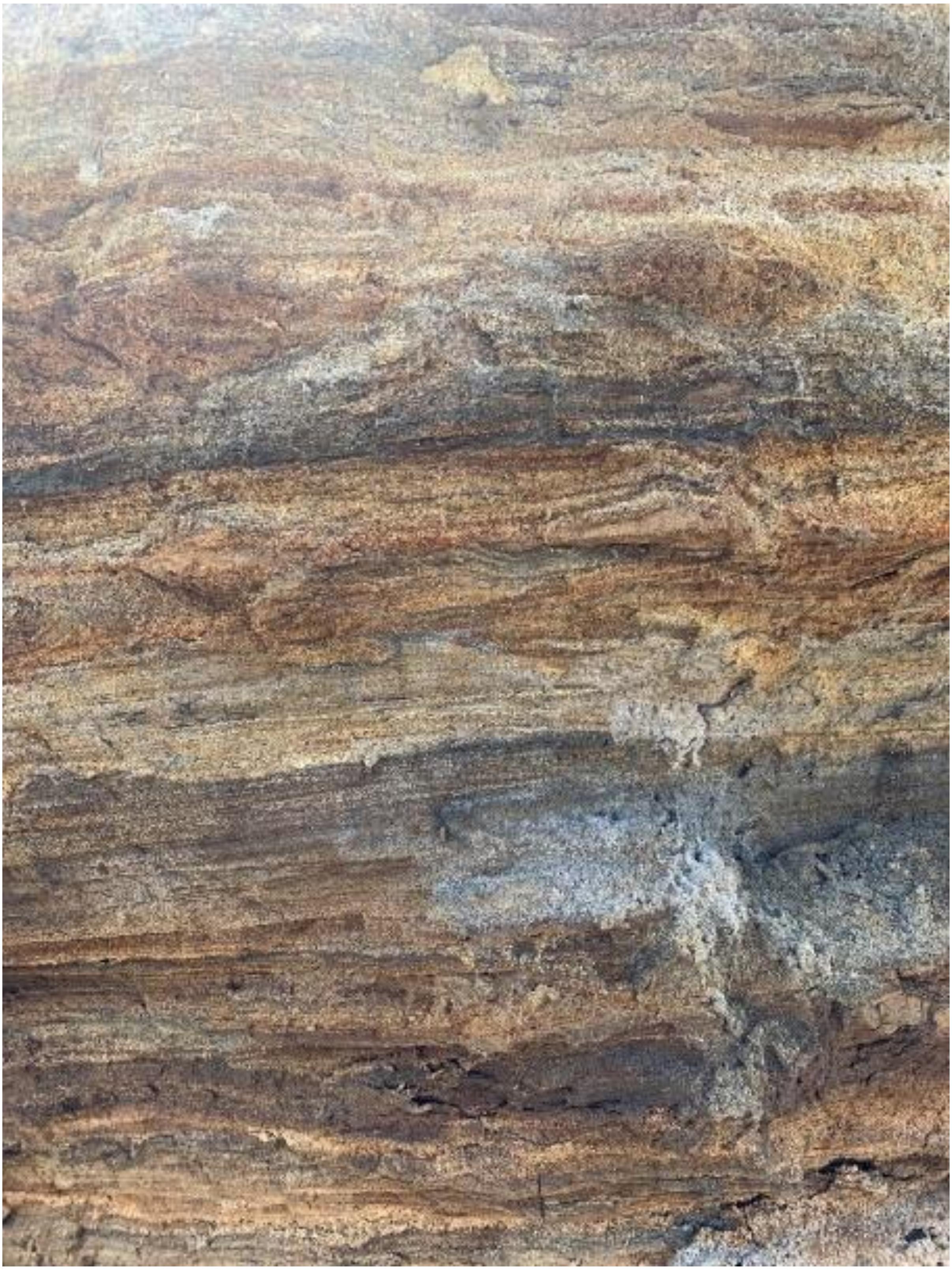
Example of Grey sand, sample collected from mine waste site in Lester St, Bendigo.

Suspected tailings pond material, located at Chum St mine waste site.

Example of Grey sand, Sailors Gully

Calcined sand sample at Marong Rd

Outlook from Lester St grey sands mine waste site.



Suspected tailings pond material, located at Chum St mine waste site.

Appendix D – Laboratory reports

University of South Australia

Assessment of metal(loid) concentration and bioaccessibility in mine waste from the Central Victorian Goldfields

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Date of issue: 16 June 2023

Important Notice

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INTRODUCTION

This report was prepared for EPA Victoria to assess metal(loid) concentration and bioaccessibility in mine waste from the Central Victorian Goldfields. Testing was conducted at the Future Industries Institute, based at the Mawson Lakes Campus of the University of South Australia (UniSA). UniSA's Flagship Institute focuses on building knowledge and capacity in core research strengths of physical chemistry and environmental science and management. The Institute has four distinct yet inter-related strands: Minerals and Resources; Energy and Advanced Manufacturing; Environmental Science and Engineering; and Bioengineering and Nanomedicine. The Institute aggregates and builds upon existing expertise and infrastructure from the Ian Wark Research Institute, the Mawson Institute and the Centre for Environmental Risk Assessment and Remediation. The vision for the Future Industries Institute aligns strongly with South Australian and National economic and research priorities by building a critical mass of trans-disciplinary research capacity focused on pressing real-world challenges.

OBJECTIVES

The objective of this assessment was to:

- Assess the metal(loid) concentration in the < 2 mm, < 250 μm, <106 μm and < 53 μm soil particle size fractions; and
- Assess metal(loid) bioaccessibility in the < 250 μm, <106 μm and < 53 μm soil particle size fractions using the Solubility Bioaccessibility Research Consortium assay encompassing gastric phase extraction (USEPA method 1340).

OUTCOMES AND DELIVERABLES

The expected outcome from this assessment was:

- A report assessing metal(loid) concentration and bioaccessibility in mine waste from the Central Victorian Goldfields. The report was to include:
    - Assessment of metal(loid) concentration in the < 2 mm, < 250 μm, <106 μm and < 53 μm soil particle size fractions;
    - Assessment of metal(loid) bioaccessibility in the < 250 μm, <106 μm and < 53 μm soil particle size fractions using an vitro method;
    - Methodology procedures; and
    - QA/QC protocols

PROJECT BACKGROUND

Soil testing was initiated at the invitation of EPA Victoria for an assessment of metal(loid) concentration and bioaccessibility in mine waste from the Central Victorian Goldfields. Human exposure to a contaminant may be through a number of pathways including inhalation, dermal absorption and ingestion. For many metal(loid) contaminants, the most significant exposure pathway is via soil ingestion. Generally, soil ingestion results from the accidental or, in the case of children less than 5 years old, the incidental ingestion of soil (< 250 µm particle size fraction) via hand-to-mouth contact (Basta et al., 2001). In assessing contaminant exposure, it is often assumed that the contaminant is 100% bioaccessible / bioavailable, however, there is growing evidence to suggest that contaminant bioaccessibility / bioavailability in soil may be less than 100%. Therefore, incorporation of metal(loid) bioaccessibility / bioavailability may reduce the uncertainty in estimating exposure associated with the incidental ingestion of contaminated soil.

Contaminant bioaccessibility may be estimated using *in vitro* assays that simulate processes that occur in the human body that lead to the release of contaminants from the soil matrix. A frequently used assay for the determination of contaminant bioaccessibility is the Solubility Bioaccessibility Research Consortium (SBRC) method (Kelly *et al.,* 2002). The gastric phase of this method (termed the Simplified Bioaccessibility Extraction Test [SBET] for arsenic or the Relative Bioavailability Leaching Procedure [RBALP] for lead) has been correlated to *in vivo* arsenic and lead relative bioavailability when determined using juvenile swine (Juhasz *et al*., 2007; USEPA 2007).

FINDINGS

Total metal(loid) concentration in the < 2 mm, < 250 µm, <106 µm and < 53 µm soil particle size fractions are shown in Tables 1-4 while bioaccessibility results for selected metal(loid)s of concern are shown in Tables 5, 6 and 7 for the <250 µm, <106 µm and < 53 µm soil particle size fractions respectively.

Table 1. Total Metal(loid) Concentration (mg/kg): < 2 mm soil particle size fraction

Sample #	Type	Sample ID	As	Pb	Sb	Be	B	Mg	Al	Si	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Se	Sr	Y
		HIL A	100	300		60	4500								100 (VI)	3800		100	400	6000	7400	200		
		HIL C	300	600		90	20000								300 (VI)	19000		300	1200	17000	30000	700		
1	Calcine sand	MARONG_01	12522.7	2113.5	574.0	3.5	37.1	6802.0	19679.7	534.1	8919.1	4.5	556.8	29.1	47.8	1748.4	199431.0	120.6	276.2	283.0	1212.5	3.7	82.6	6.8
2	Calcine sand	MARONG_02	8074.6	3299.0	235.4	1.2	24.2	5325.1	18537.1	596.2	9984.2	5.0	544.1	23.8	28.6	1144.1	182349.9	90.3	223.5	313.7	2662.0	5.7	62.3	6.8
3	Calcine sand	MARONG_03	14628.2	2130.0	613.4	1.0	23.8	8689.6	22400.2	537.3	2573.8	6.6	611.7	35.5	34.2	1129.4	267539.3	161.1	374.3	446.2	1237.6	3.6	48.3	7.6
4	Calcine sand	MARONG_05	15993.9	2000.3	441.4	1.3	22.5	8606.4	23385.9	493.2	4165.6	6.4	624.8	35.3	33.5	1155.3	245876.5	151.7	354.4	373.3	1165.8	4.3	67.1	7.5
5	Calcine sand	MARONG_06	14503.3	3438.6	2980.6	1.0	20.6	9098.6	24390.4	489.8	3361.6	6.8	599.8	34.6	36.1	956.6	251685.3	160.6	388.1	436.5	1885.9	4.4	61.9	7.4
6	Mixed	MCC_01_red	195.7	32.6	16.5	1.8	17.1	3136.0	52819.9	355.8	2360.9	9.9	444.0	39.5	45.6	52.8	33572.8	5.8	14.0	21.4	62.6	4.4	51.4	12.6
7	Grey sand	MCC_01_top	2200.7	41.1	3.0	3.8	19.1	6140.7	31854.1	395.7	2477.9	5.7	270.7	32.1	36.3	294.5	29161.1	7.2	22.5	24.1	92.9	3.1	65.8	8.4
8	Grey sand	MCC_02	1024.4	18.1	1.4	1.2	10.7	2982.0	8300.9	380.2	1774.0	2.3	59.9	1.5	10.5	885.4	26119.2	10.9	19.3	23.4	77.2	2.1	46.1	5.6
9	Mixed	MCC_02_0.9	189.0	52.9	1.4	1.2	7.3	3980.0	24820.2	507.1	2206.6	3.8	205.9	25.0	31.9	125.8	27405.8	11.0	25.6	20.4	74.4	0.6	64.0	10.0
10	Grey sand	MCC_03_top	1661.0	33.9	2.0	0.6	4.8	6051.8	11109.2	528.9	6197.5	2.3	127.8	13.8	15.0	377.5	24454.4	7.0	20.5	26.9	137.7	0.5	82.6	6.1
11	Grey sand	MCC_03_0.4	1869.1	40.7	1.9	0.6	4.2	6210.1	10256.9	431.9	13050.2	2.3	124.2	13.1	14.9	1187.1	20651.6	6.8	19.9	19.0	154.3	0.6	124.1	6.1
12	Grey sand	MCC_03_0.9	1403.9	32.4	2.0	1.0	6.2	5404.9	14814.4	425.4	13394.4	3.0	224.5	20.5	21.7	468.0	22893.9	8.2	22.5	19.1	174.0	0.5	117.1	6.9
13	Grey sand	MCC_04_top	1446.3	31.3	1.9	0.5	5.4	5556.0	11434.5	461.1	6992.7	2.5	151.9	15.5	16.0	341.0	23527.5	7.8	18.9	17.9	168.9	0.5	88.9	6.0
14	Grey sand	MCC_04_0.9	1365.6	22.5	1.6	0.5	4.5	5668.1	9849.4	461.7	6632.1	2.4	77.6	12.4	12.7	505.0	25561.9	7.4	15.9	19.5	110.1	0.5	99.1	5.4
15	Mixed	CLAY_01	955.8	231.3	5.1	0.8	8.9	6520.5	26533.2	399.1	1442.8	3.9	241.5	28.5	35.0	309.0	38375.9	22.3	51.3	118.7	303.8	0.4	35.7	11.8
16	Calcine sand	CLAY_02	4663.3	2018.7	28.1	1.0	19.5	4127.2	18535.5	426.4	2734.0	3.9	395.7	18.7	23.9	655.6	109179.3	57.9	130.3	183.5	1332.4	3.1	44.9	6.7
17	Calcine sand	CLAY_03	5317.1	1309.9	17.9	1.5	12.4	4343.4	13822.0	821.9	2353.9	3.3	312.3	14.1	20.7	410.8	113416.7	61.8	143.5	153.9	782.0	3.3	43.5	5.1
18	Calcine sand	CLAY_05	10624.1	12163.9	94.1	0.8	17.1	5194.1	15370.3	468.9	2284.9	4.7	691.5	29.5	35.4	1680.3	298203.1	125.5	304.6	724.4	10375.5	2.5	28.7	5.1
19	Calcine sand	CLAY_07	5719.9	4761.1	69.8	2.1	18.6	3612.6	16706.2	526.1	2355.3	4.1	516.0	21.8	24.2	732.3	178299.7	82.2	196.7	414.8	5571.0	2.0	28.1	5.4
20	Grey sand	IRON_01	284.5	24.4	1.0	0.6	5.4	5716.8	13530.4	630.9	3171.2	2.3	84.8	12.8	15.3	301.4	20203.2	7.3	17.9	24.3	62.8	0.2	48.3	4.7
21	Grey sand	IRON_02	182.9	19.8	0.7	0.5	3.1	3950.6	7129.1	654.2	3209.2	1.3	44.8	6.8	8.9	240.2	18046.2	5.3	13.3	13.2	43.3	0.2	31.8	3.3
22	Grey sand	DEBRA_11	795.2	15.5	1.3	0.5	2.7	3385.2	6175.4	579.9	3369.6	1.8	85.0	8.8	9.4	321.0	22436.2	7.8	18.7	23.8	68.6	0.4	53.5	5.2
23	Grey sand	DEBRA_12	997.4	22.7	1.6	0.5	2.5	4930.2	8799.3	517.5	9061.9	2.0	145.8	12.5	14.9	407.4	22051.8	10.3	26.0	25.2	153.4	0.3	91.0	5.9
24	Grey sand	CHUM_27	910.2	30.4	2.5	0.8	4.5	4299.8	11895.6	446.6	4133.8	2.8	239.7	15.3	16.2	245.5	18657.7	7.3	17.5	17.5	54.1	0.5	69.7	7.6
25	Grey sand	CHUM_28	1197.1	33.0	4.2	0.5	3.8	3367.5	6555.9	499.6	3249.0	1.7	84.6	8.9	8.0	192.1	14365.0	3.7	10.4	11.5	65.8	0.5	57.1	3.5
26	Grey sand	CHUM_28_0.75	1236.8	62.8	4.9	0.7	6.2	3731.0	13842.6	523.1	2385.9	2.5	168.5	16.6	17.9	188.9	19933.5	5.6	15.1	16.8	78.8	0.6	52.1	5.7
27	Grey sand	CHUM_28_0.9	605.1	39.6	3.7	1.1	11.4	5084.3	28242.5	462.9	2204.8	4.7	339.3	33.1	35.7	130.5	29766.8	7.4	22.1	23.6	60.4	1.0	48.0	7.8
28	Grey sand	CHUM_29	804.0	29.2	3.3	0.6	4.8	5429.8	8747.0	524.5	4434.7	1.9	57.5	12.4	11.1	293.5	20275.3	6.3	16.7	20.4	82.4	0.2	64.7	4.5
29	Grey sand	CHUM_30	3283.0	37.8	4.6	0.7	5.1	7102.2	13195.8	481.8	4249.3	2.7	476.4	21.4	26.3	343.1	26389.1	10.9	31.3	29.8	93.4	1.1	80.6	5.8
30	Grey sand	CHUM_31	11585.1	32.6	6.8	0.3	3.9	453.9	3759.4	530.2	2354.0	0.8	35.8	4.5	3.9	181.6	17699.0	1.8	2.4	6.2	13.4	2.7	107.2	1.9
31	Grey sand	CHUM_32	126.2	29.7	3.2	0.8	7.0	4278.4	21895.1	479.2	3214.3	3.8	1007.8	37.0	27.6	216.3	27857.7	12.0	29.3	20.0	65.3	0.3	32.3	9.7
32	Grey sand	CHUM_33	2494.4	80.4	10.7	0.9	6.5	2182.5	10570.9	436.1	1090.8	2.3	55.7	15.6	19.7	174.0	18374.9	9.5	20.0	27.7	148.5	2.5	27.6	5.2
33	Grey sand	CHUM_34	246.1	63.0	2.2	3.2	13.8	5078.1	62881.6	376.5	1300.9	11.7	355.6	39.8	55.8	106.8	62805.6	26.5	42.2	43.2	143.2	1.8	49.2	9.7
34	Grey sand	CHUM_35	574.0	112.5	2.6	0.9	6.6	5116.7	14479.0	459.7	2684.3	2.5	240.7	17.4	18.9	304.6	22578.5	8.2	19.3	24.3	138.5	0.3	39.7	5.7
35	Grey sand	CHUM_36	936.0	61.2	6.1	1.9	12.1	2909.5	45301.2	304.7	1548.5	7.6	423.8	39.7	40.6	173.8	34446.4	12.5	30.8	41.5	165.6	4.9	58.3	12.9
36	Grey sand	CHUM_37	1394.6	33.4	3.1	0.7	6.7	9628.9	12778.4	464.9	10944.6	2.8	389.9	20.9	22.4	515.3	23938.0	8.2	22.8	24.1	93.4	0.4	145.7	5.5
37	Grey sand	CHUM_37_0.5	1258.3	31.0	2.5	0.8	5.0	8630.9	9228.9	556.1	14941.0	2.4	314.7	15.9	18.3	596.4	22515.3	7.8	22.0	20.8	87.9	0.3	193.5	5.4
38	Grey sand	CHUM_37_1.2-1.4	1372.8	36.4	3.2	0.7	7.9	9413.9	14227.2	442.4	14499.8	3.2	412.0	23.4	26.1	503.7	25404.6	8.3	26.2	23.2	96.5	0.3	184.5	6.1
39	Mixed	JACKASS_03	445.7	83.5	2.2	2.0	27.7	2715.7	55257.6	370.9	489.8	11.9	583.2	50.9	51.4	44.9	48065.0	11.4	26.4	33.2	76.0	4.6	29.3	10.4
40	Calcine sand	JACKASS_06	10728.3	1229.0	29.1	1.2	16.6	7687.8	26187.0	310.7	9142.6	6.7	740.1	34.7	39.8	796.5	260376.0	158.8	358.9	314.7	945.5	3.1	124.1	8.6
41	Calcine sand	JACKASS_07	11807.1	1786.5	19.8	0.9	18.4	8009.5	25057.9	274.5	8071.1	6.2	864.2	32.2	38.4	834.3	296357.8	166.0	367.6	325.2	938.9	2.8	114.5	7.5
42	Grey sand	WELLS_01	172.3	14.5	0.6	0.3	2.6	3841.4	7176.6	829.8	1834.7	1.2	51.0	7.0	9.1	166.7	15892.8	3.1	10.4	10.1	41.2	0.1	23.8	3.1
43	Grey sand	PASC_01	239.0	17.0	1.1	0.3	2.7	4189.5	7127.7	406.7	9135.1	1.6	94.2	9.1	9.6	359.3	17400.2	5.8	13.9	14.5	241.1	0.2	81.8	4.5
44	Grey sand	PASC_02	133.2	15.9	1.6	0.5	2.8	5710.5	7661.2	630.2	9550.0	2.0	135.7	9.8	11.4	515.5	24645.5	9.2	19.5	25.6	63.2	0.2	106.9	5.9
45	Grey sand	PASC_03	148.8	19.4	1.6	0.5	3.2	6127.7	9113.1	691.5	8904.8	2.3	245.7	12.9	13.9	534.3	25113.6	7.7	19.2	19.8	71.8	0.2	107.2	6.4
46	Alluvial	BENDCK_01	35.8	10.0	1.3	0.4	2.6	557.2	6867.1	601.8	349.7	1.3	173.7	15.5	12.5	83.4	14457.1	10.8	6.2	7.2	13.7	0.2	9.6	3.3
47	Alluvial	BENDCK_02	32.8	19.7	1.8	1.1	8.5	3211.0	25982.5	606.4	1316.9	4.2	410.9	36.0	31.0	166.3	31180.2	9.8	15.4	17.8	34.3	0.3	31.3	9.2
48	Old tailings pond	CHUM_TOW_LOW	2798.7	82.2	12.3	1.4	8.6	2240.0	14135.7	551.4	1757.9	5.7	77.4	20.9	24.2	234.6	21560.5	20.2	12.7	54.5	83.9	2.4	31.5	5.9
49	Grey sand	LEST_01	890.6	20.9	0.8	0.5	4.3	7742.3	11845.6	718.8	5179.6	2.0	203.7	16.8	18.8	324.3	23268.5	6.3	21.0	18.4	72.8	0.3	88.1	6.2
50	Grey sand	LEST_02	716.0	26.3	0.9	0.5	2.5	7657.3	10775.3	706.6	6137.9	1.7	108.4	12.9	14.8	314.1	22961.2	7.3	21.5	19.9	83.8	0.2	78.5	5.4
51	Grey sand	LEST_03	806.5	29.0	1.0	0.8	5.6	9495.5	18201.2	567.5	5103.9	2.7	187.6	20.5	26.3	413.6	29317.4	10.0	29.1	23.3	86.6	0.2	69.5	7.9
52	Grey sand	LEST_04	226.1	7.4	0.4	0.4	2.2	6009.9	9455.8	1061.6	4269.9	1.3	83.2	11.8	12.7	206.9	19189.5	3.7	12.8	12.4	46.7	0.1	49.3	4.8
53	Grey sand	LEST_05	1695.2	116.3	2.4	3.7	13.9	12778.5	56328.4	475.9	2827.6	9.7	303.6	61.6	58.2	459.1	56948.1	13.2	45.7	60.8	287.4	4.7	89.8	14.5
54	Old tailings pond	CHUM_TOW_01	No soil supplied																					
55	Old tailings pond	CHUM_TOW_02	102745.5	212.7	43.6	0.2	6.9	212.3	3453.6	660.4	6566.2	2.0	19.4	5.2	6.6	52.5	103019.4	4.6	16.4	59.6	95.4	50.1	37.3	2.1
56	Old tailings pond	CHUM_TOW_BULK	8000.7	91.6	13.7	0.4	2.8	570.3	4160.2	867.2	212.7	2.4	22.8	6.9	7.5	119.6	31930.7	5.5	11.0	39.5	112.1	4.3	20.7	2.4
56-1	Old tailings pond	Brown material	16156.1	73.6	15.2	0.3	8.8	738.9	4979.4	694.1	553.6	4.2	29.2	7.8	10.9	129.2	54964.1	8.4	14.8	45.6	132.8	4.3	21.7	3.3
56-2	Old tailings pond	White material	231678.7	187.7	127.7	0.1	5.9	191.7	1635.2	694.7	468.0	2.3	13.6	2.4	4.0	22.0	181929.5	0.6	2.4	48.9	46.0	70.0	8.3	1.2
57	Calcine sand	DAYLES_01	11849.1	16677.4	117.1	1.1	15.0	4117.1	15099.0	609.4	1584.0	4.9	405.9	44.2	31.4	2939.8	405963.6	112.1	334.3	788.1	10604.1	2.8	18.6	6.2
58	Calcine sand	DAYLES_02	10022.8	16540.8	115.7	1.2	14.1	3852.9	14657.4	625.8	6863.8	4.5	410.3	42.7	32.3	2816.8	341340.5	77.1	242.8	777.1	9997.8	2.3	40.2	6.3
59	Calcine sand	DAYLES_03	10831.0	16950.1	119.0	1.5	10.5	4493.2	14371.8	546.5	2926.6	4.5	482.0	37.5	29.2	2598.7	381072.7	120.4	322.3	763.8	10497.0	1.6	22.8	7.1

Table 1 cont. Total Metal(loid) Concentration (mg/kg): < 2 mm soil particle size fraction

