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Dear Dominique

XRF SURVEY OF THAMES KINDERGARTEN

1.0 Introduction

Waikato Regional Council (WRC) has engaged Pattle Delamore Partners Limited (PDP) to undertake an x-ray fluorescence (XRF) survey of Thames Kindergarten to identify the concentration of trace elements in surface soils