Sample #	Type	Sample ID	Mo	Cd	Ba	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Th
		HIL A		20																
		HIL C		90																
1	Calcine sand	MARONG_01	3.9	5.4	270.3	35.8	96.5	9.1	37.1	7.4	1.4	5.7	0.43	2.42	0.27	0.67	0.09	0.75	0.67	9.6
2	Calcine sand	MARONG_02	2.6	10.5	225.1	30.2	69.5	7.5	34.0	6.6	1.2	5.1	0.36	2.21	0.25	0.67	0.08	0.68	0.78	8.2
3	Calcine sand	MARONG_03	3.7	5.8	251.2	43.2	118.3	11.1	58.8	9.3	1.7	6.9	0.50	2.84	0.30	0.75	0.09	0.73	0.77	11.2
4	Calcine sand	MARONG_05	3.9	6.1	257.5	60.7	123.3	11.8	49.9	9.6	1.6	7.1	0.52	2.70	0.30	0.71	0.09	0.75	0.62	11.9
5	Calcine sand	MARONG_06	3.3	9.9	268.9	58.4	138.4	11.5	54.4	10.5	1.9	7.6	0.49	2.85	0.27	0.63	0.07	0.81	0.62	10.5
6	Mixed	MCC_01_red	0.6	0.2	206.8	35.8	98.9	9.4	40.7	8.5	1.3	7.1	0.57	3.91	0.46	1.31	0.16	1.44	1.73	21.6
7	Grey sand	MCC_01_top	0.4	0.3	244.2	28.4	64.3	7.2	25.7	6.0	1.0	4.7	0.35	2.34	0.29	0.87	0.12	1.03	1.15	11.5
8	Grey sand	MCC_02	0.3	0.3	81.6	18.6	41.7	4.7	21.7	4.1	0.7	3.3	0.26	1.71	0.20	0.56	0.08	0.63	0.70	6.5
9	Mixed	MCC_02_0.9	0.4	0.0	111.6	35.9	71.9	8.1	31.2	5.6	0.8	4.2	0.50	2.29	0.39	0.96	0.13	0.96	0.13	14.2
10	Grey sand	MCC_03_top	0.3	0.2	58.5	24.4	50.6	5.9	22.6	4.1	0.6	2.8	0.31	1.34	0.22	0.59	0.08	0.64	0.09	8.2
11	Grey sand	MCC_03_0.4	0.5	0.2	71.6	21.7	43.1	5.3	18.7	3.7	0.6	2.6	0.29	1.29	0.22	0.57	0.08	0.64	0.09	7.4
12	Grey sand	MCC_03_0.9	0.6	0.2	111.8	23.8	47.1	5.9	23.7	4.0	0.7	2.8	0.33	1.50	0.26	0.68	0.09	0.78	0.11	8.1
13	Grey sand	MCC_04_top	0.3	0.2	69.2	21.0	42.7	5.1	19.6	3.6	0.6	2.5	0.29	1.31	0.22	0.58	0.08	0.64	0.09	6.9
14	Grey sand	MCC_04_0.9	0.2	0.2	62.4	15.8	31.4	3.9	14.3	2.7	0.5	2.1	0.24	1.14	0.20	0.53	0.08	0.60	0.09	5.9
15	Mixed	CLAY_01	0.8	0.9	145.9	32.4	63.9	8.1	30.5	5.6	0.9	4.1	0.49	2.34	0.43	1.15	0.16	1.22	0.17	11.2
16	Calcine sand	CLAY_02	1.8	6.9	138.9	30.9	57.7	8.0	35.5	5.8	1.1	4.5	0.40	2.04	0.28	0.79	0.09	0.81	0.72	9.7
17	Calcine sand	CLAY_03	1.4	4.1	124.9	22.8	49.9	5.8	23.2	4.9	0.9	3.8	0.27	1.62	0.19	0.49	0.06	0.53	0.46	7.0
18	Calcine sand	CLAY_05	3.5	43.9	166.2	25.0	52.2	6.3	31.1	5.3	0.9	4.3	0.30	1.72	0.20	0.52	0.06	0.63	0.55	7.6
19	Calcine sand	CLAY_07	2.4	20.2	151.2	28.2	60.4	7.0	34.5	5.7	1.0	4.3	0.31	1.85	0.20	0.51	0.06	0.54	0.61	8.2
20	Grey sand	IRON_01	0.3	0.1	68.7	24.8	46.5	6.0	21.0	3.8	0.6	2.5	0.27	1.12	0.18	0.44	0.06	0.50	0.07	7.2
21	Grey sand	IRON_02	0.4	0.1	29.4	17.0	31.0	4.0	15.6	2.5	0.4	1.8	0.20	0.84	0.14	0.34	0.05	0.40	0.06	7.2
22	Grey sand	DEBRA_11	0.4	0.2	42.4	21.6	41.8	5.1	19.6	3.4	0.6	2.5	0.28	1.22	0.20	0.51	0.07	0.58	0.08	6.4
23	Grey sand	DEBRA_12	0.3	0.2	57.4	20.3	44.7	4.9	19.0	3.8	0.6	2.4	0.27	1.19	0.20	0.57	0.07	0.65	0.08	7.3
24	Grey sand	CHUM_27	0.3	0.1	70.5	34.6	68.5	8.3	33.9	5.4	0.8	3.7	0.40	1.75	0.30	0.77	0.11	0.91	0.13	10.8
25	Grey sand	CHUM_28	0.3	0.2	57.3	15.3	27.4	3.9	15.2	2.3	0.4	1.8	0.20	0.87	0.15	0.35	0.06	0.39	0.06	5.1
26	Grey sand	CHUM_28_0.75	0.6	0.2	77.5	22.5	52.2	5.6	21.5	3.7	0.6	2.6	0.29	1.28	0.22	0.58	0.08	0.60	0.09	7.7
27	Grey sand	CHUM_28_0.9	0.5	0.1	134.0	25.4	49.2	6.2	24.7	4.1	0.7	3.1	0.36	1.71	0.30	0.80	0.11	0.82	0.12	10.8
28	Grey sand	CHUM_29	0.3	0.3	42.9	20.2	38.0	4.9	19.0	3.2	0.5	2.2	0.24	1.03	0.17	0.44	0.06	0.50	0.07	7.1
29	Grey sand	CHUM_30	0.4	0.2	109.0	28.0	54.2	6.7	24.4	4.3	0.7	2.9	0.31	1.34	0.22	0.56	0.07	0.58	0.09	8.7
30	Grey sand	CHUM_31	0.6	0.1	31.1	14.1	27.3	3.4	12.1	2.0	0.3	1.2	0.11	0.43	0.07	0.19	0.03	0.21	0.03	4.9
31	Grey sand	CHUM_32	0.6	0.1	104.3	31.5	63.0	7.6	30.7	5.1	0.8	3.8	0.44	2.06	0.35	0.90	0.12	0.83	0.11	8.5
32	Grey sand	CHUM_33	1.2	0.5	60.7	21.0	41.6	5.1	20.5	3.4	0.6	2.2	0.24	1.04	0.18	0.49	0.07	0.59	0.09	8.7
33	Grey sand	CHUM_34	0.5	0.2	106.1	28.6	64.0	7.5	33.0	7.1	1.2	5.7	0.43	2.81	0.35	1.00	0.13	1.37	1.48	18.1
34	Grey sand	CHUM_35	0.4	0.2	100.0	26.4	49.2	6.4	23.9	4.0	0.6	2.9	0.31	1.36	0.22	0.55	0.08	0.55	0.08	8.1
35	Grey sand	CHUM_36	1.1	0.4	233.8	35.1	92.2	9.1	47.8	9.2	1.6	7.5	0.51	3.93	0.39	1.13	0.15	1.55	1.45	13.2
36	Grey sand	CHUM_37	0.5	0.3	106.5	24.9	48.3	5.9	21.8	3.9	0.8	2.6	0.27	1.20	0.20	0.53	0.08	0.61	0.09	8.6
37	Grey sand	CHUM_37_0.5	0.6	0.3	77.7	22.1	42.3	5.3	20.0	3.4	0.7	2.4	0.27	1.19	0.20	0.51	0.08	0.65	0.09	7.5
38	Grey sand	CHUM_37_1.2-1.4	0.7	0.3	136.1	27.6	52.4	6.6	23.9	4.2	0.8	2.8	0.30	1.33	0.23	0.58	0.08	0.72	0.11	10.0
39	Mixed	JACKASS_03	1.0	0.3	211.7	38.5	116.7	9.7	46.5	8.4	1.5	6.7	0.52	3.60	0.41	1.14	0.14	1.28	1.39	14.3
40	Calcine sand	JACKASS_06	3.1	4.3	330.3	39.4	131.2	9.9	60.2	9.9	1.7	7.6	0.45	3.05	0.27	0.68	0.08	0.79	0.96	10.0
41	Calcine sand	JACKASS_07	3.2	5.3	319.4	39.2	84.6	9.8	47.6	7.9	1.4	6.3	0.46	2.65	0.29	0.73	0.09	0.82	0.77	11.2
42	Grey sand	WELLS_01	0.3	0.1	36.7	16.4	32.7	4.1	14.9	2.6	0.4	1.7	0.18	0.75	0.12	0.33	0.05	0.35	0.05	5.4
43	Grey sand	PASC_01	0.2	0.1	39.5	19.1	38.7	4.7	17.4	3.2	0.6	2.2	0.25	1.06	0.17	0.43	0.06	0.49	0.07	5.7
44	Grey sand	PASC_02	0.2	0.1	44.4	21.2	42.2	5.4	20.5	3.7	0.7	2.7	0.31	1.36	0.22	0.55	0.08	0.61	0.09	6.7
45	Grey sand	PASC_03	0.2	0.2	62.3	26.4	51.3	6.4	24.8	4.3	0.8	3.1	0.34	1.51	0.25	0.63	0.09	0.69	0.10	7.3
46	Alluvial	BENDCK_01	0.3	0.0	72.6	12.9	25.0	3.3	11.5	2.1	0.3	1.4	0.17	0.76	0.13	0.33	0.05	0.35	0.05	3.7
47	Alluvial	BENDCK_02	0.4	0.0	151.4	39.4	79.3	9.6	37.0	6.1	0.9	4.3	0.48	2.13	0.36	0.91	0.12	0.89	0.12	10.1
48	Old tailings pond	CHUM_TOW_LOW	0.8	0.5	82.2	24.6	46.5	5.9	22.9	4.1	0.7	3.0	0.34	1.51	0.25	0.66	0.10	0.85	0.12	8.4
49	Grey sand	LEST_01	0.3	0.2	69.0	33.4	66.5	7.8	30.4	5.3	0.9	3.6	0.38	1.55	0.24	0.61	0.08	0.60	0.08	10.3
50	Grey sand	LEST_02	0.3	0.2	53.2	22.2	46.9	5.3	18.5	3.8	0.6	2.5	0.27	1.18	0.19	0.53	0.07	0.56	0.07	8.1
51	Grey sand	LEST_03	0.3	0.2	110.3	31.7	61.3	7.6	28.9	5.0	0.8	3.6	0.40	1.78	0.30	0.76	0.11	0.85	0.12	10.9
52	Grey sand	LEST_04	0.4	0.1	41.1	23.8	45.5	5.7	21.0	3.9	0.6	2.6	0.28	1.18	0.18	0.45	0.06	0.46	0.07	6.5
53	Grey sand	LEST_05	1.2	0.5	364.8	25.5	76.8	6.4	27.0	8.0	1.3	6.5	0.40	3.68	0.35	1.06	0.15	2.14	2.15	18.1
54	Old tailings pond	CHUM_TOW_01																		
55	Old tailings pond	CHUM_TOW_02	1.7	0.8	33.2	11.8	29.7	3.0	14.8	2.9	0.5	2.2	0.11	0.69	0.07	0.18	0.02	0.23	0.38	3.3
56	Old tailings pond	CHUM_TOW_BULK	0.9	0.2	29.6	17.4	32.9	4.2	15.1	2.5	0.4	1.6	0.15	0.61	0.10	0.25	0.04	0.29	0.05	5.7
56-1	Old tailings pond	Brown material	0.7	0.4	40.6	18.1	41.4	4.6	25.2	4.0	0.8	2.8	0.20	1.23	0.12	0.33	0.04	0.51	0.56	7.9
56-2	Old tailings pond	White material	2.3	0.7	17.0	13.4	30.4	3.3	20.4	2.8	0.4	1.8	0.10	0.48	0.04	0.11	0.01	0.18	0.37	2.8
57	Calcine sand	DAYLES_01	4.7	24.6	149.5	22.5	45.7	5.8	25.6	5.2	0.9	4.0	0.30	2.10	0.23	0.61	0.07	0.69	0.69	7.7
58	Calcine sand	DAYLES_02	4.5	21.0	163.1	18.8	38.1	4.6	20.5	4.3	0.8	3.5	0.27	1.93	0.22	0.59	0.08	0.77	0.80	6.5
59	Calcine sand	DAYLES_03	4.4	25.1	138.7	20.9	41.7	5.2	22.0	4.7	0.9	4.0	0.29	2.00	0.24	0.65	0.08	0.79	0.73	7.4

Table 2. Total Metal(loid) Concentration (mg/kg): < 250 um soil particle size fraction

Sample #	Type	Sample ID	As	Pb	Sb	Be	B	Mg	Al	Si	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Se	Sr	Y
		HIL A	100	300		60	4500								100 (VI)	3800		100	400	6000	7400	200		
		HIL C	300	600		90	20000								300 (VI)	19000		300	1200	17000	30000	700		
1	Calcine sand	MARONG_01	14959.3	2735.1	715.3	1.7	14.3	7764.7	23433.1	721.9	9669.6	6.6	627.3	32.1	32.9	2092.5	235015.2	149.5	335.3	387.3	1648.7	5.4	99.1	7.8
2	Calcine sand	MARONG_02	10066.1	3998.4	308.4	1.3	15.2	5671.8	19525.7	813.0	8797.6	5.5	704.5	24.0	29.8	1132.8	203860.0	115.1	263.4	404.7	3528.7	2.0	75.6	7.7
3	Calcine sand	MARONG_03	14629.1	2644.9	877.9	2.2	12.6	8737.9	28144.5	647.8	2626.6	7.9	598.2	43.7	40.9	1412.7	341297.1	207.9	491.3	570.4	1619.8	5.6	63.5	9.4
4	Calcine sand	MARONG_05	15560.4	2051.8	371.8	1.8	14.2	9120.8	21998.5	896.9	4194.7	5.8	580.7	30.3	31.0	1061.6	236814.7	155.2	359.7	364.3	1164.0	1.7	67.4	7.6
5	Calcine sand	MARONG_06	14833.1	3336.4	3206.1	1.7	14.5	9678.8	23710.8	687.0	3746.6	6.2	565.6	31.7	32.7	915.5	241843.2	156.1	362.2	405.5	1834.3	4.1	59.5	7.2
6	Mixed	MCC_01_red	257.7	27.8	0.8	4.1	11.2	2912.1	63507.2	808.6	1592.0	12.0	452.5	47.1	52.6	63.9	40700.8	6.5	14.2	27.3	72.2	5.8	68.8	18.2
7	Grey sand	MCC_01_top	2453.6	64.1	2.9	1.5	11.2	6707.4	25620.9	1103.1	3287.9	4.5	232.1	35.5	34.3	331.1	29948.9	7.6	23.7	28.9	90.3	0.7	85.1	9.5
8	Grey sand	MCC_02	1705.5	34.4	1.9	1.0	5.2	4337.7	10969.0	1314.8	3093.7	2.7	81.2	14.0	14.2	919.3	36862.0	15.5	26.2	30.9	101.7	0.4	85.7	8.3
9	Mixed	MCC_02_0.9	192.0	46.0	0.8	0.9	6.0	3801.5	22306.5	841.6	2180.7	3.4	177.4	22.9	29.7	120.6	27016.7	10.2	23.9	18.2	74.1	0.5	72.9	10.2
10	Grey sand	MCC_03_top	2536.5	57.4	2.2	0.7	6.1	6161.1	13119.6	799.3	7548.3	2.7	162.7	18.0	18.4	496.6	28512.0	9.7	25.3	25.5	191.2	0.7	108.3	7.7
11	Grey sand	MCC_03_0.4	3278.9	73.0	2.6	0.8	4.6	7301.3	11769.1	844.8	18293.0	2.5	142.7	16.2	17.5	451.1	29404.6	9.9	27.5	35.1	245.1	1.1	125.9	7.4
12	Grey sand	MCC_03_0.9	1934.3	56.6	2.2	0.9	4.6	6616.5	13498.4	903.7	17299.0	2.9	167.4	19.6	22.7	493.2	32657.3	10.3	27.7	24.8	237.9	0.7	137.2	8.5
13	Grey sand	MCC_04_top	2836.9	64.7	2.6	0.9	5.4	6729.7	12281.6	1033.6	7785.5	2.7	145.7	17.1	18.4	490.8	31995.5	10.8	26.6	26.7	262.3	0.9	112.8	8.3
14	Grey sand	MCC_04_0.9	2856.3	43.6	2.2	0.4	3.2	5688.1	8100.3	1306.6	7297.5	2.1	55.8	10.6	13.0	574.2	32653.6	12.3	23.7	30.2	169.8	0.9	106.6	6.8
15	Mixed	CLAY_01	986.5	226.1	28.3	0.4	15.7	7768.2	29498.9	811.1	3803.0	4.9	269.4	19.3	35.2	267.6	51151.3	25.6	65.2	74.0	352.5	2.2	45.9	13.3
16	Calcine sand	CLAY_02	5470.7	2612.3	40.9	1.3	13.1	4741.7	23738.2	662.5	2540.5	4.9	529.9	25.2	29.8	715.9	135461.1	76.5	175.8	237.2	1791.7	2.6	45.0	8.0
17	Calcine sand	CLAY_03	7802.6	1648.2	31.0	1.7	11.7	6361.8	19985.2	805.5	6246.1	4.6	487.4	21.3	27.8	585.6	155196.7	92.3	266.1	241.7	1140.8	2.8	71.9	7.0
18	Calcine sand	CLAY_05	11894.2	13546.6	111.9	1.0	13.0	5327.1	13729.3	862.4	2116.0	4.9	618.5	24.8	26.1	1531.2	296383.1	119.5	300.4	825.4	12027.8	0.2	31.7	5.5
19	Calcine sand	CLAY_07	6111.8	5136.2	80.3	1.0	10.4	3629.7	16262.3	1199.2	1559.3	4.5	526.6	19.1	23.9	755.1	189094.4	89.2	212.3	442.6	6242.7	1.2	25.5	5.0
20	Grey sand	IRON_01	331.4	50.9	1.4	1.4	5.3	5553.1	9306.5	1277.3	3395.9	2.3	57.7	9.9	12.3	326.4	25255.4	9.3	23.4	26.6	118.9	3.3	58.0	4.8
21	Grey sand	IRON_02	340.3	32.2	1.1	0.2	4.5	5318.5	8723.3	1021.3	5039.1	1.9	56.6	10.2	12.3	317.1	24006.7	8.8	25.3	38.3	112.3	0.6	49.0	5.1
22	Grey sand	DEBRA_11	1266.2	29.5	2.3	0.8	3.7	4286.7	9360.8	1322.0	4358.3	2.7	100.8	14.1	14.6	418.6	33825.2	13.8	29.3	33.9	105.6	0.7	76.6	8.0
23	Grey sand	DEBRA_12	1704.7	34.7	2.3	0.6	3.2	5289.9	9025.3	1183.4	10376.6	2.2	138.6	13.8	15.4	490.8	29252.8	10.9	28.3	31.3	193.0	0.5	96.6	6.6
24	Grey sand	CHUM_27	1158.4	42.3	3.6	0.7	5.5	5163.8	15183.1	817.8	4892.7	3.4	254.2	20.1	20.8	304.6	23495.3	8.9	21.4	21.1	70.5	0.5	88.4	9.9
25	Grey sand	CHUM_28	1929.7	64.7	7.3	0.4	3.2	4573.6	6009.6	1306.6	4501.7	1.6	77.7	8.9	8.8	274.3	20570.9	5.7	15.3	17.7	102.9	0.8	84.1	4.5
26	Grey sand	CHUM_28_0.75	1703.4	94.4	7.0	0.6	5.2	4005.0	12239.8	1078.2	2961.8	2.4	154.3	16.2	18.8	228.9	23020.0	6.4	17.4	19.9	97.4	0.7	65.4	6.4
27	Grey sand	CHUM_28_0.9	911.8	64.2	4.9	0.9	7.9	4925.9	19652.5	1076.1	2825.3	3.5	221.7	24.1	60.9	161.5	30960.7	7.6	34.7	38.6	68.5	1.1	57.8	8.0
28	Grey sand	CHUM_29	1275.9	63.0	4.9	0.4	5.4	8929.5	9964.7	1955.8	7604.8	2.1	67.6	14.5	13.0	406.3	36697.0	9.2	23.1	26.9	109.4	0.6	86.9	5.8
29	Grey sand	CHUM_30	866.4	58.1	4.5	0.8	4.7	7353.3	12738.7	765.9	4226.0	2.6	422.7	21.1	27.1	365.0	26639.0	12.2	33.0	35.2	109.6	0.3	87.1	6.3
30	Grey sand	CHUM_31	18866.9	71.9	11.1	0.3	5.0	712.7	4861.9	1388.2	4104.3	1.0	42.6	6.1	5.8	311.0	28259.3	3.0	4.4	7.1	22.8	4.1	183.3	3.0
31	Grey sand	CHUM_32	136.6	31.0	3.0	1.0	7.1	3864.1	20616.2	1088.1	2963.5	3.5	860.7	35.1	26.2	206.8	27610.8	11.0	25.8	18.1	60.8	0.3	29.7	9.3
32	Grey sand	CHUM_33	2628.7	104.8	11.0	0.9	6.3	2481.9	9803.1	1173.6	1392.4	2.2	49.7	15.1	20.8	188.9	20251.0	10.1	19.6	25.7	148.9	2.8	32.5	5.6
33	Grey sand	CHUM_34	330.6	43.8	1.8	1.7	8.1	4848.5	47491.5	930.5	1066.3	7.5	261.2	29.2	44.0	118.4	51101.6	21.6	34.7	36.7	102.3	2.7	37.2	8.3
34	Grey sand	CHUM_35	778.5	194.2	3.6	0.9	7.0	5570.1	15820.0	1289.6	3812.0	2.8	257.6	19.9	22.1	425.8	28543.7	11.1	24.3	37.6	218.7	0.4	57.2	6.9
35	Grey sand	CHUM_36	1023.6	65.8	6.0	0.6	9.5	2754.5	39335.6	696.8	1628.7	7.7	322.2	34.4	36.4	197.6	34469.9	13.8	29.1	43.4	170.0	4.1	53.3	12.2
36	Grey sand	CHUM_37	1609.5	40.1	3.8	0.8	5.1	9412.4	9749.2	1386.1	10930.1	2.4	288.7	17.5	20.1	533.7	24558.8	8.6	24.3	22.8	107.1	0.4	158.0	5.6
37	Grey sand	CHUM_37_0.5	1407.7	34.8	2.9	0.5	4.4	8575.1	7517.9	1414.1	14430.4	2.0	254.4	13.7	16.7	506.9	23868.8	7.8	20.8	21.2	85.8	0.3	180.6	4.9
38	Grey sand	CHUM_37_1.2-1.4	1593.2	41.2	3.6	0.7	7.0	9598.2	12052.9	1285.8	15394.5	2.8	357.4	20.8	24.6	548.7	27232.6	8.7	27.0	23.1	102.2	0.4	208.0	6.4
39	Mixed	JACKASS_03	425.9	78.3	2.0	1.6	11.5	2497.3	47828.2	777.3	680.1	10.2	534.3	41.5	43.6	42.4	43013.2	11.2	26.4	30.8	64.8	3.4	26.8	10.1
40	Calcine sand	JACKASS_06	11177.5	1089.4	24.9	1.6	14.6	7376.6	22453.2	801.9	6866.9	5.6	807.8	25.0	30.6	620.3	209035.6	129.3	286.3	244.9	651.0	2.4	86.2	7.1
41	Calcine sand	JACKASS_07	13098.9	1676.0	20.2	0.7	16.3	7632.3	24050.4	604.6	6897.7	5.4	799.1	28.1	35.4	776.0	273617.6	155.4	344.6	304.8	885.8	2.8	102.1	7.1
42	Grey sand	WELLS_01	272.2	22.2	0.9	0.6	3.9	5220.6	10683.8	1459.1	2367.6	1.7	94.5	10.9	13.0	229.8	20993.9	4.4	14.1	14.9	55.4	0.2	35.7	4.5
43	Grey sand	PASC_01	416.3	30.1	1.7	0.6	2.9	5660.1	8125.6	1146.9	13020.8	1.9	115.1	10.8	11.8	561.3	26585.3	9.4	20.6	23.8	402.9	0.3	112.9	6.3
44	Grey sand	PASC_02	295.9	36.8	3.1	0.5	4.0	8109.0	10357.9	1083.2	11660.8	2.7	214.2	14.9	16.6	689.6	38475.5	17.5	32.6	38.4	101.1	0.4	135.1	8.3
45	Grey sand	PASC_03	254.2	47.2	2.7	1.0	8.5	7764.7	18748.9	925.1	9543.3	4.2	542.7	29.6	26.8	805.4	33850.2	22.7	30.2	31.4	103.6	0.3	124.3	8.8
46	Alluvial	BENDCK_01	33.9	9.2	1.2	0.2	2.3	557.6	6115.6	1351.1	504.8	1.2	184.8	11.8	9.0	57.6	12896.9	3.2	5.3	6.5	14.7	0.1	7.2	5.2
47	Alluvial	BENDCK_02	39.1	22.4	3.7	1.1	7.6	3157.1	23206.3	943.1	1377.3	3.9	330.6	34.8	31.1	151.9	31510.0	9.6	15.5	15.9	34.8	0.3	33.3	9.3
48	Old tailings pond	CHUM_TOW_LOW	3162.1	98.6	14.7	1.2	6.2	2183.2	11064.5	1050.4	1669.2	5.6	51.5	16.6	25.0	158.4	21817.3	13.0	11.3	46.8	69.5	2.6	33.9	5.9
49	Grey sand	LEST_01	1106.3	23.9	0.9	0.8	5.6	8985.2	13401.6	932.9	5741.6	2.3	258.7	20.7	20.9	338.9	27755.7	6.9	21.8	19.9	74.3	0.4	90.5	6.4
50	Grey sand	LEST_02	1096.9	44.9	1.5	0.6	4.1	8537.6	13690.6	828.0	6405.7	2.2	154.9	18.4	19.6	342.4	27583.8	10.9	28.3	30.1	114.4	0.4	90.6	7.0
51	Grey sand	LEST_03	838.4	30.0	1.0	0.8	5.3	9150.7	17437.0	932.9	5081.7	2.6	189.7	20.5	24.7	365.1	29281.8	8.6	27.4	23.1	83.7	0.2	71.3	8.1
52	Grey sand	LEST_04	388.7	12.3	0.6	0.8	5.0	7670.4	15006.4	1644.2	5699.6	2.4	173.0	22.7	20.1	301.7	24312.9	6.0	18.7	17.4	63.4	0.2	78.6	7.7
53	Grey sand	LEST_05	1672.5	95.3	1.8	2.0	16.9	12122.0	54898.3	812.2	2570.2	9.9	414.1	64.3	57.7	385.7	48673.3	11.1	37.2	49.1	230.1	5.3	78.9	12.7
54	Old tailings pond	CHUM_TOW_01		No soil supplied																				
55	Old tailings pond	CHUM_TOW_02		No < 250 um PSF																				
56	Old tailings pond	CHUM_TOW_BULK	16865.9	176.2	26.2	1.1	5.3	584.5	5107.2	1253.0	502.2	3.9	33.6	9.8	9.1	109.8	44503.5	6.8	12.4	49.3	119.1	11.3	42.2	4.0
56-1	Old tailings pond	Brown material	27306.6	112.6	20.8	0.2	5.9	847.7	5307.0	1244.0	678.5	6.4	29.4	10.0	13.6	149.0	73816.6	9.9	12.3	41.5	114.9	5.5	31.1	3.6
56-2	Old tailings pond	White material	200293.2	302.4	119.3	0.1	8.1	402.9	7152.2	1230.3	133.1	3.8	74.1	0.4	9.7	28.2	144354.5	0.9	2.4	50.9	57.7	75.9	13.5	2.3
57	Calcine sand	DAYLES_01	11331.8	17245.6	134.3	1.2	10.5	3919.1	14234.7	1225.2	2848.3	4.4	437.6	35.9	29.6	2624.2	379225.4	102.8	337.0	957.5	11660.0	2.0	23.9	5.9
58	Calcine sand	DAYLES_02	10392.1	15998.2	124.5	0.1	9.1	3577.2	12269.7	944.6	7050.8	4.3	388.3	31.4	26.9	2377.0	305539.9	77.2	255.2	740.5	9209.3	0.1	37.6	5.7
59	Calcine sand	DAYLES_03	11675.3	18399.2	134.3	0.7	9.2	3737.7	12786.2	1061.3	1601.9	4.1	412.5	31.2	24.8	2421.5	370308.5	109.4	309.8	828.5	12181.5	0.8	18.8	5.7

Table 2 cont. Total Metal(loid) Concentration (mg/kg): < 250 um soil particle size fraction

Sample #	Type	Sample ID	Mo	Cd	Ba	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Th
		HIL A		20																
		HIL C		90																
1	Calcine sand	MARONG_01	3.4	7.3	364.1	36.7	83.1	9.2	38.2	8.2	1.4	6.5	0.43	2.55	0.27	0.67	0.08	0.80	0.79	10.6
2	Calcine sand	MARONG_02	2.7	12.6	216.6	34.6	77.9	8.8	40.7	7.6	1.3	6.0	0.43	2.62	0.28	0.73	0.09	0.77	0.79	9.8
3	Calcine sand	MARONG_03	4.7	7.5	323.6	40.0	107.7	10.0	40.5	10.3	2.0	8.5	0.46	3.13	0.26	0.65	0.08	0.79	0.75	10.6
4	Calcine sand	MARONG_05	3.7	6.0	272.5	43.6	109.7	11.0	57.1	9.6	1.6	7.3	0.49	2.79	0.27	0.66	0.08	0.72	0.66	11.9
5	Calcine sand	MARONG_06	2.9	9.0	277.5	47.3	121.6	11.9	50.3	10.1	1.7	7.6	0.51	2.69	0.27	0.64	0.07	0.61	0.58	11.7
6	Mixed	MCC_01_red	0.8	0.2	284.5	41.6	116.9	11.0	48.8	12.0	1.9	10.0	0.70	5.32	0.56	1.55	0.20	2.23	2.42	25.8
7	Grey sand	MCC_01_top	0.4	0.2	232.0	39.8	83.9	9.3	38.1	6.3	0.9	4.1	0.46	2.10	0.37	1.05	0.14	1.03	0.15	13.4
8	Grey sand	MCC_02	0.2	0.3	101.6	31.3	76.5	7.5	29.3	5.5	0.8	3.6	0.42	1.86	0.31	0.89	0.11	0.85	0.12	8.9
9	Mixed	MCC_02_0.9	0.4	0.0	122.3	47.2	99.4	10.2	38.9	6.8	0.9	5.0	0.57	2.54	0.42	1.06	0.13	0.90	0.12	16.1
10	Grey sand	MCC_03_top	0.3	0.2	112.9	34.4	72.3	8.2	30.8	5.5	0.9	3.8	0.42	1.82	0.30	0.79	0.11	0.75	0.11	10.3
11	Grey sand	MCC_03_0.4	0.6	0.3	85.0	31.3	66.9	7.5	28.1	5.3	0.8	3.5	0.38	1.66	0.28	0.79	0.10	0.75	0.11	10.1
12	Grey sand	MCC_03_0.9	0.8	0.3	132.7	36.7	76.8	8.9	32.4	5.9	1.0	4.1	0.46	2.03	0.34	0.89	0.12	0.87	0.12	11.0
13	Grey sand	MCC_04_top	0.5	0.4	91.0	38.0	80.8	9.1	33.9	6.2	0.9	4.1	0.46	2.00	0.34	0.88	0.12	0.84	0.12	11.7
14	Grey sand	MCC_04_0.9	0.3	0.3	59.3	29.7	79.6	7.2	24.8	4.9	0.7	3.4	0.37	1.63	0.27	0.73	0.10	0.71	0.10	9.6
15	Mixed	CLAY_01	0.8	1.2	170.0	38.3	82.0	9.7	40.1	8.1	1.4	6.6	0.55	3.59	0.44	1.27	0.17	1.52	1.52	13.2
16	Calcine sand	CLAY_02	2.0	8.9	178.7	35.2	75.1	8.9	45.6	7.2	1.2	5.7	0.43	2.50	0.29	0.81	0.10	0.96	0.90	11.2
17	Calcine sand	CLAY_03	2.3	5.9	186.8	29.9	67.3	7.7	30.4	6.7	1.1	5.1	0.38	2.31	0.25	0.64	0.08	0.75	0.79	9.2
18	Calcine sand	CLAY_05	4.0	48.5	159.5	21.1	46.9	5.3	28.1	5.0	0.9	4.0	0.28	1.83	0.20	0.52	0.06	0.59	0.53	7.1
19	Calcine sand	CLAY_07	2.6	21.7	139.0	26.0	54.5	6.6	31.0	5.2	0.9	4.1	0.30	1.66	0.19	0.50	0.06	0.47	0.45	8.7
20	Grey sand	IRON_01	0.3	0.4	53.6	22.3	50.1	5.7	26.4	4.7	0.7	3.8	0.26	1.55	0.16	0.46	0.06	0.64	0.71	8.4
21	Grey sand	IRON_02	0.5	0.3	48.3	26.6	55.6	6.7	26.0	5.1	0.8	4.0	0.29	1.54	0.19	0.52	0.07	0.65	0.82	9.4
22	Grey sand	DEBRA_11	0.4	0.3	78.9	37.7	77.9	8.9	33.3	6.0	0.9	4.0	0.44	1.92	0.32	0.84	0.11	0.77	0.11	9.5
23	Grey sand	DEBRA_12	0.4	0.3	67.6	29.3	60.9	6.9	26.0	4.7	0.7	3.2	0.36	1.57	0.26	0.69	0.09	0.67	0.10	8.4
24	Grey sand	CHUM_27	0.5	0.2	126.8	44.0	94.0	10.8	42.3	7.4	1.1	4.8	0.53	2.36	0.41	1.11	0.15	1.10	0.16	13.1
25	Grey sand	CHUM_28	0.5	0.4	49.8	23.0	48.7	5.5	22.1	3.7	0.6	2.5	0.26	1.10	0.18	0.49	0.06	0.46	0.07	6.8
26	Grey sand	CHUM_28_0.75	0.6	0.3	88.7	27.6	67.3	6.6	24.6	4.4	0.7	3.1	0.34	1.49	0.26	0.69	0.09	0.64	0.09	8.8
27	Grey sand	CHUM_28_0.9	0.6	0.2	122.1	30.5	63.7	7.3	28.9	4.9	0.7	3.5	0.40	1.84	0.32	0.85	0.12	0.80	0.12	11.1
28	Grey sand	CHUM_29	0.5	0.4	65.5	30.8	61.5	7.2	26.8	4.8	0.7	3.2	0.34	1.42	0.23	0.64	0.09	0.63	0.10	9.1
29	Grey sand	CHUM_30	0.5	0.3	139.0	36.7	71.7	8.5	33.0	5.3	0.8	3.5	0.37	1.56	0.25	0.65	0.09	0.61	0.09	11.4
30	Grey sand	CHUM_31	1.0	0.1	51.8	25.6	51.1	5.8	20.0	3.5	0.4	2.0	0.19	0.74	0.12	0.33	0.04	0.31	0.05	9.1
31	Grey sand	CHUM_32	0.5	0.1	131.2	38.4	79.7	9.1	33.8	6.0	0.8	4.1	0.47	2.14	0.36	0.95	0.12	0.79	0.11	9.0
32	Grey sand	CHUM_33	1.1	0.6	70.9	30.5	61.1	7.2	27.2	4.6	0.7	2.9	0.31	1.32	0.22	0.62	0.09	0.62	0.10	11.2
33	Grey sand	CHUM_34	0.7	0.4	81.1	31.6	68.5	8.3	40.6	7.1	1.2	5.4	0.45	2.74	0.32	0.93	0.13	1.28	1.32	16.1
34	Grey sand	CHUM_35	0.5	0.3	148.5	32.0	66.0	7.6	28.3	5.0	0.7	3.4	0.37	1.61	0.27	0.72	0.10	0.65	0.10	9.0
35	Grey sand	CHUM_36	1.1	0.6	196.0	37.0	101.8	9.6	53.8	9.5	1.6	7.8	0.51	3.67	0.38	1.05	0.14	1.46	1.54	13.1
36	Grey sand	CHUM_37	0.6	0.4	114.6	29.4	62.0	6.9	25.2	4.6	0.7	2.9	0.30	1.30	0.22	0.58	0.08	0.59	0.09	9.6
37	Grey sand	CHUM_37_0.5	0.7	0.3	84.9	26.1	53.4	6.2	22.1	3.9	0.6	2.6	0.28	1.19	0.20	0.51	0.07	0.53	0.08	8.3
38	Grey sand	CHUM_37_1.2-1.4	0.7	0.3	143.3	35.5	66.6	8.3	31.6	4.9	0.8	3.5	0.37	1.60	0.27	0.66	0.10	0.70	0.11	11.8
39	Mixed	JACKASS_03	0.9	0.2	211.5	39.4	109.4	10.1	51.1	8.2	1.4	6.9	0.54	3.46	0.41	1.15	0.15	1.33	1.19	14.2
40	Calcine sand	JACKASS_06	2.6	3.4	287.9	38.7	86.9	9.8	45.9	8.4	1.3	6.4	0.45	2.51	0.26	0.65	0.08	0.73	0.57	10.8
41	Calcine sand	JACKASS_07	3.1	5.2	310.0	41.6	77.8	10.4	41.9	7.4	1.3	5.8	0.50	2.41	0.31	0.78	0.10	0.77	0.68	12.3
42	Grey sand	WELLS_01	0.5	0.1	64.5	28.8	57.3	6.8	23.5	4.2	0.7	2.7	0.28	1.12	0.18	0.49	0.07	0.46	0.07	8.3
43	Grey sand	PASC_01	0.3	0.3	52.3	31.3	65.2	7.4	29.2	5.0	0.8	3.4	0.37	1.59	0.26	0.67	0.09	0.65	0.09	9.0
44	Grey sand	PASC_02	0.3	0.3	82.8	43.0	89.7	10.0	36.4	7.0	1.1	4.7	0.52	2.15	0.34	0.88	0.11	0.83	0.12	11.4
45	Grey sand	PASC_03	0.3	0.3	210.8	39.5	82.4	9.5	35.4	6.3	1.0	4.3	0.48	2.10	0.35	0.90	0.12	0.89	0.12	10.2
46	Alluvial	BENDCK_01	0.3	0.0	118.9	32.5	71.7	7.7	28.4	5.0	0.6	3.1	0.33	1.37	0.21	0.54	0.06	0.43	0.06	8.2
47	Alluvial	BENDCK_02	0.4	0.0	186.6	45.6	98.3	10.8	42.3	7.0	0.9	4.7	0.52	2.28	0.38	0.98	0.13	0.81	0.12	11.1
48	Old tailings pond	CHUM_TOW_LOW	0.8	0.6	72.9	27.4	54.1	6.4	25.2	4.4	0.8	3.0	0.35	1.55	0.26	0.71	0.11	0.81	0.12	9.9
49	Grey sand	LEST_01	0.4	0.3	120.6	42.8	81.5	10.0	36.1	6.0	0.9	4.3	0.46	1.89	0.29	0.70	0.10	0.58	0.10	10.6
50	Grey sand	LEST_02	0.3	0.4	87.8	38.5	78.6	9.1	37.1	5.9	0.8	3.9	0.43	1.78	0.28	0.75	0.10	0.67	0.10	10.9
51	Grey sand	LEST_03	0.4	0.2	132.6	36.9	76.0	8.7	31.1	5.7	0.8	4.0	0.44	1.93	0.32	0.84	0.12	0.83	0.12	11.4
52	Grey sand	LEST_04	0.3	0.2	131.2	52.0	106.7	12.2	45.9	8.0	1.2	5.1	0.54	2.11	0.31	0.76	0.09	0.64	0.09	10.3
53	Grey sand	LEST_05	0.7	0.4	394.4	25.6	66.9	6.5	41.3	6.9	1.2	5.5	0.40	3.31	0.35	1.13	0.15	1.89	1.82	17.7
54	Old tailings pond	CHUM_TOW_01																		
55	Old tailings pond	CHUM_TOW_02																		
56	Old tailings pond	CHUM_TOW_BULK	1.2	0.3	52.3	29.6	60.7	7.1	29.1	5.6	0.9	4.1	0.26	1.37	0.15	0.40	0.05	0.46	0.63	9.2
56-1	Old tailings pond	Brown material	0.8	0.5	47.3	21.9	47.6	5.6	27.0	4.8	0.9	3.5	0.26	1.45	0.15	0.39	0.05	0.53	0.63	10.7
56-2	Old tailings pond	White material	2.3	0.5	142.7	20.9	43.1	5.1	30.2	4.0	0.6	2.5	0.16	0.80	0.08	0.23	0.03	0.30	0.40	4.6
57	Calcine sand	DAYLES_01	4.4	24.5	131.4	25.2	51.3	6.4	34.2	5.7	1.0	4.4	0.31	1.96	0.23	0.61	0.08	0.64	0.65	7.9
58	Calcine sand	DAYLES_02	4.0	18.1	144.7	20.2	39.2	5.0	19.2	4.4	0.8	3.4	0.27	1.80	0.22	0.59	0.07	0.66	0.71	6.3
59	Calcine sand	DAYLES_03	4.1	27.3	120.4	23.3	45.7	5.7	23.6	4.7	0.9	3.8	0.29	1.96	0.22	0.58	0.07	0.65	0.60	7.6

Table 3. Total Metal(loid) Concentration (mg/kg): < 106 um soil particle size fraction

Sample #	Type	Sample ID	As	Pb	Sb	Be	B	Mg	Al	Si	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Se	Sr	Y
		HIL A	100	300		60	4500								100 (VI)	3800		100	400	6000	7400	200		
		HIL C	300	600		90	20000								300 (VI)	19000		300	1200	17000	30000	700		
1	Calcine sand	MARONG_01	15506.3	3249.7	799.8	0.8	14.7	7330.5	23708.1	930.1	13817.1	6.1	680.4	29.7	33.5	2199.5	240263.8	155.0	347.0	479.6	2000.0	7.2	116.8	9.7
2	Calcine sand	MARONG_02	10239.4	3687.7	235.7	0.5	16.1	5584.1	22213.3	945.5	11388.1	5.3	797.8	24.6	31.8	1111.2	192131.0	105.0	240.9	374.7	3142.1	2.5	91.4	8.4
3	Calcine sand	MARONG_03	16135.2	2304.5	736.6	2.2	11.3	8930.9	21569.0	700.1	2526.8	5.9	661.2	30.7	30.5	1167.6	279510.3	169.3	395.4	467.3	1343.0	2.8	48.6	7.7
4	Calcine sand	MARONG_05	17841.0	2220.1	452.1	0.2	13.3	9289.1	22541.8	681.0	4345.8	6.6	682.7	32.6	32.2	1132.6	257904.4	169.4	385.8	391.8	1342.6	3.6	68.9	8.4
5	Calcine sand	MARONG_06	17720.1	4852.8	5280.1	1.0	13.0	8575.8	28803.8	410.5	3370.9	8.2	700.0	43.3	41.7	1290.2	341482.0	223.2	512.3	580.7	3526.9	7.1	80.5	9.9
6	Mixed	MCC_01_red	508.8	43.4	4.2	1.7	23.9	4192.9	90156.8	827.9	2556.0	18.1	681.2	71.7	77.1	105.6	57514.1	9.9	22.3	38.3	141.8	8.5	104.6	27.9
7	Grey sand	MCC_01_top	3077.2	55.7	3.8	2.3	14.2	5487.2	31015.7	584.4	2727.2	6.0	197.6	25.1	35.5	284.4	38517.9	8.5	29.5	40.6	139.3	4.1	94.1	12.0
8	Grey sand	MCC_02	4563.6	69.8	3.7	1.9	7.6	5096.9	16643.6	606.6	5228.6	4.8	126.7	10.5	20.6	1495.5	63508.7	27.6	66.1	83.6	249.8	4.4	141.3	14.3
9	Mixed	MCC_02_0.9	230.2	42.8	0.6	0.7	6.1	4386.6	20028.6	915.6	2683.3	3.0	177.4	20.2	27.1	117.3	24602.6	10.0	21.6	15.7	63.8	1.5	68.6	8.9
10	Grey sand	MCC_03_top	3701.8	81.0	2.6	1.0	7.0	6526.0	14254.1	706.4	7556.8	3.0	202.3	18.9	21.1	490.6	33167.5	11.9	30.1	31.2	238.5	2.3	103.9	8.0
11	Grey sand	MCC_03_0.4	5582.5	102.2	3.0	1.0	4.5	8123.3	12265.8	755.4	25063.3	2.5	145.6	16.1	18.8	456.5	32210.3	11.2	31.9	39.5	325.2	2.5	135.5	7.7
12	Grey sand	MCC_03_0.9	2605.3	76.7	2.8	1.4	6.1	6668.6	16860.7	635.1	17785.3	3.4	235.0	23.7	28.2	494.0	34685.4	12.2	32.4	30.6	301.3	2.2	152.2	9.4
13	Grey sand	MCC_04_top	4437.2	87.1	2.8	0.8	5.1	8132.4	12400.0	687.7	9025.8	2.7	160.5	16.7	19.5	516.7	35721.1	13.0	29.7	30.8	325.5	2.0	113.8	8.2
14	Grey sand	MCC_04_0.9	7585.6	89.7	5.7	1.1	11.7	6458.9	30948.2	562.5	7978.1	6.7	231.8	27.5	37.7	1011.0	59484.8	26.6	54.0	70.3	408.6	7.6	163.8	14.6
15	Mixed	CLAY_01	1362.2	272.7	7.5	0.2	10.4	6488.8	41258.0	459.8	1269.3	7.0	310.4	30.8	46.2	337.0	64974.9	34.5	77.2	78.6	336.2	3.9	48.5	17.8
16	Calcine sand	CLAY_02	5834.2	3297.1	57.3	0.7	9.7	4482.6	29870.9	558.8	2699.6	6.4	494.8	29.1	37.7	669.6	168030.7	92.4	207.2	293.8	2070.6	4.9	64.7	11.7
17	Calcine sand	CLAY_03	10694.0	2192.9	32.4	1.0	9.2	5338.8	21717.2	583.9	3261.7	5.6	542.7	24.8	32.0	789.0	218582.4	145.6	325.8	299.6	1281.3	3.9	82.5	9.2
18	Calcine sand	CLAY_05	13828.3	23940.8	200.8	1.9	10.7	4104.2	19526.3	644.1	2169.9	6.0	810.9	34.4	38.8	1955.6	427269.9	182.4	451.6	1314.7	19110.2	4.5	47.1	8.7
19	Calcine sand	CLAY_07	5722.6	5842.5	118.5	0.5	9.0	2911.3	27272.5	599.7	1647.3	6.4	644.4	31.1	36.0	640.1	210514.1	108.8	250.8	537.4	7214.5	6.7	42.2	9.7
20	Grey sand	IRON_01	873.9	57.9	1.8	0.8	4.6	7726.0	14119.8	871.3	4719.5	2.8	60.5	12.6	18.5	573.7	37246.1	16.3	34.9	39.7	106.5	1.8	95.8	6.8
21	Grey sand	IRON_02	913.6	121.1	2.5	1.0	9.4	7729.1	21136.8	659.3	5628.0	4.0	158.4	22.6	30.2	597.0	39932.6	18.5	36.0	45.8	151.5	1.9	73.6	7.7
22	Grey sand	DEBRA_11	2148.1	47.7	3.0	1.3	4.5	4937.1	13362.7	765.6	4619.3	3.6	122.1	18.4	21.4	537.1	44717.3	24.2	42.3	47.8	146.8	2.5	92.1	10.9
23	Grey sand	DEBRA_12	3754.0	77.1	3.5	1.3	8.4	7433.4	18938.7	701.2	15825.1	4.2	294.1	27.2	33.5	681.9	39963.6	14.5	38.8	43.0	295.3	1.9	127.3	9.6
24	Grey sand	CHUM_27	1639.8	61.0	4.9	1.9	7.6	6308.4	23757.3	678.8	5202.7	5.3	361.9	30.3	32.3	399.1	30867.8	13.1	29.5	30.5	98.6	2.7	116.4	13.7
25	Grey sand	CHUM_28	3373.4	97.3	10.1	0.9	7.5	6046.0	12367.1	692.0	5542.6	2.8	169.0	17.8	17.1	341.5	24211.6	8.5	21.3	24.3	165.9	2.1	109.7	6.0
26	Grey sand	CHUM_28_0.75	2593.3	124.2	8.4	1.0	9.3	5164.1	19974.8	640.4	3714.6	3.5	250.8	24.6	32.4	261.7	26520.0	7.6	21.0	24.4	114.0	1.7	82.6	8.0
27	Grey sand	CHUM_28_0.9	1231.5	81.2	5.9	1.3	10.3	4795.9	25470.7	607.5	2799.6	4.3	277.8	29.9	39.4	175.6	29190.1	8.2	25.8	26.4	78.2	2.1	69.4	8.5
28	Grey sand	CHUM_29	2134.3	89.9	6.7	0.9	8.2	8046.2	13887.3	897.7	7391.8	3.0	107.0	20.6	17.6	477.6	30255.5	10.8	27.7	36.9	154.2	1.6	107.8	7.1
29	Grey sand	CHUM_30	1125.6	69.5	4.8	0.8	5.0	8491.9	13397.8	797.3	4893.1	2.7	491.4	21.5	30.3	394.2	27538.1	13.0	34.9	27.6	109.3	1.5	99.4	6.6
30	Grey sand	CHUM_31	27590.2	108.2	14.5	0.4	8.6	1053.4	9620.8	789.5	5584.3	1.7	98.2	11.2	11.0	466.2	38137.7	4.5	6.1	9.9	32.4	6.5	293.0	4.1
31	Grey sand	CHUM_32	153.6	32.7	3.0	0.9	7.3	4020.8	22421.0	608.7	3290.0	4.0	1067.7	38.7	31.6	216.0	26701.8	11.9	26.0	19.3	60.9	1.5	33.7	9.9
32	Grey sand	CHUM_33	3066.9	131.6	11.1	1.0	7.0	2713.5	11804.2	569.1	1503.7	2.5	56.7	17.0	27.5	162.4	20979.0	7.6	19.4	26.7	165.7	4.3	40.4	6.0
33	Grey sand	CHUM_34	404.6	65.1	2.5	2.8	10.7	5646.4	73484.9	505.7	1199.5	14.0	475.4	51.1	65.7	170.9	67831.0	28.5	49.1	49.8	146.0	3.4	50.4	13.1
34	Grey sand	CHUM_35	1066.9	271.7	4.4	1.3	13.1	5908.4	27581.0	1076.9	4188.2	4.8	617.8	38.5	39.6	536.3	32367.4	14.5	30.4	47.9	297.1	1.4	74.7	8.8
35	Grey sand	CHUM_36	1257.2	71.3	4.4	1.3	11.9	4098.0	33025.3	699.2	2269.5	5.7	402.0	43.0	39.0	191.0	27873.7	11.6	22.9	27.5	102.1	1.8	48.1	9.4
36	Grey sand	CHUM_37	1914.3	41.9	3.9	0.8	7.7	10160.6	13625.1	553.3	11606.5	3.2	435.4	23.8	26.0	558.3	25406.6	8.8	24.5	23.4	104.5	1.6	178.9	6.0
37	Grey sand	CHUM_37_0.5	1872.7	35.7	3.2	0.8	5.9	9204.6	8671.4	741.2	15174.9	2.3	310.9	15.4	19.0	536.4	22437.0	7.6	20.6	22.7	89.3	1.0	201.7	5.2
38	Grey sand	CHUM_37_1.2-1.4	1838.9	46.5	4.1	1.1	8.6	9805.0	15001.6	534.1	14412.0	3.4	424.8	25.4	32.5	571.4	27792.3	9.0	28.4	26.0	107.2	1.4	229.0	6.6
39	Mixed	JACKASS_03	559.0	126.3	2.5	1.8	11.7	2748.8	47562.1	829.4	547.8	9.3	699.2	62.6	60.9	58.3	48606.8	13.8	30.6	31.1	58.6	2.4	32.2	10.1
40	Calcine sand	JACKASS_06	13589.5	1603.2	38.9	0.7	14.7	6922.4	30992.9	354.5	6411.9	7.5	951.5	40.0	45.6	939.4	314941.4	194.8	436.1	365.9	978.0	6.4	127.7	10.1
41	Calcine sand	JACKASS_07	12271.1	2255.2	27.3	0.9	13.7	7158.5	30162.3	459.7	6364.8	7.5	910.3	39.4	46.2	1048.3	362563.6	207.1	466.1	413.7	1181.2	6.0	135.3	9.4
42	Grey sand	WELLS_01	421.3	35.0	0.9	0.9	6.8	7551.1	16749.4	807.6	3385.4	2.7	133.8	16.6	19.5	295.2	27828.4	7.0	19.7	19.8	68.7	0.9	47.4	5.6
43	Grey sand	PASC_01	721.7	41.7	2.3	1.0	6.9	7660.6	14888.0	710.8	18799.6	3.3	244.3	19.1	20.1	651.3	31320.3	13.4	31.0	30.5	534.7	1.3	126.8	8.1
44	Grey sand	PASC_02	634.8	85.2	8.1	0.5	7.9	8163.3	23700.9	454.8	11245.7	6.7	389.4	23.0	32.3	1159.0	67600.7	44.2	76.4	109.0	250.9	6.6	213.1	15.5
45	Grey sand	PASC_03	464.7	88.4	3.5	0.9	5.6	9621.9	15103.1	797.5	13366.1	3.9	408.8	24.1	26.0	903.9	41299.1	25.4	42.4	49.7	147.7	1.6	154.1	9.8
46	Alluvial	BENDCK_01	74.7	19.2	1.7	0.6	4.6	1235.9	12265.7	1226.5	1596.1	2.4	399.6	19.5	16.7	131.5	19742.0	6.6	9.8	11.7	28.0	1.9	17.7	10.4
47	Alluvial	BENDCK_02	59.6	25.7	4.5	1.3	11.2	4157.8	28469.5	802.4	1831.5	4.7	527.8	41.1	39.7	163.1	31209.5	10.9	16.8	17.0	37.5	1.7	38.8	11.1
48	Old tailings pond	CHUM_TOW_LOW	3813.1	103.1	14.2	1.2	4.8	2213.8	8851.4	902.7	1906.5	5.3	35.7	11.6	24.6	116.4	18843.7	7.8	10.2	41.1	61.2	3.4	34.2	5.4
49	Grey sand	LEST_01	1555.4	28.8	1.1	0.8	7.7	10699.3	17362.3	664.6	6687.8	3.1	383.9	28.9	31.2	370.2	26528.1	8.5	24.7	20.9	83.1	1.5	104.4	7.3
50	Grey sand	LEST_02	1874.6	75.6	1.9	0.9	7.1	10356.3	19424.5	722.7	7290.7	3.2	260.4	25.5	30.7	334.7	29770.0	12.7	34.0	35.5	168.8	1.6	96.9	7.8
51	Grey sand	LEST_03	1025.3	31.6	1.0	0.6	4.3	9707.7	15643.6	648.2	5348.2	2.2	150.2	16.5	22.3	335.4	29187.2	7.8	25.9	25.8	83.4	1.2	72.1	7.4
52	Grey sand	LEST_04	859.5	18.9	0.7	0.7	3.0	9110.7	11428.7	1138.5	8041.1	2.0	142.1	14.9	18.1	368.2	26289.8	8.3	20.7	32.6	74.3	2.4	102.0	8.8
53	Grey sand	LEST_05	1539.7	87.9	1.2	2.0	18.4	17258.5	39261.5	883.9	3736.3	6.2	459.9	64.5	51.8	298.2	34530.4	6.9	23.8	27.1	122.7	1.6	63.3	8.6
54	Old tailings pond	CHUM_TOW_01	No soil supplied																					
55	Old tailings pond	CHUM_TOW_02	No < 106 um PSF																					
56	Old tailings pond	CHUM_TOW_BULK	38713.0	590.3	71.6	0.9	5.4	855.6	9533.9	642.0	964.9	9.6	52.6	8.0	22.2	189.3	98878.6	11.3	29.2	103.8	230.2	34.4	129.8	7.6
56-1	Old tailings pond	Brown material	68079.1	342.4	57.2	1.4	5.0	961.1	8832.8	617.3	1021.0	15.9	43.6	7.0	30.6	323.6	188829.0	21.2	26.7	104.7	245.6	19.0	78.7	6.8
56-2	Old tailings pond	White material	272617.3	639.0	221.6	1.0	3.8	376.6	5813.4	677.9	909.7	5.2	48.8	6.4	11.6	57.2	242176.2	1.7	4.6	107.3	105.4	170.7	27.1	4.1
57	Calcine sand	DAYLES_01	12154.8	23627.5	224.7	0.5	9.7	3065.6	17206.3	714.4	1389.2	5.5	420.3	42.6	35.7	3221.9	474447.2	140.6	405.9	1061.4	13524.6	2.9	27.8	8.6
58	Calcine sand	DAYLES_02	11383.2	23459.4	184.6	0.4	11.4	3191.7	16974.1	676.7	11412.2	5.4	433.1	43.6	40.0	3199.6	376015.4	104.6	319.0	961.5	10618.1	2.5	71.6	8.5
59	Calcine sand	DAYLES_03	13015.6	29851.7	238.1	0.2	8.9	3230.6	15487.8	699.1	2170.8	5.9	445.7	41.1	35.0	3267.5	530573.7	143.8	421.8	1220.5	17105.8	2.9	32.1	8.9

Table 3 cont. Total Metal(loid) Concentration (mg/kg): < 106 um soil particle size fraction

Sample #	Type	Sample ID	Mo	Cd	Ba	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Th
		HIL A		20																
		HIL C		90																
1	Calcine sand	MARONG_01	3.5	7.6	436.1	55.2	157.3	13.9	67.8	11.3	1.9	8.5	0.61	3.41	0.35	0.89	0.11	1.07	1.00	15.2
2	Calcine sand	MARONG_02	2.7	9.8	265.4	40.4	89.6	10.2	46.2	8.4	1.5	6.4	0.48	2.84	0.32	0.83	0.11	0.90	0.91	11.6
3	Calcine sand	MARONG_03	3.7	6.5	262.2	48.4	102.8	12.2	60.3	10.1	1.8	7.6	0.55	2.95	0.30	0.67	0.08	0.75	0.67	14.2
4	Calcine sand	MARONG_05	3.8	7.0	262.5	55.2	147.2	13.9	75.8	11.0	1.9	8.4	0.60	3.07	0.33	0.75	0.09	0.71	0.68	14.1
5	Calcine sand	MARONG_06	4.7	13.8	343.2	55.1	183.0	14.0	61.5	13.8	2.4	10.1	0.61	3.80	0.31	0.77	0.09	0.88	0.95	13.6
6	Mixed	MCC_01_red	1.3	0.3	454.2	86.6	241.4	17.6	89.0	18.4	3.0	15.3	1.09	8.30	0.87	2.46	0.32	3.43	3.58	39.9
7	Grey sand	MCC_01_top	0.6	0.6	220.8	36.6	99.8	9.3	43.4	9.0	1.6	7.0	0.45	3.31	0.34	1.03	0.14	1.62	1.73	15.7
8	Grey sand	MCC_02	0.8	0.7	142.7	47.3	153.8	11.9	57.8	11.5	1.9	9.3	0.61	4.36	0.44	1.24	0.16	1.67	1.64	14.4
9	Mixed	MCC_02_0.9	0.3	0.04	110.2	50.3	95.7	11.1	39.1	6.4	0.8	5.2	0.6	2.5	0.4	1.2	0.1	0.9	1.1	15.2
10	Grey sand	MCC_03_top	0.5	0.37	115.1	39.7	86.3	9.4	36.1	6.4	0.9	4.9	0.5	2.2	0.3	1.0	0.1	0.9	1.0	10.8
11	Grey sand	MCC_03_0.4	0.7	0.46	75.9	43.1	82.4	10.5	36.6	6.2	0.9	4.6	0.5	2.0	0.3	1.0	0.1	0.8	0.9	12.1
12	Grey sand	MCC_03_0.9	1.0	0.45	156.3	46.0	101.9	11.2	40.8	7.8	1.1	5.8	0.5	2.7	0.4	1.2	0.1	1.1	1.2	12.0
13	Grey sand	MCC_04_top	0.5	0.51	101.9	48.7	93.4	11.9	40.9	6.9	1.0	5.2	0.5	2.3	0.4	1.1	0.1	0.9	1.0	12.1
14	Grey sand	MCC_04_0.9	0.9	1.05	249.9	48.1	155.0	12.4	59.0	11.7	2.0	9.9	0.6	4.3	0.4	1.2	0.2	1.6	1.8	16.0
15	Mixed	CLAY_01	1.0	1.27	228.9	45.1	144.9	11.6	60.1	11.8	2.1	9.7	0.6	4.8	0.5	1.5	0.2	2.2	2.1	16.1
16	Calcine sand	CLAY_02	2.7	9.62	221.2	42.4	111.8	10.8	55.2	10.9	1.8	8.7	0.5	3.9	0.4	1.0	0.1	1.4	1.2	13.4
17	Calcine sand	CLAY_03	3.2	7.44	207.6	37.8	96.1	9.7	46.2	9.1	1.7	7.3	0.5	3.1	0.3	0.8	0.1	0.9	0.9	10.6
18	Calcine sand	CLAY_05	6.0	64.11	231.7	33.0	86.9	8.2	26.3	8.3	1.4	6.7	0.4	2.8	0.3	0.7	0.1	1.0	0.9	10.7
19	Calcine sand	CLAY_07	3.1	22.41	223.5	46.0	118.2	11.5	66.5	10.8	1.7	8.0	0.5	3.1	0.3	0.7	0.1	1.0	0.8	12.9
20	Grey sand	IRON_01	0.5	0.36	59.9	48.7	108.9	11.8	40.4	7.8	1.0	5.5	0.5	2.1	0.3	0.8	0.1	0.8	0.9	11.0
21	Grey sand	IRON_02	0.7	0.46	168.3	55.2	105.5	13.3	47.5	7.7	1.0	5.6	0.5	2.3	0.4	1.0	0.1	0.9	1.1	13.2
22	Grey sand	DEBRA_11	0.7	0.48	111.3	61.5	133.0	14.7	52.8	9.7	1.3	7.2	0.7	3.1	0.5	1.3	0.2	1.2	1.2	13.0
23	Grey sand	DEBRA_12	0.6	0.60	176.7	56.6	104.3	13.6	48.2	7.7	1.1	5.8	0.6	2.6	0.4	1.3	0.2	1.0	1.2	13.0
24	Grey sand	CHUM_27	0.6	0.36	186.0	58.0	141.8	14.5	52.1	11.0	1.5	8.1	0.7	3.8	0.5	1.6	0.2	1.7	1.9	15.7
25	Grey sand	CHUM_28	0.6	0.60	117.8	39.3	73.3	9.4	33.8	5.3	0.8	3.9	0.4	1.6	0.3	0.8	0.1	0.7	0.8	9.8
26	Grey sand	CHUM_28_0.75	0.7	0.49	156.6	42.6	92.5	10.2	35.4	5.8	0.8	4.5	0.5	2.1	0.4	1.1	0.1	0.9	1.0	11.4
27	Grey sand	CHUM_28_0.9	0.6	0.26	173.3	34.8	76.8	8.4	31.8	5.7	0.8	4.5	0.4	2.2	0.4	1.0	0.1	1.0	1.1	10.9
28	Grey sand	CHUM_29	0.5	0.64	107.7	44.3	82.5	10.6	38.6	6.1	0.9	4.6	0.5	2.0	0.3	0.9	0.1	0.9	0.9	11.4
29	Grey sand	CHUM_30	0.5	0.42	134.9	47.1	90.1	11.1	38.4	6.4	0.9	4.7	0.4	1.9	0.3	0.8	0.1	0.7	0.9	11.5
30	Grey sand	CHUM_31	1.3	0.13	93.5	33.5	69.3	7.7	28.1	4.5	0.6	3.1	0.2	1.1	0.2	0.5	0.1	0.5	0.6	10.5
31	Grey sand	CHUM_32	0.6	0.09	133.0	47.1	95.4	11.6	38.3	6.9	0.9	5.3	0.6	2.6	0.4	1.2	0.1	0.9	1.0	10.1
32	Grey sand	CHUM_33	1.0	0.68	72.1	31.9	68.0	7.7	26.6	5.1	0.8	3.8	0.3	1.6	0.2	0.7	0.1	0.8	1.0	11.0
33	Grey sand	CHUM_34	0.8	0.13	182.3	39.7	103.9	10.4	53.7	10.8	1.9	8.4	0.5	4.1	0.4	1.2	0.2	1.8	2.1	19.7
34	Grey sand	CHUM_35	0.6	0.50	254.2	42.1	90.6	10.2	36.6	6.6	1.0	5.1	0.5	2.4	0.4	1.0	0.1	1.0	1.1	10.6
35	Grey sand	CHUM_36	0.8	0.31	198.1	48.5	96.9	11.9	40.7	7.1	1.0	5.5	0.6	2.6	0.4	1.3	0.2	1.0	1.1	12.6
36	Grey sand	CHUM_37	0.7	0.48	152.2	34.8	73.3	8.4	30.8	5.3	0.8	3.9	0.3	1.7	0.3	0.7	0.1	0.7	0.9	9.9
37	Grey sand	CHUM_37_0.5	0.6	0.39	108.9	33.8	62.9	8.1	29.4	4.6	0.7	3.3	0.3	1.4	0.2	0.7	0.1	0.6	0.7	9.7
38	Grey sand	CHUM_37_1.2-1.4	0.8	0.48	179.5	36.8	79.0	8.8	30.4	5.6	0.8	4.2	0.4	1.8	0.3	0.8	0.1	0.8	1.0	10.9
39	Mixed	JACKASS_03	1.1	0.32	258.4	49.9	113.5	12.1	44.2	8.0	1.2	6.2	0.6	3.1	0.5	1.3	0.2	1.2	1.3	12.6
40	Calcine sand	JACKASS_06	3.8	5.52	410.8	48.2	167.9	12.2	54.5	12.4	2.1	9.3	0.6	3.6	0.3	0.8	0.1	1.1	0.9	13.1
41	Calcine sand	JACKASS_07	4.9	7.17	419.0	40.8	103.1	10.2	47.5	9.5	1.7	7.5	0.5	3.1	0.3	0.8	0.1	1.0	1.0	11.6
42	Grey sand	WELLS_01	0.4	0.17	119.7	44.8	83.0	10.7	37.9	5.9	0.8	4.2	0.4	1.6	0.3	0.8	0.1	0.6	0.8	10.4
43	Grey sand	PASC_01	0.3	0.41	116.6	53.4	99.0	13.0	47.1	7.3	1.0	5.4	0.6	2.3	0.4	1.1	0.1	0.9	1.0	14.5
44	Grey sand	PASC_02	0.9	0.82	176.5	57.3	198.3	14.5	75.3	15.0	2.6	11.6	0.7	5.1	0.4	1.2	0.1	1.8	1.9	18.1
45	Grey sand	PASC_03	0.4	0.50	141.0	56.7	106.5	14.0	48.8	8.0	1.2	6.1	0.7	2.7	0.5	1.3	0.2	1.0	1.2	16.7
46	Alluvial	BENDCK_01	0.3	0.03	314.3	92.9	180.5	22.5	76.4	11.9	1.4	8.8	0.8	3.4	0.5	1.3	0.2	1.0	1.0	18.6
47	Alluvial	BENDCK_02	0.4	0.04	194.0	58.3	111.4	14.3	49.3	7.8	1.0	6.1	0.7	2.8	0.5	1.4	0.2	1.1	1.2	12.7
48	Old tailings pond	CHUM_TOW_LOW	0.8	0.67	44.9	34.2	62.6	8.2	29.1	5.0	0.9	3.7	0.4	1.7	0.3	0.9	0.1	0.9	0.9	10.5
49	Grey sand	LEST_01	0.4	0.37	151.9	53.0	95.9	12.6	44.3	6.9	1.0	5.3	0.6	2.2	0.4	1.0	0.1	0.8	1.0	12.4
50	Grey sand	LEST_02	0.4	0.62	154.8	51.2	96.9	12.4	43.4	7.0	1.0	5.4	0.5	2.3	0.4	1.0	0.1	0.8	1.0	13.8
51	Grey sand	LEST_03	0.3	0.25	97.2	42.1	83.2	10.1	34.1	6.1	0.9	4.8	0.5	2.1	0.3	1.0	0.1	0.8	0.9	11.9
52	Grey sand	LEST_04	0.3	0.28	60.8	86.2	163.1	20.3	70.2	11.6	1.6	8.6	0.8	3.0	0.4	1.1	0.1	0.8	0.9	13.5
53	Grey sand	LEST_05	0.5	0.17	354.0	31.1	59.6	7.8	27.5	4.5	0.7	3.7	0.4	2.1	0.4	1.3	0.2	1.2	1.4	15.0
54	Old tailings pond	CHUM_TOW_01																		
55	Old tailings pond	CHUM_TOW_02																		
56	Old tailings pond	CHUM_TOW_BULK	2.9	0.68	113.3	52.3	161.7	13.0	60.0	11.7	2.1	8.5	0.5	2.9	0.3	0.7	0.1	1.1	1.2	16.6
56-1	Old tailings pond	Brown material	2.4	1.20	86.0	30.0	79.0	7.8	37.9	8.4	1.5	6.3	0.4	2.7	0.2	0.6	0.1	1.0	1.2	18.1
56-2	Old tailings pond	White material	4.4	1.03	68.8	37.2	93.4	9.1	43.3	8.3	1.4	5.6	0.3	1.7	0.1	0.3	0.0	0.5	0.8	7.3
57	Calcine sand	DAYLES_01	5.9	27.47	167.6	34.2	80.7	8.6	43.1	8.4	1.5	6.4	0.4	2.7	0.3	0.7	0.1	0.9	0.9	10.1
58	Calcine sand	DAYLES_02	5.2	20.95	226.8	25.7	61.9	6.4	27.0	6.8	1.2	5.4	0.3	2.6	0.2	0.7	0.1	1.0	1.0	7.9
59	Calcine sand	DAYLES_03	6.2	36.49	164.5	32.5	77.6	8.1	38.5	8.3	1.4	6.3	0.4	2.8	0.3	0.7	0.1	0.9	0.9	9.4

Table 4. Total Metal(loid) Concentration (mg/kg): < 53 um soil particle size fraction

Sample #	Type	Sample ID	As	Pb	Sb	Be	B	Mg	Al	Si	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Se	Sr	Y
		HIL A	100	300		60	4500								100 (VI)	3800		100	400	6000	7400	200		
		HIL C	300	600		90	20000								300 (VI)	19000		300	1200	17000	30000	700		
1	Calcine sand	MARONG_01	19952.7	5471.3	1088.7	2.4	16.8	7381.3	35060.5	649.1	17319.5	8.9	801.7	44.9	50.2	3569.3	312645.5	184.0	429.8	738.2	4090.5	11.2	203.4	16.3
2	Calcine sand	MARONG_02	12550.0	5735.9	260.8	1.9	18.1	6203.2	36723.6	590.2	13935.9	8.4	910.1	42.8	51.9	1570.1	274194.9	145.7	339.2	562.1	4278.2	5.9	160.4	14.2
3	Calcine sand	MARONG_03	19069.3	3601.0	993.3	2.0	9.7	9794.1	25948.4	624.3	3598.9	8.7	641.2	39.4	38.9	1800.9	404846.0	230.5	542.5	741.4	2069.0	4.7	70.4	10.5
4	Calcine sand	MARONG_05	20300.7	4279.7	1110.1	0.8	15.0	9859.7	38538.5	532.8	4316.0	10.7	814.9	57.4	53.5	1934.1	405490.3	238.5	561.6	703.8	2557.5	7.5	105.2	14.1
5	Calcine sand	MARONG_06	20715.0	6338.6	7625.2	2.8	16.4	10941.7	37458.0	625.5	4211.2	10.7	829.5	55.9	52.4	1693.9	397384.3	226.2	532.3	770.8	4649.9	6.5	88.7	12.9
6	Mixed	MCC_01_red	469.2	63.9	43.4	1.7	11.4	4233.8	56165.6	1126.9	2806.0	9.9	517.6	53.7	54.0	87.0	36125.2	7.4	15.6	117.7	72.3	2.7	77.8	18.8
7	Grey sand	MCC_01_top	2632.9	55.0	4.2	1.4	8.1	7027.7	22886.7	1068.4	3466.6	3.8	193.8	25.3	27.5	212.4	28802.0	5.5	19.5	169.3	85.2	1.6	72.8	8.5
8	Grey sand	MCC_02	11948.4	148.3	12.3	1.6	7.1	5918.5	24498.1	660.9	5896.8	7.5	235.5	20.0	32.9	2054.0	110198.4	36.1	90.3	409.7	392.3	9.8	234.8	21.3
9	Mixed	MCC_02_0.9	368.5	78.2	1.7	1.2	7.3	4908.8	30453.6	1231.4	3547.3	4.3	255.9	27.4	40.1	158.8	32323.4	12.8	28.4	113.5	93.1	2.1	91.1	11.2
10	Grey sand	MCC_03_top	5549.2	107.7	3.4	1.5	12.7	8073.1	28167.1	1187.2	11144.0	5.1	438.7	39.2	40.1	514.5	37125.8	11.4	32.9	85.0	298.8	2.4	112.5	10.2
11	Grey sand	MCC_03_0.4	7148.2	132.3	3.9	1.0	7.0	7841.7	19193.7	1064.4	32519.8	3.6	216.0	22.9	24.7	436.6	35079.6	10.3	33.8	129.7	396.1	2.9	142.0	9.4
12	Grey sand	MCC_03_0.9	3601.0	95.4	3.0	1.3	8.4	8075.0	24126.4	1242.3	24377.0	4.6	352.5	30.5	40.9	470.9	36980.6	11.6	33.6	119.8	343.1	2.2	160.5	10.9
13	Grey sand	MCC_04_top	5588.7	116.2	3.5	1.5	9.3	8585.3	21598.0	1100.3	10061.2	4.1	332.1	26.2	31.8	539.1	39593.4	13.9	32.5	92.9	389.5	2.7	123.4	10.0
14	Grey sand	MCC_04_0.9	13316.1	152.9	10.0	3.0	12.3	7029.6	40728.8	683.9	9652.2	9.1	327.6	39.5	55.6	1093.3	81991.1	35.2	79.1	146.1	640.2	11.7	185.2	20.1
15	Mixed	CLAY_01	1284.3	273.0	7.7	2.3	9.2	7634.8	45442.0	688.8	1332.8	8.1	347.4	34.7	51.3	354.8	65955.5	34.6	81.0	105.6	331.6	5.0	48.3	19.7
16	Calcine sand	CLAY_02	5845.7	3182.1	43.9	1.8	9.9	4869.0	31721.7	996.1	2631.8	6.4	458.8	29.6	42.0	629.2	158535.0	78.9	187.9	291.2	1699.2	4.8	68.3	13.2
17	Calcine sand	CLAY_03	11645.6	2515.4	40.1	0.7	11.6	6595.5	31960.1	736.3	3850.4	7.2	740.9	36.7	46.3	820.6	250106.8	155.6	356.1	578.0	1395.9	5.4	97.0	13.5
18	Calcine sand	CLAY_05	17930.5	36247.1	249.6	2.0	14.7	5387.6	24372.3	786.7	3263.5	7.6	841.0	40.5	49.8	2438.1	417538.8	166.8	412.5	2163.5	22634.6	2.9	58.9	12.2
19	Calcine sand	CLAY_07	4755.5	5378.7	88.5	0.8	9.4	3112.2	35317.3	744.6	1844.6	7.2	765.9	36.9	43.2	548.8	133439.6	59.9	141.9	385.0	4025.3	6.0	49.2	12.3
20	Grey sand	IRON_01	3196.3	167.4	6.0	1.6	8.0	8810.4	25601.4	1046.5	5418.9	6.2	108.5	13.5	31.2	1065.6	79944.0	37.2	86.3	141.9	281.2	7.2	142.8	14.0
21	Grey sand	IRON_02	1955.1	172.5	3.0	1.2	8.5	8156.4	19910.3	1028.4	8488.0	4.1	163.2	19.1	24.6	681.3	47905.1	24.3	43.1	88.1	173.1	2.5	83.2	9.0
22	Grey sand	DEBRA_11	3292.3	68.3	3.4	1.5	10.7	6752.4	26569.5	910.5	6537.5	5.6	342.4	33.7	39.2	531.1	43842.5	25.6	41.9	62.2	190.5	3.0	92.8	16.0
23	Grey sand	DEBRA_12	6394.1	132.7	5.7	1.1	7.5	7863.0	21177.8	990.9	28452.9	4.7	330.0	27.1	38.9	846.2	50203.5	15.9	46.9	99.5	427.6	3.0	178.3	12.4
24	Grey sand	CHUM_27	2270.8	73.2	4.6	1.8	8.5	7485.1	24749.9	967.0	6788.1	5.3	445.4	27.5	34.8	354.1	28292.2	11.1	25.9	51.0	92.6	2.3	106.2	15.7
25	Grey sand	CHUM_28	5015.2	130.1	13.4	1.1	7.8	6112.5	14648.3	881.0	6536.9	3.1	203.8	18.6	18.9	336.7	27095.1	9.1	24.2	38.6	218.2	2.6	117.2	7.3
26	Grey sand	CHUM_28_0.75	3334.3	142.3	9.9	1.1	7.6	5240.4	19143.0	1254.5	4487.6	3.3	225.2	21.0	30.9	249.9	27289.5	7.0	20.9	36.4	124.5	2.2	88.9	8.5
27	Grey sand	CHUM_28_0.9	No < 53 um PSF																					
28	Grey sand	CHUM_29	3336.7	114.6	8.4	1.1	10.0	7881.2	16021.7	925.9	8765.5	3.3	154.3	21.6	17.9	462.6	31655.1	9.4	27.6	47.7	189.7	1.6	112.5	7.6
29	Grey sand	CHUM_30	1639.7	81.3	5.3	0.7	5.5	9174.6	14363.0	848.4	6215.6	3.0	555.1	21.4	32.5	366.0	28132.3	10.6	32.3	34.8	114.7	1.6	103.7	6.9
30	Grey sand	CHUM_31	47068.6	169.8	28.7	0.9	10.6	1128.7	18596.7	623.1	7191.5	3.8	153.3	10.9	18.7	923.5	74978.1	8.8	12.0	41.5	88.3	17.5	701.9	8.3
31	Grey sand	CHUM_32	251.3	34.8	3.4	1.1	8.4	4044.9	28601.4	866.7	4091.8	4.7	1352.2	43.2	35.7	220.6	27216.5	11.5	24.3	31.5	64.5	1.9	40.4	10.6
32	Grey sand	CHUM_33	3672.4	119.7	9.4	1.1	9.0	3216.4	13252.6	915.1	2405.4	2.6	78.7	16.7	32.8	122.8	18400.2	4.7	15.0	29.3	118.3	3.9	41.6	5.9
33	Grey sand	CHUM_34	472.5	66.9	2.6	4.7	9.8	5464.8	75401.8	664.3	1180.4	13.7	442.3	52.8	67.6	185.1	70784.4	30.0	54.8	74.6	158.0	4.7	50.6	14.2
34	Grey sand	CHUM_35	1305.5	308.1	4.1	1.1	5.3	4848.3	16122.3	245.1	3467.3	3.8	131.7	23.1	30.4	619.8	38439.1	15.8	35.5	67.6	394.4	2.3	83.1	8.6
35	Grey sand	CHUM_36	1325.2	81.3	4.9	1.3	8.8	3717.9	26921.4	1038.2	1733.4	6.0	333.1	44.5	43.1	242.3	32390.8	13.6	26.0	42.1	120.8	2.7	54.8	10.9
36	Grey sand	CHUM_37	2467.8	48.9	5.1	1.3	6.8	11890.1	13987.3	1038.6	12170.7	4.3	408.6	30.3	34.4	758.8	36035.3	9.9	32.1	37.9	139.0	2.0	232.5	8.4
37	Grey sand	CHUM_37_0.5	2400.2	45.2	4.4	0.9	6.1	10705.7	10165.9	1115.8	15914.7	3.3	365.9	22.4	27.2	711.5	31591.0	8.4	27.3	33.8	121.3	1.6	261.2	7.4
38	Grey sand	CHUM_37_1.2-1.4	1988.8	44.4	4.3	1.9	14.0	10594.0	25757.9	796.9	12506.5	6.6	672.1	61.5	58.5	624.2	32271.8	8.6	31.4	39.6	119.9	2.0	246.7	8.3
39	Mixed	JACKASS_03	572.4	188.9	2.7	1.9	9.7	2686.4	37453.3	975.7	532.8	9.7	498.5	63.4	59.5	91.8	51383.7	15.2	34.4	95.4	109.7	2.4	27.8	10.0
40	Calcine sand	JACKASS_06	15447.0	1816.5	47.9	2.4	16.9	13397.1	36338.5	900.8	12039.5	9.0	1078.5	48.2	52.9	1119.2	396599.5	244.1	540.2	452.3	1190.6	4.8	146.1	12.7
41	Calcine sand	JACKASS_07	12763.2	2300.8	28.2	1.2	14.8	7649.8	31521.4	536.1	6812.9	7.7	936.8	40.3	48.8	1069.6	385086.5	222.2	491.7	436.4	1231.1	2.8	135.2	10.0
42	Grey sand	WELLS_01	639.8	52.1	1.5	1.0	7.2	8402.7	21368.7	817.4	3200.4	4.5	203.3	27.2	31.1	466.3	44246.7	11.1	31.7	39.9	107.1	2.8	64.6	10.4
43	Grey sand	PASC_01	1099.9	95.0	3.8	1.3	7.2	7834.8	18309.0	859.9	20901.1	5.3	292.8	29.2	31.0	1034.2	50046.4	20.4	44.7	59.4	938.0	3.1	176.7	13.1
44	Grey sand	PASC_02	1591.5	181.0	14.4	2.5	7.1	10168.3	26191.2	557.2	16133.6	7.8	526.8	29.5	41.4	1546.0	105845.9	76.8	133.3	259.5	374.9	6.7	273.2	20.3
45	Grey sand	PASC_03	723.6	147.9	9.2	2.0	7.8	10537.4	32987.2	700.9	14154.4	9.7	870.6	42.2	52.4	1763.5	82723.1	45.7	102.0	138.6	359.4	8.2	245.8	21.6
46	Alluvial	BENDCK_01	No < 53 um PSF																					
47	Alluvial	BENDCK_02	No < 53 um PSF																					
48	Old tailings pond	CHUM_TOW_LOW	4637.1	128.7	20.3	2.2	10.4	2772.4	18453.1	851.3	1964.1	9.3	100.4	31.3	52.6	155.8	27352.8	8.7	15.6	60.4	88.3	5.1	54.1	8.6
49	Grey sand	LEST_01	2210.5	38.3	1.7	1.0	5.6	9702.8	17362.1	970.7	5368.6	3.8	293.9	31.0	35.2	517.3	37961.5	12.4	37.2	39.4	123.8	2.6	135.5	10.6
50	Grey sand	LEST_02	2432.6	99.9	2.4	0.9	2.2	8867.2	11967.3	1315.7	5887.4	2.1	87.8	15.8	21.4	371.1	36494.6	13.9	45.3	54.1	251.8	2.4	107.4	7.9
51	Grey sand	LEST_03	1202.7	40.6	1.3	1.2	4.4	9239.7	17832.5	927.7	4867.1	3.3	162.2	23.9	30.6	405.0	38502.5	8.8	34.1	40.8	115.3	2.2	92.7	11.1
52	Grey sand	LEST_04	No < 53 um PSF																					
53	Grey sand	LEST_05	1376.9	87.2	1.2	1.6	8.9	13426.3	24327.6	695.3	3137.4	4.4	204.1	39.1	46.8	329.2	37277.2	6.7	26.8	66.8	136.8	1.8	67.3	8.9
54	Old tailings pond	CHUM_TOW_01	No < 53 um PSF																					
55	Old tailings pond	CHUM_TOW_02	No < 53 um PSF																					
56	Old tailings pond	CHUM_TOW_BULK	55269.7	1515.8	120.2	2.1	19.2	1762.9	35991.3	1082.2	732.8	16.6	202.7	38.2	53.9	294.9	155294.0	17.9	29.0	184.3	358.6	60.3	229.9	11.5
56-1	Old tailings pond	Brown material	No < 53 um PSF																					
56-2	Old tailings pond	White material	No < 53 um PSF																					
57	Calcine sand	DAYLES_01	15064.8	32444.4	237.7	0.8	11.2	3501.0	19717.7	685.0	1859.0	6.6	578.2	45.8	43.8	3973.2	448227.5	156.7	436.5	1209.7	12279.2	4.7	37.1	12.5
58	Calcine sand	DAYLES_02	13259.9	27184.0	167.7	1.8	12.0	3099.2	15499.0	552.2	17233.8	5.9	477.1	43.3	43.7	3657.4	346208.0	110.1	315.1	1028.7	10827.1	6.9	90.6	10.6
59	Calcine sand	DAYLES_03	16085.4	39953.7	242.9	1.0	9.0	3528.7	18313.1	572.3	2099.5	6.6	558.4	45.5	40.5	4054.4	523362.7	141.2	404.3	1416.9	17902.5	6.1	33.3	12.1

Table 4 cont. Total Metal(loid) Concentration (mg/kg): < 53 um soil particle size fraction

Sample #	Type	Sample ID	Mo	Cd	Ba	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Th
		HIL A		20																
		HIL C		90																
1	Calcine sand	MARONG_01	5.1	12.41	630.5	123.5	323.0	23.6	107.1	22.7	3.6	16.5	0.9	5.9	0.5	1.2	0.1	1.8	1.6	25.7
2	Calcine sand	MARONG_02	3.8	14.02	387.5	61.2	219.3	15.6	68.7	15.3	2.6	11.7	0.7	4.7	0.4	1.1	0.1	1.6	1.4	17.0
3	Calcine sand	MARONG_03	5.6	9.70	342.9	55.7	184.9	14.2	66.2	13.7	2.5	10.7	0.6	4.0	0.3	0.8	0.1	0.9	1.0	15.3
4	Calcine sand	MARONG_05	6.3	12.19	439.0	99.9	292.9	19.3	84.1	21.2	3.4	15.4	0.8	5.3	0.4	0.9	0.1	1.3	1.3	20.3
5	Calcine sand	MARONG_06	4.9	16.90	415.6	113.6	276.0	21.5	104.3	20.2	3.3	14.6	0.8	4.8	0.4	1.0	0.1	1.1	1.1	21.4
6	Mixed	MCC_01_red	0.6	0.14	321.3	67.9	134.2	17.5	62.2	10.1	1.4	8.0	0.9	4.3	0.8	2.3	0.3	1.7	1.9	26.5
7	Grey sand	MCC_01_top	0.3	0.26	174.9	50.6	98.2	12.3	43.3	6.7	0.9	5.0	0.5	2.3	0.4	1.2	0.2	1.0	1.2	14.3
8	Grey sand	MCC_02	1.3	1.68	170.9	67.0	226.9	16.9	92.4	16.3	2.7	12.8	0.8	6.1	0.6	1.8	0.2	2.7	2.5	21.6
9	Mixed	MCC_02_0.9	0.4	0.06	155.8	66.6	129.0	15.1	52.4	8.2	1.1	6.6	0.7	3.3	0.6	1.6	0.2	1.1	1.3	19.9
10	Grey sand	MCC_03_top	0.5	0.50	242.2	68.6	124.6	16.9	59.4	8.6	1.2	6.3	0.7	2.8	0.5	1.5	0.2	1.1	1.2	16.5
11	Grey sand	MCC_03_0.4	0.7	0.56	151.3	61.1	112.1	15.2	49.8	7.9	1.1	5.9	0.6	2.5	0.5	1.3	0.2	1.0	1.1	17.1
12	Grey sand	MCC_03_0.9	1.0	0.48	222.8	73.6	135.6	18.2	61.7	9.5	1.3	7.1	0.7	3.1	0.6	1.6	0.2	1.2	1.3	17.0
13	Grey sand	MCC_04_top	0.6	0.64	188.0	68.2	124.9	16.7	57.9	8.6	1.2	6.6	0.7	2.9	0.5	1.5	0.2	1.1	1.2	16.4
14	Grey sand	MCC_04_0.9	1.6	1.99	314.4	96.9	255.5	18.4	78.0	18.1	2.8	13.8	0.8	5.9	0.6	1.6	0.2	2.4	2.6	24.5
15	Mixed	CLAY_01	1.1	1.39	259.0	54.0	177.5	13.8	60.8	13.3	2.2	10.5	0.7	5.4	0.6	1.7	0.2	2.3	2.3	18.0
16	Calcine sand	CLAY_02	2.6	8.68	218.3	52.3	151.9	13.1	65.4	13.0	2.1	9.9	0.6	4.3	0.4	1.1	0.1	1.5	1.4	16.8
17	Calcine sand	CLAY_03	3.7	8.13	286.3	60.4	215.0	15.2	73.4	15.2	2.5	11.5	0.7	4.5	0.4	1.0	0.1	1.3	1.4	17.1
18	Calcine sand	CLAY_05	6.9	81.94	276.2	57.0	199.2	14.2	67.7	13.9	2.3	10.7	0.6	4.4	0.4	1.0	0.1	1.4	1.3	16.3
19	Calcine sand	CLAY_07	2.4	15.25	271.3	62.7	215.8	15.8	80.9	14.2	2.3	11.1	0.6	4.3	0.4	1.0	0.1	1.2	1.2	17.4
20	Grey sand	IRON_01	1.5	1.53	139.3	94.3	241.4	18.1	89.1	17.1	2.6	12.3	0.7	4.8	0.4	1.1	0.1	1.5	1.7	21.7
21	Grey sand	IRON_02	0.9	0.65	145.5	81.3	135.1	19.8	66.2	9.5	1.2	6.8	0.7	2.7	0.5	1.5	0.2	1.1	1.3	18.6
22	Grey sand	DEBRA_11	0.7	0.55	234.3	100.9	171.2	24.9	84.6	11.7	1.6	8.7	1.0	3.7	0.7	2.0	0.3	1.4	1.5	21.1
23	Grey sand	DEBRA_12	0.7	1.02	189.0	82.6	153.8	20.1	66.5	10.8	1.5	8.1	0.8	3.6	0.6	1.8	0.2	1.4	1.5	19.8
24	Grey sand	CHUM_27	0.5	0.32	187.5	86.8	152.1	22.0	75.6	10.8	1.5	8.1	0.9	3.6	0.7	2.1	0.3	1.5	1.6	21.7
25	Grey sand	CHUM_28	0.7	0.81	128.1	59.2	99.3	14.6	48.0	7.0	1.0	5.1	0.5	2.1	0.4	1.1	0.1	0.8	0.9	14.2
26	Grey sand	CHUM_28_0.75	0.8	0.57	143.1	57.2	115.8	14.2	49.4	7.0	1.0	5.2	0.6	2.3	0.4	1.3	0.2	0.9	1.1	15.0
27	Grey sand	CHUM_28_0.9																		
28	Grey sand	CHUM_29	0.5	0.86	129.7	60.2	94.5	14.8	50.9	6.9	1.0	5.1	0.6	2.2	0.4	1.2	0.2	0.9	1.0	15.1
29	Grey sand	CHUM_30	0.4	0.46	147.9	67.3	102.9	16.1	57.9	7.1	1.0	5.2	0.6	2.1	0.4	1.1	0.1	0.7	0.9	16.6
30	Grey sand	CHUM_31	2.7	0.41	169.2	44.5	115.3	10.7	45.2	9.5	1.4	6.9	0.4	2.4	0.2	0.7	0.1	0.9	1.2	18.7
31	Grey sand	CHUM_32	0.6	0.09	165.1	64.9	120.7	16.1	56.1	8.3	1.0	6.5	0.7	3.0	0.5	1.5	0.2	1.0	1.1	13.5
32	Grey sand	CHUM_33	0.8	0.58	85.4	48.6	77.6	12.0	39.7	5.5	0.8	3.9	0.4	1.6	0.3	1.0	0.1	0.7	0.8	15.5
33	Grey sand	CHUM_34	0.7	0.19	176.8	46.2	118.5	11.9	46.3	11.8	2.1	9.3	0.6	4.1	0.4	1.3	0.2	1.9	2.3	21.3
34	Grey sand	CHUM_35	0.7	0.58	170.8	48.3	111.0	11.2	38.3	8.7	1.5	6.7	0.5	2.8	0.3	0.8	0.1	1.0	0.9	10.3
35	Grey sand	CHUM_36	0.9	0.32	192.5	54.9	126.6	12.9	45.5	9.9	1.6	7.6	0.6	3.4	0.4	1.1	0.1	1.3	1.4	16.3
36	Grey sand	CHUM_37	0.7	0.65	175.5	43.7	102.7	9.9	35.1	8.0	1.4	6.0	0.4	2.5	0.3	0.8	0.1	1.1	1.3	14.7
37	Grey sand	CHUM_37_0.5	0.8	0.61	144.2	42.9	96.8	10.0	35.6	7.4	1.3	5.5	0.4	2.3	0.3	0.7	0.1	0.9	1.2	14.6
38	Grey sand	CHUM_37_1.2-1.4	0.9	0.49	320.8	42.3	98.3	9.9	33.2	7.6	1.3	5.7	0.4	2.5	0.3	0.8	0.1	1.1	1.4	15.0
39	Mixed	JACKASS_03	1.1	0.45	229.0	56.1	122.2	13.0	44.4	9.2	1.6	7.1	0.6	3.5	0.4	1.2	0.1	1.2	1.3	17.0
40	Calcine sand	JACKASS_06	4.6	6.62	493.8	61.9	212.8	15.6	66.5	15.2	2.5	11.5	0.7	4.4	0.4	0.9	0.1	1.2	1.1	16.6
41	Calcine sand	JACKASS_07	4.3	7.36	421.0	44.5	117.1	11.3	56.5	11.0	1.8	8.5	0.5	3.6	0.3	0.8	0.1	1.1	1.0	12.9
42	Grey sand	WELLS_01	0.7	0.30	172.3	72.5	169.2	16.9	57.0	12.9	2.0	9.3	0.6	3.5	0.4	1.0	0.1	1.2	1.4	19.1
43	Grey sand	PASC_01	0.5	0.74	155.5	74.9	170.3	17.4	60.7	13.5	2.3	10.1	0.7	4.3	0.5	1.3	0.2	1.6	1.9	22.5
44	Grey sand	PASC_02	1.2	1.66	226.2	110.8	293.3	21.1	104.7	20.7	3.6	16.3	1.0	6.5	0.6	1.6	0.2	2.4	2.5	25.3
45	Grey sand	PASC_03	1.0	1.45	273.4	74.8	260.6	19.2	101.7	17.7	3.4	14.6	0.9	6.6	0.6	1.7	0.2	2.6	2.8	24.3
46	Alluvial	BENDCK_01																		
47	Alluvial	BENDCK_02																		
48	Old tailings pond	CHUM_TOW_LOW	1.1	0.95	156.0	38.3	86.1	9.0	32.0	7.6	1.5	5.7	0.4	2.8	0.3	1.0	0.1	1.5	1.5	14.9
49	Grey sand	LEST_01	0.6	0.57	156.3	64.3	150.2	14.9	51.9	11.7	2.0	8.9	0.6	3.7	0.4	1.0	0.1	1.2	1.4	17.9
50	Grey sand	LEST_02	0.5	0.86	60.2	48.7	105.7	11.3	39.4	8.4	1.4	6.6	0.5	2.7	0.3	0.8	0.1	0.8	0.9	15.9
51	Grey sand	LEST_03	0.4	0.35	105.4	49.2	122.8	11.5	38.4	9.9	1.7	7.8	0.5	3.6	0.4	1.0	0.1	1.3	1.6	16.2
52	Grey sand	LEST_04																		
53	Grey sand	LEST_05	0.6	0.20	201.6	30.8	64.6	7.4	27.2	5.5	1.0	4.5	0.4	2.5	0.3	1.0	0.1	1.2	1.4	16.8
54	Old tailings pond	CHUM_TOW_01																		
55	Old tailings pond	CHUM_TOW_02																		
56	Old tailings pond	CHUM_TOW_BULK	5.1	1.26	302.2	99.6	259.5	18.8	96.0	17.9	3.3	12.6	0.7	4.0	0.3	0.9	0.1	1.5	1.4	24.5
56-1	Old tailings pond	Brown material																		
56-2	Old tailings pond	White material																		
57	Calcine sand	DAYLES_01	6.9	29.66	202.2	63.8	149.6	15.9	78.9	15.4	2.5	11.4	0.6	4.3	0.4	1.0	0.1	1.2	1.2	15.0
58	Calcine sand	DAYLES_02	5.3	20.84	229.8	40.5	90.5	10.1	46.0	9.4	1.8	7.4	0.5	3.3	0.3	0.9	0.1	1.3	1.1	10.6
59	Calcine sand	DAYLES_03	7.4	42.91	179.7	51.4	121.6	12.5	58.7	12.7	2.2	10.3	0.6	4.0	0.4	0.9	0.1	1.2	1.2	13.3

Table 5. Metal(loid) Bioaccessibility: < 250 um soil particle size fraction

			Bioaccessibility (mg/kg)														
Sample #	**Type**	**Sample ID**	**As**	**Pb**	**Sb**	**Mn**	**Fe**	**Co**	**Ni**	**Zn**	**Sr**	**Cd**	**Ba**	**La**	**Ce**	**Pr**	**Nd**
1	Calcine sand	MARONG_01	5893.3	1625.1	11.5	293.0	923.0	5.1	4.3	362.6	63.3	2.0	74.5	2.28	1.64	0.65	3.01
2	Calcine sand	MARONG_02	4698.7	2765.1	5.6	199.3	877.3	2.8	4.4	335.5	50.2	3.0	41.9	2.58	2.79	0.72	3.20
3	Calcine sand	MARONG_03	6792.5	1354.8	8.0	300.8	793.7	7.7	6.0	249.5	31.6	2.2	62.0	1.84	1.37	0.60	3.00
4	Calcine sand	MARONG_05	5940.1	1243.1	6.8	286.7	987.2	5.7	5.1	280.2	45.5	1.9	48.9	1.93	1.41	0.58	2.91
5	Calcine sand	MARONG_06	6673.9	2231.8	32.8	244.3	856.6	5.3	5.0	290.3	40.6	3.2	42.9	1.79	1.20	0.58	2.78
6	Mixed	MCC_01_red	73.4	7.6	0.1	15.1	263.1	1.0	0.9	8.7	27.9	0.0	25.5	10.69	24.71	2.99	11.89
7	Grey sand	MCC_01_top	936.1	22.6	0.3	125.3	2167.9	3.0	4.1	25.2	52.0	0.2	18.0	1.52	4.26	0.47	2.23
8	Grey sand	MCC_02	304.4	16.4	0.1	214.3	1377.8	3.2	4.7	17.5	47.8	0.1	4.2	0.52	1.23	0.21	1.08
9	Mixed	MCC_02_0.9	44.6	24.9	0.03	32.6	294.7	0.8	0.6	5.0	24.8	0.0	21.9	5.74	10.11	1.13	4.24
10	Grey sand	MCC_03_top	1270.0	29.2	0.3	241.0	3408.5	5.0	7.1	88.6	66.7	0.2	15.0	1.38	3.84	0.46	2.23
11	Grey sand	MCC_03_0.4	2228.0	47.7	0.4	273.4	5785.4	6.6	10.5	146.0	93.7	0.2	13.2	1.60	3.90	0.52	2.47
12	Grey sand	MCC_03_0.9	1065.3	32.5	0.3	288.8	4374.0	6.2	9.0	115.6	92.8	0.2	17.7	1.69	5.16	0.55	2.60
13	Grey sand	MCC_04_top	1082.9	32.9	0.3	255.2	3432.3	6.6	8.0	115.9	76.7	0.2	13.6	1.50	4.54	0.51	2.46
14	Grey sand	MCC_04_0.9	986.6	25.1	0.3	260.4	3689.0	6.9	7.4	81.7	78.2	0.2	5.9	0.75	2.16	0.32	1.65
15	Mixed	CLAY_01	450.8	172.2	0.2	91.2	618.6	3.9	1.7	23.3	17.3	0.4	29.3	2.19	4.98	0.63	2.81
16	Calcine sand	CLAY_02	1975.0	1676.1	0.6	142.3	901.1	3.0	2.5	94.5	27.5	1.9	33.3	2.11	4.96	0.61	2.71
17	Calcine sand	CLAY_03	3748.5	945.4	0.5	162.8	1378.7	3.7	3.7	147.2	44.0	1.6	42.2	1.94	4.85	0.61	2.92
18	Calcine sand	CLAY_05	4712.2	9601.5	1.6	156.2	365.2	2.4	2.5	164.0	17.6	11.0	24.3	2.35	4.88	0.64	2.77
19	Calcine sand	CLAY_07	1961.1	3489.8	0.8	95.6	244.1	1.6	1.2	139.0	16.0	4.1	44.3	1.72	3.47	0.43	1.84
20	Grey sand	IRON_01	27.4	12.5	0.1	242.8	1512.2	7.1	8.2	14.7	47.2	0.1	2.4	0.31	0.81	0.17	0.99
21	Grey sand	IRON_02	18.7	13.6	0.1	215.4	1174.5	5.5	7.9	11.2	31.0	0.1	2.2	0.43	1.19	0.20	1.04
22	Grey sand	DEBRA_11	296.8	11.4	0.1	221.6	1599.9	7.2	7.7	28.1	46.8	0.1	17.5	1.25	3.42	0.42	1.97
23	Grey sand	DEBRA_12	694.6	16.6	0.3	238.5	2739.2	3.5	7.6	78.4	67.9	0.2	10.8	1.25	2.82	0.40	1.92
24	Grey sand	CHUM_27	353.6	23.5	0.4	197.9	2203.2	4.6	5.1	18.0	59.4	0.1	31.9	4.07	12.31	1.33	5.92
25	Grey sand	CHUM_28	845.1	35.0	1.1	157.1	2334.0	3.7	5.7	56.6	56.1	0.3	8.3	1.26	4.03	0.43	2.05
26	Grey sand	CHUM_28_0.75	769.1	59.9	1.0	123.6	1772.0	3.0	5.0	52.1	43.0	0.2	15.9	2.64	14.32	0.81	3.63
27	Grey sand	CHUM_28_0.9	372.0	29.9	0.6	56.7	1052.3	2.1	3.3	20.2	31.3	0.1	15.9	3.27	8.91	0.88	3.84
28	Grey sand	CHUM_29	229.6	25.7	0.4	227.7	1677.0	6.4	9.0	38.3	62.5	0.2	7.5	0.61	1.43	0.28	1.48
29	Grey sand	CHUM_30	181.9	23.4	0.4	188.0	1621.8	7.0	10.1	35.3	48.1	0.2	26.6	3.58	7.43	0.90	4.02
30	Grey sand	CHUM_31	6897.6	3.3	0.6	88.7	3881.3	0.5	1.8	11.8	82.8	<0.1	<0.1	0.01	<0.1	0.05	0.25
31	Grey sand	CHUM_32	22.9	15.1	0.0	62.1	267.6	2.3	1.6	11.7	9.2	0.0	28.9	4.76	10.53	1.07	4.45
32	Grey sand	CHUM_33	566.4	16.6	0.9	31.9	1238.9	1.7	6.2	62.8	9.0	0.4	0.7	0.49	1.15	0.24	1.26
33	Grey sand	CHUM_34	10.9	24.5	<0.05	26.6	218.9	1.6	0.2	3.8	11.4	<0.1	11.1	2.86	7.06	0.86	3.83
34	Grey sand	CHUM_35	194.8	127.4	0.1	142.4	846.7	3.4	4.7	110.6	35.3	0.2	58.1	2.07	4.34	0.55	2.39
35	Grey sand	CHUM_36	239.3	31.3	0.2	72.1	798.1	3.3	3.3	32.4	21.2	0.2	42.1	4.92	12.84	1.32	5.58
36	Grey sand	CHUM_37	866.4	33.9	0.6	375.1	5115.1	6.8	8.9	52.0	120.0	0.3	29.2	2.65	6.13	0.78	3.54
37	Grey sand	CHUM_37_0.5	846.1	27.1	0.6	391.4	4971.7	6.7	8.5	51.2	154.7	0.3	37.8	2.73	6.19	0.77	3.54
38	Grey sand	CHUM_37_1.2-1.4	891.2	31.6	0.7	402.2	5355.4	7.2	10.3	55.4	164.2	0.3	42.5	3.62	7.77	0.95	4.24
39	Mixed	JACKASS_03	26.7	24.3	0.0	3.1	677.0	0.3	0.2	3.4	2.7	0.1	28.9	6.07	17.35	1.55	6.04
40	Calcine sand	JACKASS_06	8393.2	485.3	0.2	146.9	673.5	2.5	0.2	238.6	71.3	1.3	65.6	1.72	1.51	0.56	2.72
41	Calcine sand	JACKASS_07	8023.0	949.0	0.1	167.9	1006.6	3.7	2.3	331.2	86.1	2.0	85.8	2.01	2.19	0.64	2.94
42	Grey sand	WELLS_01	21.6	6.4	0.0	114.2	709.6	2.1	1.9	5.5	24.5	0.1	3.6	0.34	0.81	0.15	0.82
43	Grey sand	PASC_01	42.0	11.2	0.1	385.0	2712.5	7.2	7.2	170.9	95.6	0.2	5.9	1.32	3.45	0.49	2.47
44	Grey sand	PASC_02	15.3	14.1	0.2	445.9	3374.1	13.4	11.1	18.9	105.3	0.1	16.5	1.86	4.81	0.63	3.09
45	Grey sand	PASC_03	15.4	32.5	0.1	419.2	2620.5	9.5	9.3	17.9	92.4	0.1	16.6	2.41	6.10	0.74	3.45
46	Alluvial	BENDCK_01	3.4	2.8	0.0	11.6	55.1	0.4	<0.1	1.1	2.6	<0.1	22.9	1.54	2.85	0.43	1.76
47	Alluvial	BENDCK_02	4.2	7.6	0.0	32.1	179.7	1.1	0.4	1.6	16.4	<0.1	25.5	4.95	4.43	1.13	4.68
48	Old tailings pond	CHUM_TOW_LOW	585.6	18.0	0.6	13.3	1645.5	1.1	0.7	4.7	9.4	0.2	0.4	0.45	1.39	0.30	1.66
49	Grey sand	LEST_01	278.8	10.4	0.1	209.8	2005.7	4.5	5.8	27.2	72.9	0.2	15.4	2.01	4.58	0.60	2.82
50	Grey sand	LEST_02	371.6	25.2	0.4	208.2	2897.2	8.5	11.2	61.5	68.0	0.3	8.9	1.41	3.37	0.46	2.25
51	Grey sand	LEST_03	356.2	15.4	0.2	200.7	2362.0	4.8	8.6	28.9	53.6	0.1	15.5	1.37	3.31	0.46	2.29
52	Grey sand	LEST_04	62.2	4.0	0.0	145.1	1305.2	3.5	3.6	15.7	51.4	0.1	8.8	1.09	2.36	0.38	1.88
53	Grey sand	LEST_05	913.9	56.8	0.3	168.0	3362.7	5.5	8.4	83.9	49.8	0.1	13.4	1.31	3.21	0.46	2.34
54	Old tailings pond	CHUM_TOW_01	No soil supplied														
55	Old tailings pond	CHUM_TOW_02	No < 250 um PSF														
56	Old tailings pond	CHUM_TOW_BULK	535.4	10.8	0.4	3.0	1121.2	0.2	<0.1	1.3	3.0	<0.1	0.3	0.1	0.1	0.1	0.4
56-1	Old tailings pond	Brown material	789.8	2.3	0.2	4.4	2198.1	0.2	0.1	1.7	5.1	<0.1	0.8	0.2	0.4	0.1	0.6
56-2	Old tailings pond	White material	2220.5	11.9	2.6	1.4	1869.0	0.1	<0.1	0.8	1.1	<0.1	1.0	0.1	<0.1	0.0	0.1
57	Calcine sand	DAYLES_01	4510.2	13784.6	0.5	242.2	133.2	2.8	0.8	169.8	7.3	6.9	10.4	3.0	3.6	0.7	3.2
58	Calcine sand	DAYLES_02	4190.6	14086.8	0.4	266.1	168.3	2.7	1.5	173.3	23.4	5.7	11.3	4.1	4.8	0.9	3.9
59	Calcine sand	DAYLES_03	4821.7	15340.4	0.3	205.6	81.6	2.6	1.4	182.8	6.6	7.9	12.8	2.8	2.5	0.7	2.9

Table 5 cont. Metal(loid) Bioaccessibility: < 250 um soil particle size fraction

			Bioaccessibility (%)													
Sample #	**Type**	**Sample ID**	**As**	**Pb**	**Sb**	**Mn**	**Fe**	**Co**	**Ni**	**Zn**	**Sr**	**Cd**	**Ba**	**La**	**Ce**	**Pr**	**Nd**
1	Calcine sand	MARONG_01	39.4	59.4	1.6	14.0	0.4	3.4	1.3	22.0	63.9	27.3	20.5	6.2	2.0	7.0	7.9
2	Calcine sand	MARONG_02	46.7	69.2	1.8	17.6	0.4	2.4	1.7	9.5	66.4	23.4	19.4	7.4	3.6	8.1	7.9
3	Calcine sand	MARONG_03	46.4	51.2	0.9	21.3	0.2	3.7	1.2	15.4	49.8	28.9	19.1	4.6	1.3	6.0	7.4
4	Calcine sand	MARONG_05	38.2	60.6	1.8	27.0	0.4	3.7	1.4	24.1	67.5	31.1	17.9	4.4	1.3	5.3	5.1
5	Calcine sand	MARONG_06	45.0	66.9	1.0	26.7	0.4	3.4	1.4	15.8	68.2	36.0	15.5	3.8	1.0	4.8	5.5
6	Mixed	MCC_01_red	28.5	27.3	8.8	23.7	0.6	15.0	6.5	12.1	40.6	16.4	8.9	25.7	21.1	27.2	24.4
7	Grey sand	MCC_01_top	38.1	35.3	9.5	37.8	7.2	39.9	17.4	27.8	61.0	64.9	7.8	3.8	5.1	5.1	5.9
8	Grey sand	MCC_02	17.8	47.7	4.1	23.3	3.7	20.4	18.0	17.2	55.8	38.6	4.1	1.7	1.6	2.8	3.7
9	Mixed	MCC_02_0.9	23.2	54.2	3.5	27.0	1.1	7.5	2.4	6.7	34.0	28.8	17.9	12.2	10.2	11.1	10.9
10	Grey sand	MCC_03_top	50.1	51.0	11.6	48.5	12.0	52.0	27.9	46.4	61.6	62.4	13.2	4.0	5.3	5.6	7.2
11	Grey sand	MCC_03_0.4	67.9	65.4	16.3	60.6	19.7	66.4	38.0	59.6	74.4	72.7	15.5	5.1	5.8	6.9	8.8
12	Grey sand	MCC_03_0.9	55.1	57.4	15.2	58.6	13.4	60.7	32.4	48.6	67.7	65.7	13.3	4.6	6.7	6.2	8.0
13	Grey sand	MCC_04_top	38.2	50.8	10.6	52.0	10.7	60.7	30.0	44.2	68.0	62.7	15.0	3.9	5.6	5.6	7.3
14	Grey sand	MCC_04_0.9	34.5	57.4	14.3	45.3	11.3	56.7	31.1	48.1	73.3	63.9	9.9	2.5	2.7	4.5	6.7
15	Mixed	CLAY_01	45.7	76.1	0.6	34.1	1.2	15.4	2.6	6.6	37.6	33.6	17.2	5.7	6.1	6.5	7.0
16	Calcine sand	CLAY_02	36.1	64.2	1.4	19.9	0.7	3.9	1.4	5.3	61.1	21.2	18.6	6.0	6.6	6.8	5.9
17	Calcine sand	CLAY_03	48.0	57.4	1.5	27.8	0.9	4.0	1.4	12.9	61.1	27.0	22.6	6.5	7.2	8.0	9.6
18	Calcine sand	CLAY_05	39.6	70.9	1.4	10.2	0.1	2.0	0.8	1.4	55.6	22.6	15.2	11.1	10.4	12.1	9.9
19	Calcine sand	CLAY_07	32.1	67.9	1.0	12.7	0.1	1.8	0.6	2.2	62.6	19.1	31.9	6.6	6.4	6.6	5.9
20	Grey sand	IRON_01	8.3	24.5	4.7	74.4	6.0	76.2	35.2	12.3	81.4	17.6	4.5	1.4	1.6	3.1	3.7
21	Grey sand	IRON_02	5.5	42.1	8.5	67.9	4.9	62.6	31.2	9.9	63.3	30.5	4.7	1.6	2.1	2.9	4.0
22	Grey sand	DEBRA_11	23.4	38.8	6.3	52.9	4.7	52.4	26.3	26.6	61.1	48.2	22.1	3.3	4.4	4.7	5.9
23	Grey sand	DEBRA_12	40.7	47.7	11.5	48.6	9.4	32.3	27.0	40.6	70.3	67.9	15.9	4.3	4.6	5.8	7.4
24	Grey sand	CHUM_27	30.5	55.5	9.8	65.0	9.4	52.3	24.0	25.6	67.2	66.2	25.2	9.2	13.1	12.3	14.0
25	Grey sand	CHUM_28	43.8	54.2	15.5	57.3	11.3	65.7	37.3	55.0	66.7	69.1	16.7	5.5	8.3	8.0	9.2
26	Grey sand	CHUM_28_0.75	45.2	63.4	14.9	54.0	7.7	47.3	28.5	53.5	65.8	71.1	17.9	9.6	21.3	12.2	14.7
27	Grey sand	CHUM_28_0.9	40.8	46.6	12.4	35.1	3.4	27.6	9.4	29.4	54.3	62.7	13.1	10.7	14.0	12.1	13.3
28	Grey sand	CHUM_29	18.0	40.8	9.0	56.0	4.6	69.4	39.0	35.0	71.9	58.2	11.5	2.0	2.3	3.8	5.5
29	Grey sand	CHUM_30	21.0	40.3	9.2	51.5	6.1	57.6	30.7	32.2	55.2	60.3	19.1	9.7	10.4	10.5	12.2
30	Grey sand	CHUM_31	36.6	4.7	5.8	28.5	13.7	18.2	41.8	51.8	45.2	nd	nd	0.1	nd	0.8	1.2
31	Grey sand	CHUM_32	16.8	48.6	1.3	30.0	1.0	20.8	6.2	19.2	31.0	64.3	22.0	12.4	13.2	11.7	13.2
32	Grey sand	CHUM_33	21.5	15.8	7.7	16.9	6.1	17.2	31.5	42.2	27.5	73.9	1.0	1.6	1.9	3.3	4.6
33	Grey sand	CHUM_34	3.3	55.8	nd	22.5	0.4	7.6	0.5	3.7	30.7	nd	13.7	9.0	10.3	10.4	9.4
34	Grey sand	CHUM_35	25.0	65.6	4.0	33.4	3.0	30.4	19.2	50.6	61.7	69.5	39.1	6.5	6.6	7.3	8.4
35	Grey sand	CHUM_36	23.4	47.5	3.0	36.5	2.3	23.7	11.3	19.1	39.7	34.4	21.5	13.3	12.6	13.7	10.4
36	Grey sand	CHUM_37	53.8	84.4	15.7	70.3	20.8	79.6	36.6	48.5	76.0	79.9	25.5	9.0	9.9	11.2	14.0
37	Grey sand	CHUM_37_0.5	60.1	77.8	21.5	77.2	20.8	86.6	41.0	59.7	85.6	89.0	44.6	10.5	11.6	12.6	16.0
38	Grey sand	CHUM_37_1.2-1.4	55.9	76.6	18.2	73.3	19.7	83.3	38.2	54.2	78.9	86.8	29.7	10.2	11.7	11.4	13.4
39	Mixed	JACKASS_03	6.3	31.1	1.0	7.4	1.6	2.4	0.8	5.2	9.9	25.0	13.7	15.4	15.9	15.4	11.8
40	Calcine sand	JACKASS_06	75.1	44.5	0.9	23.7	0.3	1.9	0.1	36.7	82.7	38.7	22.8	4.5	1.7	5.8	5.9
41	Calcine sand	JACKASS_07	61.2	56.6	0.4	21.6	0.4	2.3	0.7	37.4	84.3	37.4	27.7	4.8	2.8	6.2	7.0
42	Grey sand	WELLS_01	7.9	28.7	2.4	49.7	3.4	46.6	13.7	10.0	68.6	46.5	5.6	1.2	1.4	2.2	3.5
43	Grey sand	PASC_01	10.1	37.1	6.1	68.6	10.2	76.4	35.1	42.4	84.7	70.0	11.3	4.2	5.3	6.6	8.5
44	Grey sand	PASC_02	5.2	38.3	7.0	64.7	8.8	76.7	34.1	18.7	78.0	43.9	20.0	4.3	5.4	6.3	8.5
45	Grey sand	PASC_03	6.1	68.8	5.6	52.1	7.7	41.6	30.8	17.3	74.3	42.5	7.9	6.1	7.4	7.8	9.7
46	Alluvial	BENDCK_01	10.0	30.5	1.3	20.1	0.4	12.8	nd	7.6	35.6	nd	19.3	4.7	4.0	5.5	6.2
47	Alluvial	BENDCK_02	10.7	34.0	1.2	21.1	0.6	11.0	2.4	4.5	49.2	nd	13.7	10.8	4.5	10.5	11.1
48	Old tailings pond	CHUM_TOW_LOW	18.5	18.2	3.9	8.4	7.5	8.3	6.6	6.8	27.8	34.6	0.5	1.6	2.6	4.7	6.6
49	Grey sand	LEST_01	25.2	43.7	11.2	61.9	7.2	66.0	26.7	36.6	80.6	67.7	12.8	4.7	5.6	6.0	7.8
50	Grey sand	LEST_02	33.9	56.2	24.4	60.8	10.5	78.1	39.6	53.8	75.1	65.0	10.2	3.7	4.3	5.0	6.1
51	Grey sand	LEST_03	42.5	51.4	18.7	55.0	8.1	55.7	31.4	34.6	75.2	73.8	11.7	3.7	4.4	5.2	7.4
52	Grey sand	LEST_04	16.0	32.5	6.0	48.1	5.4	58.8	19.1	24.8	65.3	54.0	6.7	2.1	2.2	3.1	4.1
53	Grey sand	LEST_05	54.6	59.6	17.6	43.5	6.9	49.5	22.6	36.5	63.1	23.5	3.4	5.1	4.8	7.1	5.7
54	Old tailings pond	CHUM_TOW_01		No soil supplied													
55	Old tailings pond	CHUM_TOW_02		No < 250 um PSF													
56	Old tailings pond	CHUM_TOW_BULK	3.2	6.1	1.7	2.8	2.5	2.4	nd	1.1	7.2	nd	0.6	0.5	0.2	1.1	1.4
56-1	Old tailings pond	Brown material	2.9	2.0	0.8	2.9	3.0	2.3	1.1	1.5	16.4	nd	1.6	1.1	0.9	2.1	2.4
56-2	Old tailings pond	White material	1.1	3.9	2.2	5.1	1.3	7.7	nd	1.3	8.4	nd	0.7	0.3	nd	0.5	0.4
57	Calcine sand	DAYLES_01	39.8	79.9	0.4	9.2	0.0	2.7	0.2	1.5	30.6	28.0	7.9	12.0	7.1	11.7	9.3
58	Calcine sand	DAYLES_02	40.3	88.1	0.3	11.2	0.1	3.5	0.6	1.9	62.3	31.3	7.8	20.3	12.3	18.9	20.4
59	Calcine sand	DAYLES_03	41.3	83.4	0.2	8.5	0.0	2.4	0.5	1.5	35.0	28.8	10.6	12.2	5.4	12.2	12.4

Table 6 cont. Metal(loid) Bioaccessibility: < 106 um soil particle size fraction

Sample #	Type	Sample ID	Bioaccessibility (mg/kg) As	Pb	Sb	Mn	Fe	Co	Ni	Zn	Sr	Cd	Ba	La	Ce	Pr	Nd
1	Calcine sand	MARONG_01	6141.9	2098.9	12.2	321.3	1124.9	5.7	2.5	468.3	87.1	2.2	99.4	3.0	3.0	0.83	3.84
2	Calcine sand	MARONG_02	4818.9	2805.0	5.6	209.6	1011.3	3.0	1.1	412.4	65.4	2.6	54.2	3.2	4.1	0.88	3.81
3	Calcine sand	MARONG_03	7145.1	1500.5	8.5	340.0	871.7	8.3	2.6	276.9	35.1	2.1	67.8	1.9	1.5	0.63	3.21
4	Calcine sand	MARONG_05	6251.4	1371.7	7.5	301.4	1101.1	6.1	1.3	303.5	49.1	2.1	51.2	2.0	1.5	0.62	2.93
5	Calcine sand	MARONG_06	6882.7	2433.7	31.9	265.8	943.0	5.8	1.4	319.3	42.5	3.2	45.4	1.9	1.4	0.59	2.97
6	Mixed	MCC_01_red	87.3	6.5	0.1	19.5	297.1	1.2	1.3	10.0	37.5	0.0	35.8	15.4	35.0	4.11	16.19
7	Grey sand	MCC_01_top	962.3	18.2	0.2	107.6	2103.6	2.7	3.8	25.8	50.8	0.2	21.2	1.8	5.0	0.56	2.55
8	Grey sand	MCC_02	520.3	26.0	0.1	395.3	2666.5	6.3	9.9	37.7	80.3	0.2	10.9	1.3	3.0	0.46	2.31
9	Mixed	MCC_02_0.9	55.4	17.0	0.0	41.6	337.2	1.0	0.9	6.1	31.1	0.0	29.2	7.4	12.8	1.44	5.38
10	Grey sand	MCC_03_top	1797.1	30.3	0.3	290.7	4198.9	6.3	9.0	116.7	75.5	0.2	22.9	2.0	5.7	0.65	3.08
11	Grey sand	MCC_03_0.4	2963.7	29.6	0.4	316.2	7237.1	8.0	13.5	204.9	112.0	0.3	21.5	2.4	5.9	0.74	3.49
12	Grey sand	MCC_03_0.9	1354.3	29.6	0.3	328.0	5102.5	7.9	11.2	148.6	108.2	0.2	27.7	2.4	7.4	0.73	3.44
13	Grey sand	MCC_04_top	1445.8	32.7	0.3	315.9	4122.6	9.1	10.9	166.7	91.7	0.3	21.7	2.2	7.1	0.72	3.47
14	Grey sand	MCC_04_0.9	1724.6	36.7	0.4	384.2	5364.7	12.9	13.4	146.0	101.6	0.4	15.4	1.4	4.3	0.54	2.77
15	Mixed	CLAY_01	483.5	119.2	0.2	110.0	686.5	4.7	2.0	24.7	18.2	0.4	36.5	2.6	6.2	0.76	3.33
16	Calcine sand	CLAY_02	2135.0	1178.2	0.5	166.5	1071.2	3.5	3.0	110.4	33.5	1.6	49.8	2.8	6.8	0.80	3.60
17	Calcine sand	CLAY_03	4365.6	717.6	0.5	190.1	1576.0	4.3	4.5	185.6	52.9	1.7	57.4	2.5	6.4	0.78	3.65
18	Calcine sand	CLAY_05	5667.1	14133.2	1.7	155.1	330.2	2.4	<0.1	160.8	16.2	10.4	28.3	2.6	2.4	0.68	2.89
19	Calcine sand	CLAY_07	1711.2	2272.1	0.8	114.1	258.7	2.0	1.6	168.9	19.7	3.5	71.3	2.4	5.0	0.58	2.37
20	Grey sand	IRON_01	48.7	15.6	0.1	379.5	2246.8	12.0	13.8	24.1	69.4	0.1	4.8	0.6	1.7	0.29	1.64
21	Grey sand	IRON_02	43.0	26.5	0.1	420.0	2377.9	11.6	16.0	22.0	57.5	0.2	5.2	1.0	2.9	0.41	2.14
22	Grey sand	DEBRA_11	484.7	12.9	0.2	322.8	2177.6	11.7	12.4	48.0	58.8	0.2	31.5	2.2	6.3	0.71	3.35
23	Grey sand	DEBRA_12	1188.5	24.7	0.3	305.9	4250.6	4.1	11.2	137.9	102.8	0.4	19.9	2.0	4.8	0.66	3.20
24	Grey sand	CHUM_27	482.2	25.1	0.4	252.9	2743.6	6.9	7.4	25.0	73.0	0.2	54.1	6.2	19.1	1.97	8.70
25	Grey sand	CHUM_28	1343.0	41.9	1.3	239.8	3451.0	6.0	9.6	95.9	86.1	0.4	15.1	2.3	6.7	0.75	3.47
26	Grey sand	CHUM_28_0.75	1035.3	57.4	1.1	163.3	2386.8	4.1	6.8	70.0	58.3	0.3	21.6	4.1	20.5	1.13	4.99
27	Grey sand	CHUM_28_0.9	575.2	32.5	0.7	81.3	1541.0	2.8	5.3	28.8	43.7	0.2	22.1	4.6	11.8	1.19	5.16
28	Grey sand	CHUM_29	352.0	29.4	0.5	325.3	2351.9	8.3	12.8	61.7	88.9	0.4	12.9	1.0	2.4	0.43	2.31
29	Grey sand	CHUM_30	217.1	19.1	0.4	229.2	1983.6	8.5	11.9	41.0	58.4	0.2	35.5	4.7	10.1	1.17	5.20
30	Grey sand	CHUM_31	8155.0	0.2	0.5	109.6	4372.0	0.9	<0.1	18.4	147.8	0.0	<0.1	0.1	<0.1	0.07	0.42
31	Grey sand	CHUM_32	37.7	13.8	0.0	86.6	401.2	3.6	2.7	17.1	13.7	0.0	56.7	7.7	16.8	1.79	7.26
32	Grey sand	CHUM_33	632.9	13.9	0.8	32.7	1417.1	1.7	6.2	64.7	11.0	0.4	1.2	0.6	1.4	0.28	1.52
33	Grey sand	CHUM_34	14.7	20.6	<0.1	39.3	292.8	2.3	0.5	4.9	13.7	0.0	15.0	4.0	9.6	1.10	4.91
34	Grey sand	CHUM_35	263.9	136.0	0.2	208.1	1054.5	4.7	6.7	159.0	49.8	0.3	93.4	3.1	6.7	0.81	3.49
35	Grey sand	CHUM_36	289.0	26.3	0.2	96.7	959.0	4.2	3.9	36.4	25.5	0.2	61.1	6.1	16.1	1.61	6.73
36	Grey sand	CHUM_37	1027.9	26.2	0.6	459.9	6209.2	7.8	9.9	59.0	154.3	0.3	39.5	3.4	8.0	0.97	4.46
37	Grey sand	CHUM_37_0.5	1042.1	24.4	0.7	454.6	5986.4	6.5	8.7	58.2	182.7	0.3	45.3	3.3	7.6	0.94	4.22
38	Grey sand	CHUM_37_1.2-1.4	1067.0	26.9	0.6	452.3	6252.1	7.7	11.2	63.7	191.6	0.3	55.0	4.5	9.5	1.13	5.07
39	Mixed	JACKASS_03	49.7	36.2	0.0	6.8	1443.5	0.5	0.6	7.1	5.5	0.1	73.6	13.1	38.3	3.59	12.83
40	Calcine sand	JACKASS_06	9172.2	556.1	0.2	157.3	766.8	2.9	0.4	260.1	78.1	1.4	70.7	1.7	1.6	0.59	2.77
41	Calcine sand	JACKASS_07	7543.6	878.6	0.0	162.5	954.3	3.6	1.4	304.9	82.1	1.8	81.1	1.8	1.5	0.58	2.73
42	Grey sand	WELLS_01	31.1	9.3	0.0	153.7	1005.9	3.1	3.1	7.8	33.0	0.1	5.1	0.5	1.3	0.22	1.18
43	Grey sand	PASC_01	64.9	13.2	0.1	505.9	3281.9	11.0	10.9	270.5	116.7	0.3	8.8	2.0	5.4	0.74	3.71
44	Grey sand	PASC_02	30.5	24.6	0.3	667.3	4916.5	28.0	21.3	34.9	144.8	0.2	31.8	3.2	8.5	1.05	5.02
45	Grey sand	PASC_03	27.6	37.4	0.2	679.6	3674.6	18.3	17.6	31.6	135.6	0.2	31.0	4.9	11.5	1.35	6.12
46	Alluvial	BENDCK_01	10.8	6.0	0.0	43.2	187.3	1.5	0.6	5.2	9.4	0.0	92.5	5.3	9.9	1.29	5.30
47	Alluvial	BENDCK_02	2.8	8.0	0.1	50.2	306.9	1.8	0.7	3.4	23.6	0.0	58.7	8.8	8.0	2.08	8.56
48	Old tailings pond	CHUM_TOW_LOW	799.4	14.1	0.7	16.8	2146.3	1.2	0.9	5.9	11.8	0.2	0.4	0.5	1.7	0.36	1.99
49	Grey sand	LEST_01	388.1	10.7	0.1	261.4	2440.0	5.9	7.5	33.7	92.8	0.2	20.8	2.7	6.3	0.79	3.78
50	Grey sand	LEST_02	588.0	30.0	0.4	231.7	3659.8	10.7	15.6	96.5	83.5	0.4	14.1	2.0	4.9	0.66	3.24
51	Grey sand	LEST_03	447.4	13.2	0.2	216.8	2799.2	5.0	9.3	34.8	64.1	0.2	18.6	1.7	4.1	0.56	2.79
52	Grey sand	LEST_04	152.9	7.4	0.1	242.4	2189.9	5.8	6.5	26.7	85.8	0.2	16.1	2.1	5.5	0.73	3.61
53	Grey sand	LEST_05	977.2	42.0	0.3	164.8	3607.6	5.1	8.1	86.8	52.9	0.1	15.4	1.4	3.2	0.52	2.60
54	Old tailings pond	CHUM_TOW_01	No soil supplied														
55	Old tailings pond	CHUM_TOW_02	No < 106 um PSF														
56	Old tailings pond	CHUM_TOW_BULK	970.5	4.8	0.7	7.5	2327.5	0.4	0.1	3.1	5.4	0.1	0.8	0.2	0.5	0.14	0.78
56-1	Old tailings pond	Brown material	1097.5	4.4	0.2	10.3	3417.1	0.5	<0.1	3.5	8.2	0.1	0.7	0.3	0.6	0.17	0.91
56-2	Old tailings pond	White material	3069.1	31.0	3.0	2.2	2133.0	0.1	<0.1	1.3	1.7	0.0	0.4	0.1	<0.1	0.02	0.10
57	Calcine sand	DAYLES_01	4572.7	14930.9	0.5	248.8	154.5	2.9	0.9	172.2	8.3	6.4	12.3	3.4	4.2	0.80	3.25
58	Calcine sand	DAYLES_02	4538.8	14332.0	0.4	286.8	296.3	3.4	5.5	182.2	33.0	5.1	7.6	4.8	9.7	1.13	4.50
59	Calcine sand	DAYLES_03	5288.2	16569.0	0.5	232.9	201.5	3.3	3.8	208.4	9.8	8.3	18.9	3.5	7.3	0.84	3.49

Table 6. Metal(loid) Bioaccessibility: < 106 um soil particle size fraction

			Bioaccessibility (%)													
Sample #	Type	Sample ID	As	Pb	Sb	Mn	Fe	Co	Ni	Zn	Sr	Cd	Ba	La	Ce	Pr	Nd
1	Calcine sand	MARONG_01	39.6	64.6	1.5	14.6	0.5	3.7	0.7	23.4	74.5	28.5	22.8	5.4	1.9	6.0	5.7
2	Calcine sand	MARONG_02	47.1	76.1	2.4	18.9	0.5	2.9	0.5	13.1	71.6	26.5	20.4	7.9	4.6	8.6	8.3
3	Calcine sand	MARONG_03	44.3	65.1	1.2	29.1	0.3	4.9	0.7	20.6	72.1	33.0	25.8	4.0	1.5	5.2	5.3
4	Calcine sand	MARONG_05	35.0	61.8	1.7	26.6	0.4	3.6	0.3	22.6	71.2	30.0	19.5	3.5	1.0	4.4	3.9
5	Calcine sand	MARONG_06	38.8	50.2	0.6	20.6	0.3	2.6	0.3	9.1	52.7	23.5	13.2	3.5	0.8	4.2	4.8
6	Mixed	MCC_01_red	17.2	15.0	1.2	18.5	0.5	12.3	5.9	7.1	35.8	11.5	7.9	17.7	14.5	23.4	18.2
7	Grey sand	MCC_01_top	31.3	32.6	6.1	37.8	5.5	32.2	13.0	18.5	54.0	27.6	9.6	5.0	5.0	6.0	5.9
8	Grey sand	MCC_02	11.4	37.2	3.7	26.4	4.2	23.0	15.0	15.1	56.8	25.3	7.7	2.7	2.0	3.9	4.0
9	Mixed	MCC_02_0.9	24.1	39.7	4.7	35.4	1.4	9.6	4.1	9.6	45.3	30.2	26.5	14.8	13.4	13.0	13.7
10	Grey sand	MCC_03_top	48.5	37.4	10.1	59.3	12.7	52.8	30.0	48.9	72.7	53.0	19.9	5.0	6.7	6.9	8.5
11	Grey sand	MCC_03_0.4	53.1	29.0	13.6	69.3	22.5	71.7	42.2	63.0	82.7	62.8	28.4	5.5	7.1	7.0	9.5
12	Grey sand	MCC_03_0.9	52.0	38.6	12.4	66.4	14.7	64.3	34.6	49.3	71.1	51.6	17.7	5.1	7.3	6.6	8.4
13	Grey sand	MCC_04_top	32.6	37.5	10.0	61.1	11.5	69.6	36.8	51.2	80.6	58.9	21.3	4.5	7.6	6.1	8.5
14	Grey sand	MCC_04_0.9	22.7	40.9	6.6	38.0	9.0	48.7	24.9	35.7	62.0	35.1	6.2	2.9	2.8	4.4	4.7
15	Mixed	CLAY_01	35.5	43.7	2.4	32.6	1.1	13.7	2.6	7.4	37.5	30.5	16.0	5.8	4.3	6.5	5.5
16	Calcine sand	CLAY_02	36.6	35.7	0.9	24.9	0.6	3.8	1.4	5.3	51.8	16.9	22.5	6.6	6.0	7.4	6.5
17	Calcine sand	CLAY_03	40.8	32.7	1.4	24.1	0.7	2.9	1.4	14.5	64.2	22.6	27.6	6.6	6.6	8.1	7.9
18	Calcine sand	CLAY_05	41.0	59.0	0.8	7.9	0.1	1.3	nd	0.8	34.3	16.3	12.2	7.8	2.8	8.3	11.0
19	Calcine sand	CLAY_07	29.9	38.9	0.7	17.8	0.1	1.9	0.6	2.3	46.6	15.5	31.9	5.1	4.3	5.0	3.6
20	Grey sand	IRON_01	5.6	27.0	6.4	66.1	6.0	73.5	39.6	22.7	72.4	38.2	7.9	1.2	1.5	2.5	4.1
21	Grey sand	IRON_02	4.7	21.8	5.4	70.3	6.0	62.6	44.6	14.5	78.1	37.0	3.1	1.7	2.7	3.1	4.5
22	Grey sand	DEBRA_11	22.6	27.1	6.0	60.1	4.9	48.5	29.3	32.7	63.9	45.8	28.2	3.6	4.7	4.8	6.4
23	Grey sand	DEBRA_12	31.7	32.1	8.7	44.9	10.6	28.7	28.7	46.7	80.8	62.5	11.2	3.5	4.6	4.9	6.6
24	Grey sand	CHUM_27	29.4	41.2	7.6	63.4	8.9	52.5	25.0	25.4	62.7	50.0	29.1	10.8	13.5	13.6	16.7
25	Grey sand	CHUM_28	39.8	43.0	13.2	70.2	14.3	70.9	45.0	57.8	78.5	70.5	12.8	5.7	9.2	7.9	10.3
26	Grey sand	CHUM_28_0.75	39.9	46.2	13.7	62.4	9.0	54.3	32.4	61.4	70.6	65.6	13.8	9.6	22.1	11.1	14.1
27	Grey sand	CHUM_28_0.9	46.7	40.0	12.7	46.3	5.3	34.1	20.4	36.8	62.9	61.2	12.8	13.1	15.4	14.1	16.2
28	Grey sand	CHUM_29	16.5	32.7	8.2	68.1	7.8	77.1	46.2	40.0	82.5	58.8	11.9	2.3	3.0	4.1	6.0
29	Grey sand	CHUM_30	19.3	27.6	8.9	58.1	7.2	65.7	34.1	37.5	58.8	52.8	26.3	10.0	11.2	10.5	13.5
30	Grey sand	CHUM_31	29.6	0.1	3.2	23.5	11.5	19.5	nd	57.0	50.4	23.2	nd	0.4	nd	0.9	1.5
31	Grey sand	CHUM_32	24.5	42.3	1.5	40.1	1.5	30.4	10.5	28.0	40.7	52.8	42.6	16.5	17.6	15.5	19.0
32	Grey sand	CHUM_33	20.6	10.6	7.0	20.1	6.8	23.0	31.9	39.0	27.3	58.2	1.7	1.8	2.1	3.7	5.7
33	Grey sand	CHUM_34	3.6	31.7	nd	23.0	0.4	8.0	1.0	3.4	27.2	21.7	8.2	10.2	9.2	10.6	9.1
34	Grey sand	CHUM_35	24.7	50.0	3.4	38.8	3.3	32.0	21.9	53.5	66.7	61.9	36.8	7.5	7.4	8.0	9.5
35	Grey sand	CHUM_36	23.0	36.9	4.1	50.6	3.4	36.6	17.0	35.6	53.0	69.4	30.9	12.6	16.6	13.5	16.5
36	Grey sand	CHUM_37	53.7	62.7	14.3	82.4	24.4	88.5	40.3	56.5	86.3	66.0	25.9	9.6	10.9	11.5	14.5
37	Grey sand	CHUM_37_0.5	55.6	68.3	20.8	84.7	26.7	85.3	42.3	65.2	90.6	76.1	41.6	9.7	12.1	11.5	14.3
38	Grey sand	CHUM_37_1.2-1.4	58.0	57.9	14.5	79.2	22.5	85.3	39.4	59.4	83.6	64.7	30.6	12.1	12.1	12.9	16.7
39	Mixed	JACKASS_03	8.9	28.7	1.0	11.6	3.0	3.9	2.1	12.1	17.0	38.3	28.5	26.2	33.8	29.6	29.0
40	Calcine sand	JACKASS_06	67.5	34.7	0.5	16.7	0.2	1.5	0.1	26.6	61.1	26.1	17.2	3.6	0.9	4.8	5.1
41	Calcine sand	JACKASS_07	61.5	39.0	0.1	15.5	0.3	1.7	0.3	25.8	60.7	24.7	19.3	4.3	1.5	5.7	5.8
42	Grey sand	WELLS_01	7.4	26.6	3.8	52.1	3.6	44.4	15.6	11.4	69.6	42.7	4.2	1.1	1.5	2.0	3.1
43	Grey sand	PASC_01	9.0	31.7	5.6	77.7	10.5	82.4	35.1	50.6	92.1	67.6	7.6	3.7	5.5	5.7	7.9
44	Grey sand	PASC_02	4.8	28.8	3.9	57.6	7.3	63.3	27.9	13.9	67.9	25.8	18.0	5.6	4.3	7.2	6.7
45	Grey sand	PASC_03	5.9	42.3	5.4	75.2	8.9	72.1	41.4	21.4	88.0	46.4	22.0	8.7	10.8	9.7	12.5
46	Alluvial	BENDCK_01	14.5	31.3	2.7	32.8	0.9	22.9	6.5	18.6	53.0	39.2	29.4	5.7	5.5	5.7	6.9
47	Alluvial	BENDCK_02	4.7	31.1	1.4	30.8	1.0	16.7	4.2	8.9	60.8	37.8	30.2	15.1	7.1	14.5	17.4
48	Old tailings pond	CHUM_TOW_LOW	21.0	13.6	4.8	14.5	11.4	15.9	8.4	9.6	34.6	35.8	0.8	1.5	2.7	4.4	6.9
49	Grey sand	LEST_01	24.9	37.1	10.0	70.6	9.2	70.1	30.3	40.5	89.0	57.3	13.7	5.1	6.6	6.3	8.5
50	Grey sand	LEST_02	31.4	39.8	23.0	69.2	12.3	84.3	45.9	57.2	86.1	59.2	9.1	3.9	5.0	5.3	7.5
51	Grey sand	LEST_03	43.6	41.6	20.5	64.6	9.6	64.3	36.0	41.7	88.9	62.5	19.1	3.9	5.0	5.6	8.2
52	Grey sand	LEST_04	17.8	39.1	11.4	65.8	8.3	69.6	31.6	35.9	84.1	54.8	26.4	2.4	3.4	3.6	5.1
53	Grey sand	LEST_05	63.5	47.8	23.5	55.3	10.4	73.8	34.0	70.7	83.6	51.6	4.3	4.6	5.4	6.6	9.5
54	Old tailings pond	CHUM_TOW_01	No soil supplied														
55	Old tailings pond	CHUM_TOW_02	No < 106 um PSF														
56	Old tailings pond	CHUM_TOW_BULK	2.5	0.8	0.9	4.0	2.4	3.6	0.5	1.3	4.2	8.8	0.7	0.5	0.3	1.1	1.3
56-1	Old tailings pond	Brown material	1.6	1.3	0.4	3.2	1.8	2.3	nd	1.4	10.4	5.8	0.8	0.9	0.8	2.2	2.4
56-2	Old tailings pond	White material	1.1	4.9	1.3	3.9	0.9	4.9	nd	1.2	6.1	1.9	0.6	0.2	nd	0.2	0.2
57	Calcine sand	DAYLES_01	37.6	63.2	0.2	7.7	0.0	2.1	0.2	1.3	29.8	23.4	7.3	9.9	5.3	9.3	7.5
58	Calcine sand	DAYLES_02	39.9	61.1	0.2	9.0	0.1	3.2	1.7	1.7	46.1	24.4	3.3	18.8	15.7	17.7	16.7
59	Calcine sand	DAYLES_03	40.6	55.5	0.2	7.1	0.0	2.3	0.9	1.2	30.5	22.7	11.5	10.8	9.4	10.4	9.1

Table 7. Metal(loid) Bioaccessibility: < 53 um soil particle size fraction

			Bioaccessibility (mg/kg)														
Sample #	**Type**	**Sample ID**	**As**	**Pb**	**Sb**	**Mn**	**Fe**	**Co**	**Ni**	**Zn**	**Sr**	**Cd**	**Ba**	**La**	**Ce**	**Pr**	**Nd**
1	Calcine sand	MARONG_01	7115.6	2702.6	13.3	375.2	1413.7	7.0	6.8	585.9	134.2	2.7	137.5	4.65	9.87	1.21	5.17
2	Calcine sand	MARONG_02	5721.6	3117.7	5.4	249.1	1480.4	4.2	5.8	605.3	99.4	2.6	85.1	4.79	10.19	1.12	4.68
3	Calcine sand	MARONG_03	5563.0	3006.3	5.5	250.6	1268.7	3.6	5.3	529.9	88.6	2.7	74.0	4.26	10.34	1.12	4.85
4	Calcine sand	MARONG_05	7250.8	1644.3	8.2	386.9	1113.0	9.3	6.2	316.3	35.4	2.4	87.6	2.64	6.93	0.79	3.91
5	Calcine sand	MARONG_06	6891.7	1925.1	8.2	378.6	1588.8	8.0	5.6	430.0	56.6	2.5	79.1	3.06	7.48	0.87	3.98
6	Mixed	MCC_01_red	142.8	11.5	0.0	27.6	373.1	1.7	1.6	15.6	49.3	0.0	41.6	15.14	35.00	4.05	14.86
7	Grey sand	MCC_01_top	1073.4	34.9	0.3	100.4	1859.4	2.5	3.5	30.2	46.8	0.2	15.6	1.48	4.37	0.45	2.11
8	Grey sand	MCC_02	969.6	66.1	0.2	785.6	4704.0	12.5	18.0	94.2	135.4	0.5	16.4	1.95	4.86	0.59	2.90
9	Mixed	MCC_02_0.9	88.1	38.0	0.0	58.9	387.1	1.3	1.4	12.6	36.3	0.0	31.0	8.04	15.11	1.44	5.41
10	Grey sand	MCC_03_top	2598.3	47.7	0.3	320.4	4462.2	6.4	10.1	142.4	75.9	0.3	22.6	1.99	6.22	0.64	3.08
11	Grey sand	MCC_03_0.4	3573.1	16.0	0.4	288.0	7102.3	5.9	13.5	242.7	114.4	0.4	20.0	2.29	5.80	0.69	3.29
12	Grey sand	MCC_03_0.9	1812.4	50.3	0.4	338.2	5114.7	8.2	11.9	172.7	111.9	0.3	27.9	2.16	7.16	0.67	3.16
13	Grey sand	MCC_04_top	1833.8	60.2	0.3	316.7	3792.1	9.5	11.6	190.4	92.4	0.4	20.0	2.05	6.77	0.66	3.13
14	Grey sand	MCC_04_0.9	2451.7	78.2	0.3	496.0	6333.3	19.2	19.9	233.0	114.7	0.7	17.3	1.48	4.88	0.55	2.76
15	Mixed	CLAY_01	539.5	177.0	0.2	115.0	675.1	4.8	2.3	24.3	15.1	0.3	27.5	2.03	5.20	0.59	2.58
16	Calcine sand	CLAY_02	2439.5	1640.2	0.6	181.8	1187.7	4.1	3.2	117.4	33.5	1.6	42.9	2.37	5.96	0.67	2.95
17	Calcine sand	CLAY_03	5603.7	1184.7	0.4	238.0	1698.5	5.0	6.0	208.2	51.7	1.9	54.7	2.54	7.42	0.75	3.51
18	Calcine sand	CLAY_05	7238.5	21880.0	37.2	347.1	1407.4	7.3	6.1	440.3	48.7	3.9	71.6	2.96	7.26	0.85	3.84
19	Calcine sand	CLAY_07	1654.5	2934.7	0.7	148.7	259.9	2.7	2.1	206.4	21.4	3.4	80.0	2.39	5.53	0.54	2.14
20	Grey sand	IRON_01	106.5	64.8	0.2	546.0	2798.2	17.8	20.5	45.7	88.1	0.4	7.1	0.88	2.56	0.41	2.23
21	Grey sand	IRON_02	65.6	70.2	0.2	514.4	3403.8	14.2	19.8	34.4	72.0	0.3	6.0	1.24	3.85	0.49	2.48
22	Grey sand	DEBRA_11	646.8	22.1	0.2	348.7	2109.3	12.4	13.2	62.4	56.6	0.3	30.1	2.16	6.40	0.69	3.27
23	Grey sand	DEBRA_12	1605.8	49.4	0.3	355.3	4840.4	4.5	12.9	195.6	138.1	0.7	22.5	2.11	5.48	0.69	3.37
24	Grey sand	CHUM_27	639.0	42.4	0.4	275.7	2772.1	7.2	8.1	30.3	76.8	0.2	50.6	5.95	18.59	1.78	7.79
25	Grey sand	CHUM_28	1770.0	73.7	1.2	249.6	3361.3	6.9	10.8	116.1	89.1	0.5	14.2	2.27	7.00	0.74	3.49
26	Grey sand	CHUM_28_0.75	1356.6	96.4	1.1	171.9	2485.3	4.4	7.0	78.8	60.3	0.4	16.6	3.43	20.45	0.98	4.43
27	Grey sand	CHUM_28_0.9	No < 53 um PSF														
28	Grey sand	CHUM_29	483.8	56.4	0.6	362.8	2403.2	8.8	14.0	80.2	95.3	0.5	12.0	1.01	2.56	0.43	2.31
29	Grey sand	CHUM_30	298.6	36.8	0.4	256.9	2144.3	9.1	12.6	46.3	66.1	0.3	33.2	4.94	10.53	1.13	5.08
30	Grey sand	CHUM_31	8913.1	4.5	0.6	565.9	950.5	2.0	2.2	30.3	218.8	0.1	67.5	2.68	6.63	0.66	2.75
31	Grey sand	CHUM_32	78.8	22.3	0.1	105.8	468.7	4.0	2.8	18.9	14.0	0.1	49.1	7.24	16.23	1.58	6.49
32	Grey sand	CHUM_33	838.4	21.7	0.9	41.6	1499.5	2.3	6.3	67.1	12.3	0.4	1.0	0.57	1.38	0.26	1.39
33	Grey sand	CHUM_34	21.5	33.8	0.0	51.0	334.4	2.6	0.6	6.8	12.4	0.0	12.2	3.00	8.32	0.87	3.91
34	Grey sand	CHUM_35	352.3	227.3	0.2	243.5	1162.0	5.1	6.7	174.3	52.2	0.4	88.8	2.83	6.37	0.72	3.07
35	Grey sand	CHUM_36	346.2	41.4	0.2	105.1	988.9	4.3	3.0	33.6	23.2	0.2	58.0	4.77	13.44	1.20	5.02
36	Grey sand	CHUM_37	1226.7	41.6	0.5	492.8	6702.7	6.1	9.9	65.2	165.3	0.4	36.8	2.98	7.52	0.86	3.99
37	Grey sand	CHUM_37_0.5	1360.4	42.0	0.6	507.1	6837.2	5.9	9.2	66.8	201.5	0.4	47.3	3.06	7.62	0.87	4.02
38	Grey sand	CHUM_37_1.2-1.4	1314.6	45.2	0.6	474.0	6739.0	6.3	11.4	72.6	204.1	0.4	49.7	4.23	9.17	1.02	4.66
39	Mixed	JACKASS_03	68.8	57.6	0.0	7.6	1559.4	0.5	0.7	9.8	5.7	0.1	67.6	10.93	31.93	2.59	10.13
40	Calcine sand	JACKASS_06	10045.1	647.5	0.1	176.4	966.9	3.5	3.8	293.2	83.6	1.6	95.6	2.67	7.33	0.84	3.73
41	Calcine sand	JACKASS_07	8427.0	994.2	0.0	164.6	1127.7	4.1	5.2	331.3	88.9	1.9	96.8	2.43	7.00	0.72	3.46
42	Grey sand	WELLS_01	62.1	16.6	0.0	230.6	1380.2	5.0	5.3	14.2	42.8	0.1	9.2	0.90	2.54	0.39	2.12
43	Grey sand	PASC_01	79.0	35.5	0.1	547.3	3306.7	9.4	12.0	383.2	133.0	0.4	9.1	2.32	6.43	0.83	4.04
44	Grey sand	PASC_02	35.4	75.0	0.3	905.8	5893.1	45.5	36.4	61.9	176.0	0.4	48.0	4.30	10.61	1.19	5.62
45	Grey sand	PASC_03	38.4	80.6	0.2	956.2	3989.7	26.1	25.4	45.4	158.4	0.4	36.6	6.57	15.11	1.63	7.30
46	Alluvial	BENDCK_01	No < 53 um PSF														
47	Alluvial	BENDCK_02	No < 53 um PSF														
48	Old tailings pond	CHUM_TOW_LOW	986.8	24.4	0.7	21.9	2123.9	1.4	1.1	6.4	12.7	0.3	0.3	0.50	1.71	0.34	1.89
49	Grey sand	LEST_01	517.3	20.5	0.1	276.2	2360.2	6.4	8.3	37.3	94.5	0.3	20.9	2.63	6.84	0.80	3.78
50	Grey sand	LEST_02	788.7	61.3	0.5	215.7	3714.5	10.0	17.5	109.3	81.1	0.5	13.7	1.99	5.29	0.65	3.19
51	Grey sand	LEST_03	549.2	23.7	0.2	196.2	2738.6	3.9	8.6	35.9	62.7	0.2	16.1	1.52	4.15	0.53	2.72
52	Grey sand	LEST_04	No < 53 um PSF														
53	Grey sand	LEST_05	290.0	16.4	0.1	37.6	928.3	1.0	1.5	18.9	13.1	0.0	3.2	0.26	0.40	0.10	0.53
54	Old tailings pond	CHUM_TOW_01	No soil supplied														
55	Old tailings pond	CHUM_TOW_02	No < 53 um PSF														
56	Old tailings pond	CHUM_TOW_BULK	1201.1	11.9	0.7	16.6	2823.4	0.8	0.4	5.5	6.0	0.1	0.6	0.27	0.61	0.15	0.79
56-1	Old tailings pond	Brown material	No < 53 um PSF														
56-2	Old tailings pond	White material	No < 53 um PSF														
57	Calcine sand	DAYLES_01	5868.7	19347.8	0.6	327.2	335.7	4.9	5.3	231.4	13.8	7.1	21.5	5.23	10.54	1.12	4.70
58	Calcine sand	DAYLES_02	5233.1	17737.7	0.5	339.1	379.4	4.5	5.1	220.9	55.9	5.3	3.0	6.55	11.05	1.34	5.55
59	Calcine sand	DAYLES_03	7313.2	23101.8	0.7	316.6	257.3	5.2	5.2	291.9	13.7	9.8	29.2	5.1	9.5	1.1	4.7

Table 7 cont. Metal(loid) Bioaccessibility: < 53 um soil particle size fraction

			Bioaccessibility (%)														
Sample #	**Type**	**Sample ID**	**As**	**Pb**	**Sb**	**Mn**	**Fe**	**Co**	**Ni**	**Zn**	**Sr**	**Cd**	**Ba**	**La**	**Ce**	**Pr**	**Nd**
1	Calcine sand	MARONG_01	35.7	49.4	1.2	10.5	0.5	3.8	1.6	14.3	66.0	21.7	21.8	3.8	3.1	5.1	4.8
2	Calcine sand	MARONG_02	45.6	54.4	2.1	15.9	0.5	2.9	1.7	14.1	61.9	18.3	22.0	7.8	4.6	7.2	6.8
3	Calcine sand	MARONG_03	29.2	83.5	0.6	13.9	0.3	1.6	1.0	25.6	125.8	27.8	21.6	7.7	5.6	7.9	7.3
4	Calcine sand	MARONG_05	35.7	38.4	0.7	20.0	0.3	3.9	1.1	12.4	33.7	19.4	20.0	2.6	2.4	4.1	4.7
5	Calcine sand	MARONG_06	33.3	30.4	0.1	22.4	0.4	3.5	1.1	9.2	63.8	14.6	19.0	2.7	2.7	4.0	3.8
6	Mixed	MCC_01_red	30.4	17.9	0.1	31.8	1.0	22.4	10.6	21.6	63.4	27.4	12.9	22.3	26.1	23.1	23.9
7	Grey sand	MCC_01_top	40.8	63.5	6.0	47.2	6.5	45.0	17.8	35.4	64.2	63.9	8.9	2.9	4.4	3.6	4.9
8	Grey sand	MCC_02	8.1	44.6	1.4	38.2	4.3	34.7	19.9	24.0	57.7	26.9	9.6	2.9	2.1	3.5	3.1
9	Mixed	MCC_02_0.9	23.9	48.6	2.3	37.1	1.2	10.1	5.0	13.5	39.9	38.4	19.9	12.1	11.7	9.6	10.3
10	Grey sand	MCC_03_top	46.8	44.3	8.9	62.3	12.0	56.2	30.7	47.7	67.4	54.8	9.3	2.9	5.0	3.8	5.2
11	Grey sand	MCC_03_0.4	50.0	12.1	10.9	66.0	20.2	57.4	39.9	61.3	80.5	72.3	13.2	3.8	5.2	4.6	6.6
12	Grey sand	MCC_03_0.9	50.3	52.7	11.9	71.8	13.8	70.3	35.4	50.3	69.7	64.9	12.5	2.9	5.3	3.7	5.1
13	Grey sand	MCC_04_top	32.8	51.8	7.7	58.7	9.6	68.0	35.6	48.9	74.9	60.6	10.6	3.0	5.4	3.9	5.4
14	Grey sand	MCC_04_0.9	18.4	51.2	3.5	45.4	7.7	54.6	25.1	36.4	61.9	34.3	5.5	1.5	1.9	3.0	3.5
15	Mixed	CLAY_01	42.0	64.9	2.7	32.4	1.0	13.7	2.8	7.3	31.2	24.5	10.6	3.8	2.9	4.3	4.2
16	Calcine sand	CLAY_02	41.7	51.5	1.3	28.9	0.7	5.2	1.7	6.9	49.1	18.9	19.6	4.5	3.9	5.1	4.5
17	Calcine sand	CLAY_03	48.1	47.1	1.0	29.0	0.7	3.2	1.7	14.9	53.3	23.1	19.1	4.2	3.5	4.9	4.8
18	Calcine sand	CLAY_05	40.4	60.4	14.9	14.2	0.3	4.4	1.5	1.9	82.6	4.7	25.9	5.2	3.6	6.0	5.7
19	Calcine sand	CLAY_07	34.8	54.6	0.8	27.1	0.2	4.5	1.5	5.1	43.5	22.2	29.5	3.8	2.6	3.4	2.6
20	Grey sand	IRON_01	3.3	38.7	2.7	51.2	3.5	47.8	23.8	16.3	61.7	23.6	5.1	0.9	1.1	2.3	2.5
21	Grey sand	IRON_02	3.4	40.7	5.2	75.5	7.1	58.5	46.0	19.9	86.6	49.3	4.1	1.5	2.9	2.4	3.7
22	Grey sand	DEBRA_11	19.6	32.3	6.2	65.7	4.8	48.3	31.4	32.8	61.0	58.8	12.9	2.1	3.7	2.8	3.9
23	Grey sand	DEBRA_12	25.1	37.2	4.8	42.0	9.6	28.6	27.5	45.7	77.5	64.8	11.9	2.5	3.6	3.5	5.1
24	Grey sand	CHUM_27	28.1	58.0	7.7	77.8	9.8	65.0	31.3	32.8	72.3	66.8	27.0	6.9	12.2	8.1	10.3
25	Grey sand	CHUM_28	35.3	56.7	8.9	74.1	12.4	76.1	44.7	53.2	76.0	66.9	11.1	3.8	7.0	5.0	7.3
26	Grey sand	CHUM_28_0.75	40.7	67.7	11.3	68.8	9.1	62.4	33.7	63.2	67.8	70.3	11.6	6.0	17.7	6.9	9.0
27	Grey sand	CHUM_28_0.9		No < 53 um PSF													
28	Grey sand	CHUM_29	14.5	49.2	6.8	78.4	7.6	93.4	50.6	42.3	84.7	63.6	9.2	1.7	2.7	2.9	4.5
29	Grey sand	CHUM_30	18.2	45.3	8.4	70.2	7.6	85.9	38.9	40.4	63.8	61.1	22.4	7.3	10.2	7.0	8.8
30	Grey sand	CHUM_31	18.9	2.7	2.2	61.3	1.3	23.2	18.6	34.3	31.2	21.8	39.9	6.0	5.7	6.2	6.1
31	Grey sand	CHUM_32	31.3	64.3	1.7	48.0	1.7	34.9	11.3	29.4	34.7	65.7	29.8	11.2	13.4	9.8	11.6
32	Grey sand	CHUM_33	22.8	18.1	9.2	33.9	8.1	48.3	41.7	56.7	29.6	72.4	1.2	1.2	1.8	2.2	3.5
33	Grey sand	CHUM_34	4.6	50.5	0.3	27.6	0.5	8.6	1.1	4.3	24.5	21.0	6.9	6.5	7.0	7.3	8.5
34	Grey sand	CHUM_35	27.0	73.8	4.3	39.3	3.0	32.0	18.9	44.2	62.9	62.4	52.0	5.9	5.7	6.5	8.0
35	Grey sand	CHUM_36	26.1	50.9	3.9	43.4	3.1	31.8	11.5	27.8	42.3	62.0	30.1	8.7	10.6	9.3	11.0
36	Grey sand	CHUM_37	49.7	85.1	10.6	64.9	18.6	61.6	31.0	47.0	71.1	61.0	21.0	6.8	7.3	8.7	11.4
37	Grey sand	CHUM_37_0.5	56.7	92.9	12.8	71.3	21.6	70.1	33.6	55.0	77.1	58.9	32.8	7.1	7.9	8.8	11.3
38	Grey sand	CHUM_37_1.2-1.4	66.1	101.7	12.9	75.9	20.9	73.7	36.4	60.6	82.8	71.4	15.5	10.0	9.3	10.3	14.0
39	Mixed	JACKASS_03	12.0	30.5	1.1	8.3	3.0	3.6	2.0	8.9	20.5	28.1	29.5	19.5	26.1	19.9	22.8
40	Calcine sand	JACKASS_06	65.0	35.6	0.2	15.8	0.2	1.4	0.7	24.6	57.2	23.8	19.4	4.3	3.4	5.4	5.6
41	Calcine sand	JACKASS_07	66.0	43.2	0.0	15.4	0.3	1.8	1.1	26.9	65.7	25.7	23.0	5.4	6.0	6.4	6.1
42	Grey sand	WELLS_01	9.7	31.8	3.0	49.4	3.1	45.4	16.6	13.2	66.1	40.1	5.3	1.2	1.5	2.3	3.7
43	Grey sand	PASC_01	7.2	37.4	3.3	52.9	6.6	45.8	26.8	40.9	75.3	58.0	5.9	3.1	3.8	4.7	6.7
44	Grey sand	PASC_02	2.2	41.4	2.2	58.6	5.6	59.2	27.3	16.5	64.4	24.7	21.2	3.9	3.6	5.6	5.4
45	Grey sand	PASC_03	5.3	54.5	2.0	54.2	4.8	57.0	24.9	12.6	64.4	26.6	13.4	8.8	5.8	8.5	7.2
46	Alluvial	BENDCK_01		No < 53 um PSF													
47	Alluvial	BENDCK_02		No < 53 um PSF													
48	Old tailings pond	CHUM_TOW_LOW	21.3	19.0	3.4	14.1	7.8	16.6	6.8	7.3	23.5	28.7	0.2	1.3	2.0	3.8	5.9
49	Grey sand	LEST_01	23.4	53.7	7.4	53.4	6.2	51.8	22.3	30.1	69.7	48.4	13.4	4.1	4.6	5.4	7.3
50	Grey sand	LEST_02	32.4	61.4	18.7	58.1	10.2	72.1	38.6	43.4	75.5	56.3	22.8	4.1	5.0	5.7	8.1
51	Grey sand	LEST_03	45.7	58.2	15.1	48.4	7.1	44.7	25.2	31.2	67.7	53.6	15.3	3.1	3.4	4.6	7.1
52	Grey sand	LEST_04															
53	Grey sand	LEST_05	21.1	18.8	10.0	11.4	2.5	14.3	5.5	13.8	19.5	11.0	1.6	0.8	0.6	1.4	1.9
54	Old tailings pond	CHUM_TOW_01		No soil supplied													
55	Old tailings pond	CHUM_TOW_02		No < 53 um PSF													
56	Old tailings pond	CHUM_TOW_BULK	2.2	0.8	0.6	5.6	1.8	4.7	1.5	1.5	2.6	7.9	0.2	0.3	0.2	0.8	0.8
56-1	Old tailings pond	Brown material		No < 53 um PSF													
56-2	Old tailings pond	White material		No < 53 um PSF													
57	Calcine sand	DAYLES_01	39.0	59.6	0.3	8.2	0.1	3.1	1.2	1.9	37.3	23.9	10.6	8.2	7.0	7.0	6.0
58	Calcine sand	DAYLES_02	39.5	65.3	0.3	9.3	0.1	4.1	1.6	2.0	61.7	25.5	1.3	16.2	12.2	13.3	12.1
59	Calcine sand	DAYLES_03	45.5	57.8	0.3	7.8	0.0	3.7	1.3	1.6	41.3	22.8	16.3	10.0	7.8	9.0	8.0

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CONFIDENTIALITY

We acknowledge the confidential nature of the results of this project and will treat the results and project reports with appropriate confidentiality and security.

APPENDIX 1 - METHODOLOGY

Soil samples

Samples supplied by EPA Victoria were oven-dried at 40°C for 72 hours and sieved to obtain 4 soil particle size fractions; < 2 mm, < 250 µm, <106 µm and < 53 µm. The < 250 µm, <106 µm and < 53 µm soil particle size fractions were used to assess metal(loid) bioaccessibility.

Assessment of total metal(loid) concentration in the < 2 mm, < 250 µm, <106 µm and < 53 µm soil particle size fractions

Total metal(loid) concentration in the < 2 mm, < 250 µm, <106 µm and < 53 µm soil fractions were determined by ICP-MS following soil digestion using USEPA method 3051.

Assessment of As bioaccessibility in the < 250 µm soil particle size fraction

A frequently used assay for the determination of metal(loid) bioaccessibility is the Solubility Bioaccessibility Research Consortium (SBRC) method (Kelly *et al*., 2002). The gastric phase of this method (termed the Relative Bioavailability Leaching Procedure [RBALP] for lead) has been correlated to *in vivo* lead and arsenic relative bioavailability when determined using juvenile swine or mouse in vivo assays (USEPA 2007; Diamond et al. 2016). Contaminated soil and gastric solution (30.03 g l^{-1} glycine adjusted to pH 1.5 with concentrated HCl) were combined in polyethylene screw cap flasks at a soil:solution ratio of 1:100. The pH was noted then the flasks were incubated at 37°C, 40 rpm on a Ratek suspension mixer. After 1 hour incubation, the pH was determined and gastric phase samples (10 ml) were collected, filtered through 0.45 µm filters and analysed by ICP-MS.

QA/QC procedures

Soil digestion efficacy was assessed using NIST SRM 2710a (certified reference values of 1,540 mg As/kg). Quantitative recovery of As following digestion of SRM 2710a was 107.5 ± 3.5% (103.3-114.0%; n = 8). During replicate soil analysis, the average difference in total As concentration was 6.8% (0.0-30.1%; n = 48) while duplicate analysis resulted in an average difference of 0.8% (0.0-2.7%; n = 16) between samples. Arsenic bioaccessibility in SoFC-1 (150.8 ± 7.3 mg/kg) was within an acceptable range for this reference material (148.5 ± 1.6 mg/kg). During replicate bioaccessibility analysis, the average difference in As bioaccessibility was 5.6% (0.2-22.8%; n = 20) while duplicate analysis resulted in an average difference of 1.9% (0.2-5.4%; n = 10) between samples. During ICP-MS analysis, check values and spiked samples were run every 20 samples. The average deviation of check samples was <10% while spiked sample recoveries were within 30% of added values.

APPENDIX 2 – SAMPLE LIST

EPA Victoria Mine Waste Soil Sample List

Sample #	Sample ID	Type	Lat	Long	A (< 2 mm)	B (< 250 um)	C (< 106 um)	D (< 53 um)
1	MARONG_01	Calcine sand	36.7614655	144.2412122				
2	MARONG_02	Calcine sand	-36.7617438	144.2407773				
3	MARONG_03	Calcine sand	-36.7617846	144.2407136				
4	MARONG_05	Calcine sand	-36.762144	144.2401105				
5	MARONG_06	Calcine sand	-36.761711	144.2399318				
6	MCC_01_red	Mixed	-36.7230115	144.2422844				
7	MCC_01_top	Grey sand	-36.7230115	144.2422844				
8	MCC_02	Grey sand	-36.7227253	144.2412984				
9	MCC_02_0.9	Mixed	-36.7227253	144.2412984				
10	MCC_03_top	Grey sand	-36.7236643	144.2403187				
11	MCC_03_0.4	Grey sand	-36.7236643	144.2403187				
12	MCC_03_0.9	Grey sand	-36.7236643	144.2403187				
13	MCC_04_top	Grey sand	-36.7232131	144.2401219				
14	MCC_04_0.9	Grey sand	-36.7232131	144.2401219				
15	CLAY_01	Mixed	-36.7546454	144.2371698				
16	CLAY_02	Calcine sand	-36.7548724	144.2367064				
17	CLAY_03	Calcine sand	-36.757757	144.2363356				
18	CLAY_05	Calcine sand	-36.7542745	144.2379902				
19	CLAY_07	Calcine sand	-36.7539964	144.2380572				
20	IRON_01	Grey sand	-36.755857	144.257149				
21	IRON_02	Grey sand	-36.755101	144.25658				
22	DEBRA_11	Grey sand	-36.7169664	144.242441				
23	DEBRA_12	Grey sand	-36.7165678	144.24245				
24	CHUM_27	Grey sand	-36.7647969	144.2619688				
25	CHUM_28	Grey sand	-36.7650145	144.2632643				
26	CHUM_28_0.75	Grey sand	-36.7650145	144.2632643				
27	CHUM_28_0.9	Grey sand	-36.7650145	144.2632643				No sample
28	CHUM_29	Grey sand	-36.7645619	144.2635889				
29	CHUM_30	Grey sand	-36.764668	144.2624533				
30	CHUM_31	Grey sand	-36.763997	144.2623447				
31	CHUM_32	Grey sand	-36.7636989	144.2619296				
32	CHUM_33	Grey sand	-36.762978	144.2609003				
33	CHUM_34	Grey sand	-36.7625891	144.2595153				
34	CHUM_35	Grey sand	-36.7623731	144.2593195				
35	CHUM_36	Grey sand	-36.7636291	144.2602448				
36	CHUM_37	Grey sand	-36.7646073	144.2626571				
37	CHUM_37_0.5	Grey sand	-36.7646073	144.2626571				
38	CHUM_37_1.2-1.4	Grey sand	-36.7646073	144.2626571				
39	JACKASS_03	Mixed	-36.7245393	144.2807533				
40	JACKASS_06	Calcine sand	-36.7240937	144.2808395				
41	JACKASS_07	Calcine sand	-36.7237387	144.2805669				
42	WELLS_01	Grey sand	-36.754819	144.253956				
43	PASC_01	Grey sand	-36.7413664	144.249461				
44	PASC_02	Grey sand	-36.7402552	144.2500216				
45	PASC_03	Grey sand	-36.7411407	144.2502915				
46	BENDCK_01		36°43'36.24"S	144°18'12.66"E				No sample
47	BENDCK_02		36°43'36.24"S	144°18'12.66"E				No sample
48	CHUM_TOW_LOW	Old tailings pond	-36.763024	144.26088				
49	LEST_01	Grey sand	-36.7110774	144.242214				
50	LEST_02	Grey sand	-36.7113362	144.428034				
51	LEST_03	Grey sand	-36.7118625	144.2426482				
52	LEST_04	Grey sand	-36.7121651	144.2418291				No sample
53	LEST_05	Grey sand	-36.7102746	144.2403693				
54	CHUM_TOW_01	Old tailings pond	-36.763024	144.26088	Only 1 rock present (no soil)			
55	CHUM_TOW_02	Old tailings pond	-36.763024	144.26088	Very small sample. Only one particle size generated			
56	CHUM_TOW_BULK	Old tailings pond	-36.763024	144.26088				
56-1	Brown material	Old tailings pond	-36.763024	144.26088				No sample
56-2	White material	Old tailings pond	-36.763024	144.26088				No sample
57	DAYLES_01	Calcine sand	-37.32775	144.14126				
58	DAYLES_02	Calcine sand	-37.32775	144.14126				
59	DAYLES_03	Calcine sand	-37.32775	144.14126				
60	DAYLES_04		-37.32775	144.14126	No sample supplied			

Appendix E – Data tables

Appendix C Table 1: Summary of Arsenic (As) concentrations (mg/kg), bioaccessibilities (%) and bioaccessible concentrations (mg/kg) related to mine waste type and particle size fraction.

Arsenic	Mine waste type	Particle size fraction	Mean	±SE	Min	Median	Max	CV
Concentration (mg/kg)	Alluvial	53 µm	NA	NA	NA	NA	NA	NA
	Alluvial	106 µm	67	8	60	67	75	16%
	Alluvial	250 µm	37	3	34	37	39	10%
	Alluvial	2 mm	34	2	33	34	36	6%
	Calcine sand	53 µm	14,670	1,335	4,756	15,256	20,715	34%
	Calcine sand	106 µm	12,567	998	5,723	12,643	17,841	30%
	Calcine sand	250 µm	11,357	859	5,471	11,504	15,560	28%
	Calcine sand	2 mm	10,520	940	4,663	10,780	15,994	33%
	Grey sand	53 µm	4,620	1,423	251	2,433	47,069	177%
	Grey sand	106 µm	2,846	778	154	1,839	27,590	162%
	Grey sand	250 µm	1,823	522	137	1,266	18,867	169%
	Grey sand	2 mm	1,322	326	126	936	11,585	146%
	Mixed	53 µm	674	208	369	521	128	62%
	Mixed	106 µm	665	243	230	534	136	73%
	Mixed	250 µm	466	181	192	342	987	78%
	Mixed	2 mm	447	180	189	321	956	81%
	Old tailings pond	53 µm	29,953	25,316	4,637	29,953	55,270	120%
	Old tailings pond	106 µm	95,806	60,383	3,813	53,396	272,617	126%
	Old tailings pond	250 µm	61,907	46,393	3,162	22,086	200,293	150%
	Old tailings pond	2 mm	72,276	43,844	2,799	16,156	231,679	136%
Bioaccessibility (%)	Alluvial	53 µm	NA	NA	NA	NA	NA	NA
	Alluvial	106 µm	10	5	5	10	15	72%
	Alluvial	250 µm	10	0	10	10	11	5%
	Calcine sand	53 µm	43	3	29	40	66	26%
	Calcine sand	106 µm	43	3	30	40	68	24%
	Calcine sand	250 µm	45	3	32	41	75	25%
	Grey sand	53 µm	27	3	2	25	66	64%
	Grey sand	106 µm	29	3	4	25	64	60%
	Grey sand	250 µm	31	3	3	31	68	59%
	Mixed	53 µm	27	6	12	27	42	46%
	Mixed	106 µm	21	6	9	21	36	53%
	Mixed	250 µm	26	8	6	26	46	63%
	Old tailings pond	53 µm	12	10	2	12	21	115%
	Old tailings pond	106 µm	7	5	1	2	21	147%
	Old tailings pond	250 µm	6	4	1	3	19	126%
Bioacc. Conc. (mg/kg)	Alluvial	53 µm	NA	NA	NA	NA	NA	NA
	Alluvial	106 µm	7	4	3	7	11	83%
	Alluvial	250 µm	4	0	3	4	4	15%
	Calcine sand	53 µm	6,169	580	1,655	6,380	10,045	35%
	Calcine sand	106 µm	5,445	537	1,711	5,478	9,172	37%
	Calcine sand	250 µm	5,167	519	1,961	4,767	8,393	38%
	Grey sand	53 µm	1,155	285	22	647	8,913	142%
	Grey sand	106 µm	908	240	15	520	8,155	156%
	Grey sand	250 µm	694	200	11	356	6,898	171%
	Mixed	53 µm	210	111	69	115	540	106%
	Mixed	106 µm	169	105	50	71	484	125%
	Mixed	250 µm	149	101	27	59	451	136%
	Old tailings pond	53 µm	1,094	107	987	1,094	1,201	14%
	Old tailings pond	106 µm	1,484	532	799	1,034	3,069	72%
	Old tailings pond	250 µm	1,033	400	535	688	2,221	77%

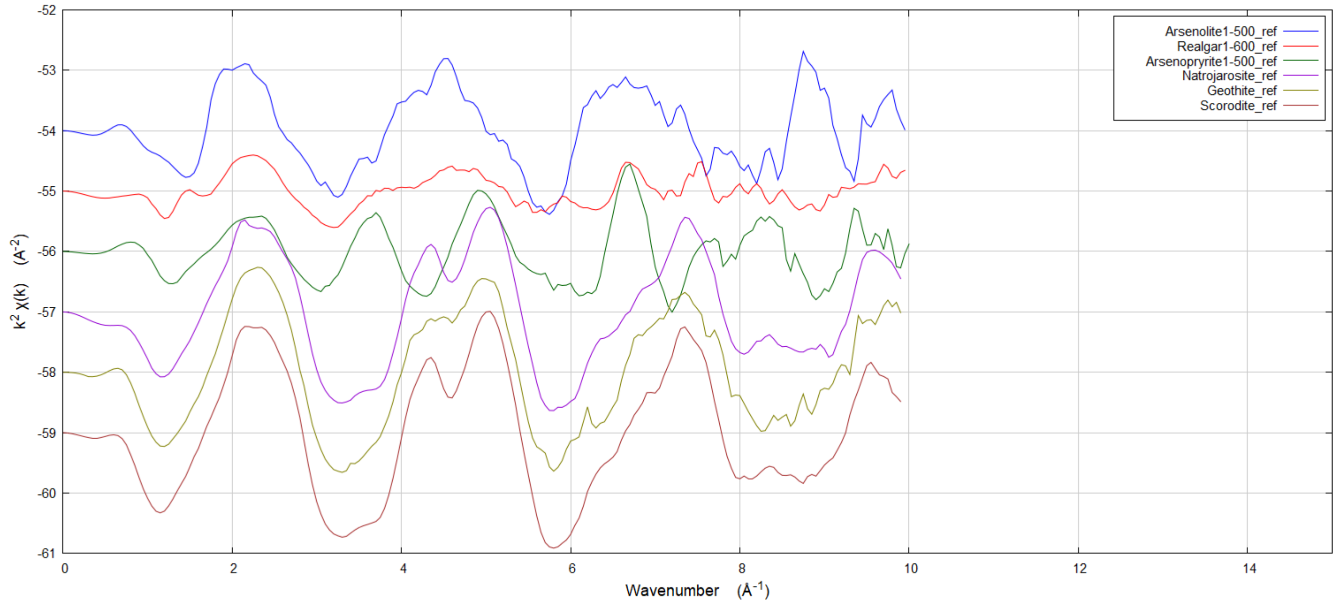
Appendix C Table 2: XANES Linear combination fitting results.

Sample ID	Particle size fraction (<)	Mine waste type	r^2	chi^2	Arsenate		Arsenite						Arsenic sorbed to iron oxides			
					Scorodite		Arsenolite		Realgar		Arsenopyrite		Geothite		Natrojarosite	
					weight	error	weight	error	weight	error	weight	error	weight	error	weight	error
CHUM_27	106 µm	grey	0.004752	0.47297	89%	1%	6%	1%			5%	1%				
CHUM_27	2 mm	grey	0.005043	0.52173	91%	1%	6%	1%			1%	1%				
CHUM_27	250 µm	grey	0.003215	0.31432	87%	0%	5%	1%			5%	1%				
CHUM_27	53 µm	grey	0.00425	0.38937	86%	0%	5%	1%			4%	1%				
CHUM_28_0.75	250 µm	grey	0.001526	0.14333	78%	2%	4%	1%			5%	1%			9%	2%
CHUM_28_0.9	250 µm	grey	0.000972	0.10047	91%	0%	4%	1%	2%	1%						
CHUM_28	250 µm	grey	0.004268	0.2829	49%	2%	2%	1%			23%	1%			22%	3%
CHUM_31	250 µm	grey	0.003132	0.30069	76%	2%	7%	1%							13%	3%
CHUM_33	250 µm	grey	0.003191	0.35065	93%	0%	5%	0%								
CHUM_36	250 µm	grey	0.005508	0.62032	94%	1%	4%	1%								
CHUM_37_0.5	250 µm	grey	0.004256	0.43435	90%	1%	5%	1%			3%	1%				
CHUM_TOW_02	2 mm	pond	0.006141	0.43794									6%	2%	88%	2%
CHUM_TOW_BROWN	250 µm	pond	0.001289	0.1169	55%	1%	2%	0%							39%	2%
CHUM_TOW_LOW	250 µm	pond	0.000546	0.05719	59%	2%							21%	1%	16%	1%
CLAY_01	250 µm	mix	0.003499	0.38067	93%	0%	5%	1%								
CLAY_02	250 µm	calcined	0.005533	0.58586	71%	3%	6%	1%							25%	4%
CLAY_05	250 µm	calcined	0.002918	0.34235									68%	2%	37%	2%
DEBRA_11	250 µm	grey	0.004589	0.45758	87%	1%	7%	1%			3%	1%				
DEBRA_12	250 µm	grey	0.002922	0.27683	86%	0%	3%	1%			8%	1%				
IRON_01	250 µm	grey	0.004553	0.52254	96%	1%	3%	1%								
IRON_02	250 µm	grey	0.004537	0.46363	88%	1%	2%	1%	9%	1%						
JACKASS_03	250 µm	mix	0.002201	0.22317	83%	3%	11%	0%					3%	3%		
JACKASS_06	250 µm	calcined	0.003761	0.39833	16%	4%							24%	3%	65%	3%
JACKASS_07	250 µm	calcined	0.004008	0.43251	77%	3%	1%	1%							22%	3%
LEST_01	250 µm	grey	0.003749	0.31372	77%	0%	1%	1%			21%	1%				
LEST_02	250 µm	grey	0.004698	0.37978	75%	0%	1%	1%			20%	1%				
LEST_03	106 µm	grey	0.005093	0.50818	87%	1%	4%	1%			9%	1%				
LEST_03	2 mm	grey	0.005375	0.56326	91%	1%	5%	1%								
LEST_03	250 µm	grey	0.006524	0.71489	92%	1%	6%	1%								
LEST_03	53 µm	grey	0.006158	0.65463	91%	1%	6%	1%			2%	1%				
LEST_05	250 µm	grey	0.00254	0.25369	89%	0%	1%	1%			7%	1%				
MARONG_01	250 µm	calcined	0.005417	0.44993	48%	3%	2%	1%							41%	3%
MARONG_03	250 µm	calcined	0.006774	0.81855									74%	3%	31%	3%
MARONG_06	250 µm	calcined	0.004405	0.43643									22%	2%	83%	2%
MCC_01_RED	250 µm	mix	0.005947	0.65238	92%	1%	6%	1%								
MCC_01_TOP	250 µm	grey	0.005055	0.49866	87%	1%	7%	1%			3%	1%				
MCC_03_0.4	250 µm	grey	0.005864	0.50712	67%	3%	4%	1%			9%	1%			17%	4%
MCC_03_0.9	250 µm	grey	0.004931	0.44358	82%	1%	5%	1%			10%	1%				
MCC_03_TOP	106 µm	grey	0.005309	0.41318	72%	3%	3%	1%			17%	1%			5%	3%
MCC_03_TOP	2 mm	grey	0.004934	0.48906	91%	1%	4%	1%								
MCC_03_TOP	53 µm	grey	0.005316	0.47212	76%	3%	4%	1%			12%	1%			6%	4%

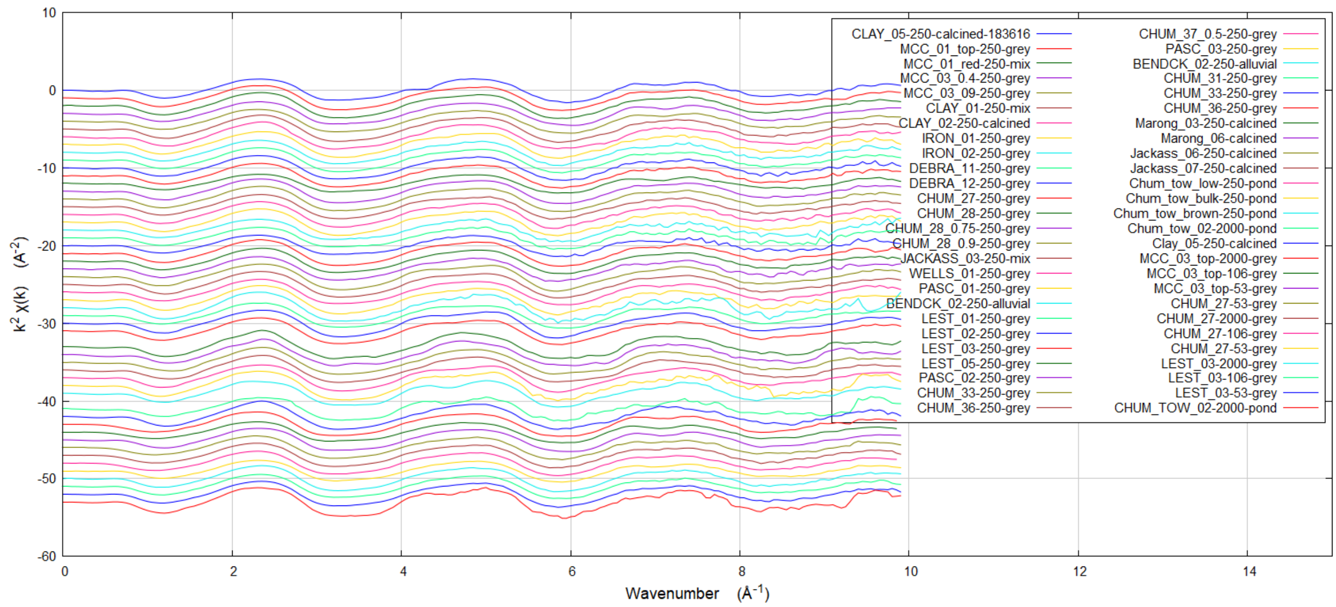
Sample ID	Particle size fraction (<)	Mine waste type	r^2	chi^2	**Arsenate**		**Arsenite**						**Arsenic sorbed to iron oxides**			
					Scorodite		**Arsenolite**		**Realgar**		**Arsenopyrite**		**Geothite**		**Natrojarosite**	
					weight	**error**	**weight**	**error**	**weight**	**error**	**weight**	**error**	**weight**	**error**	**weight**	**error**
PASC_01	250 µm	grey	0.003432	0.40753	98%	0%	0%	1%								
PASC_02	250 µm	grey	0.00156	0.16372	66%	2%			7%	2%	0%	2%	25%	2%		
PASC_03	250 µm	grey	0.00825	1.11475	75%	7%							29%	6%		
WELLS_01	250 µm	grey	0.002367	0.25941	94%	0%	3%	0%								

Appendix F – Synchrotron XANES scans

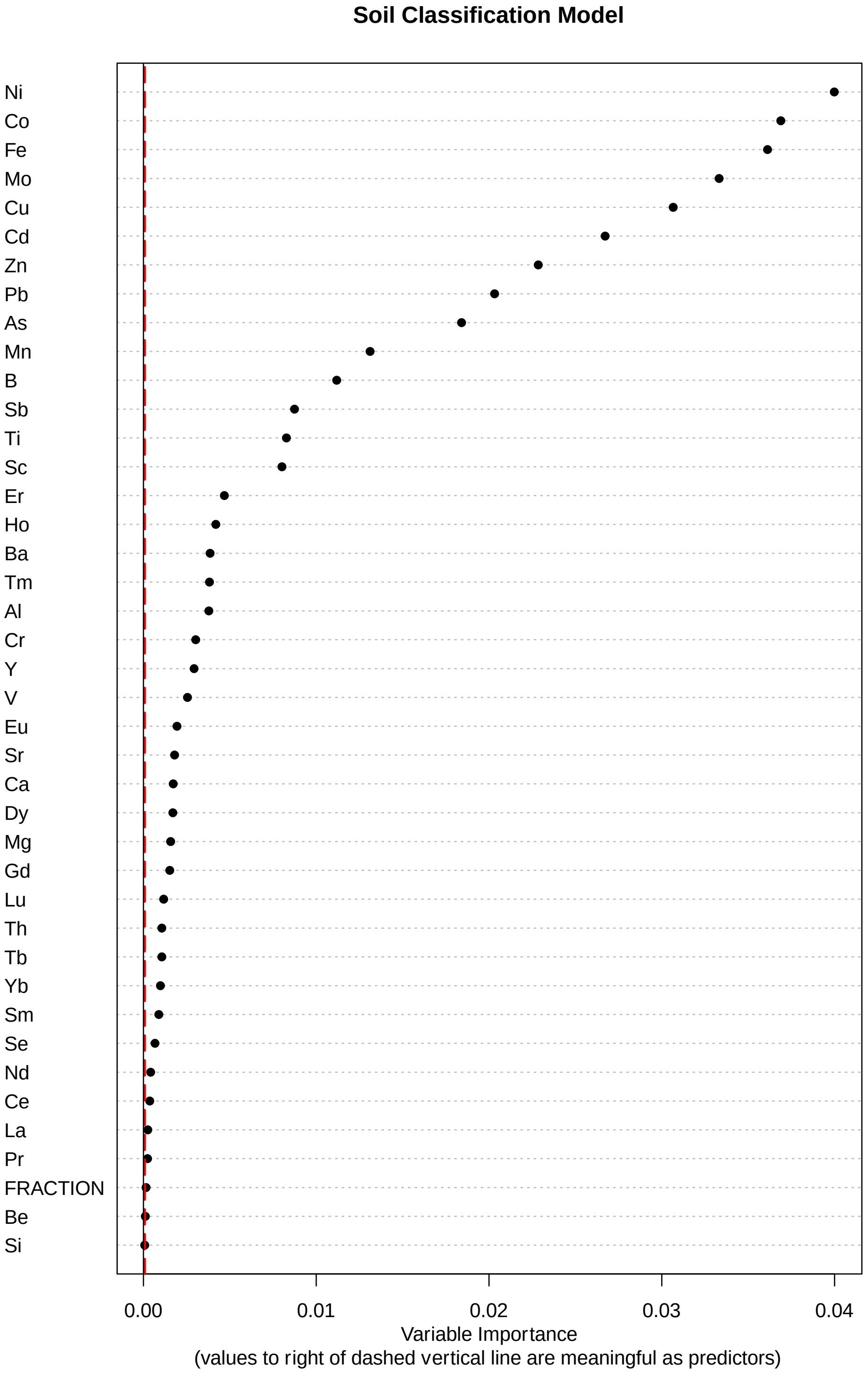
Appendix E – Figure 1: Reference mineral XANES scans



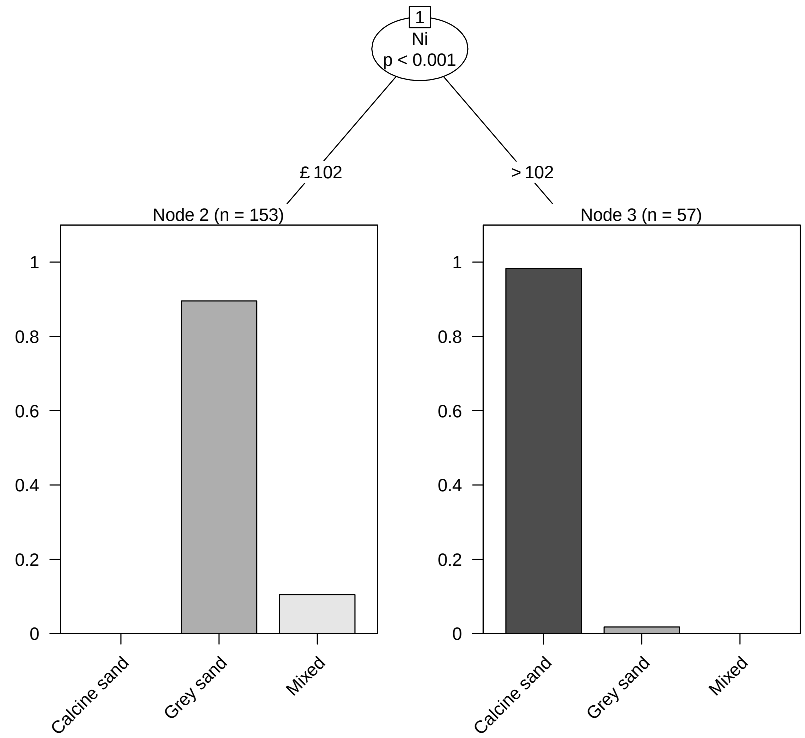
Appendix E – Figure 2: Sample XANES scans



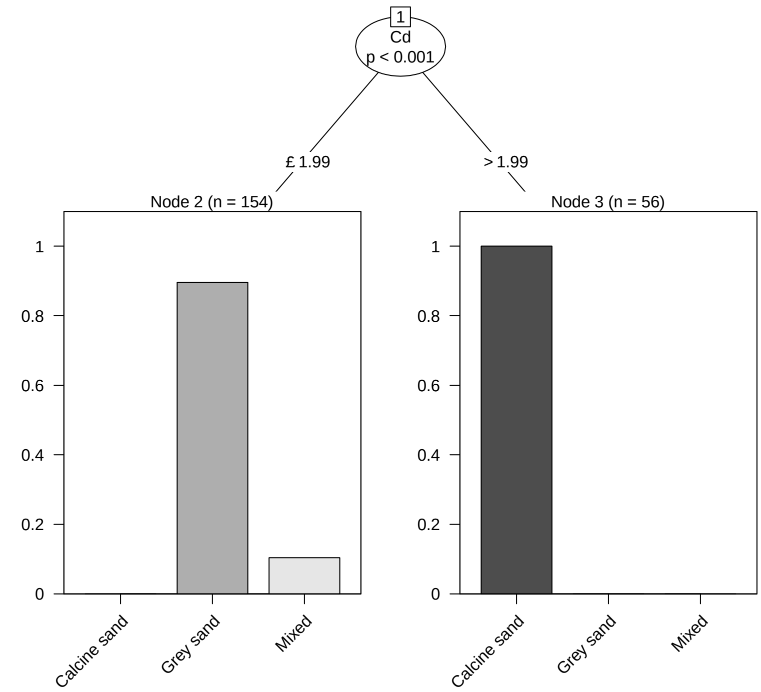
Appendix G – Random Forests analysis results



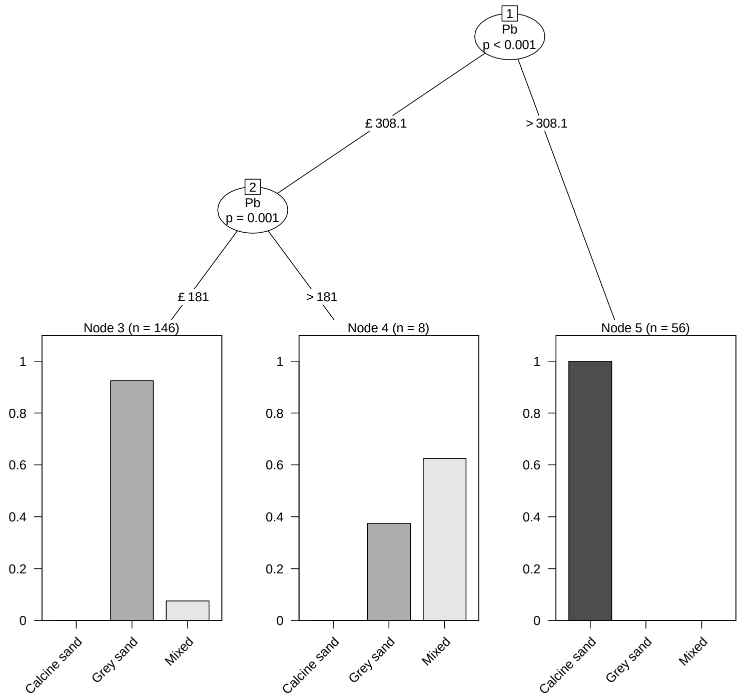
Appendix F Figure 1: Random forests analysis of the 39 elements and size fraction as predictors of soil type. Size fraction was included in case of interactive effects. Elements non-detected are not shown Variables to the right of the red dashed line may be meaningful for predicting the soil type. The farther to the right, the better the predictor. The best predictors were nickel (Ni), cobalt (Co), iron (Fe), molybdenum (Mo), and copper (Cu).



Appendix F Figure 2: Conditional inference tree showing diagnostic splits in soil types for Nickel (Ni) concentrations.



Appendix F Figure 3. Conditional inference tree showing diagnostic splits in soil types for Cadmium (Cd) concentrations.



Appendix F Figure 4. Conditional inference tree showing diagnostic splits in soil types for Lead (Pb) concentration

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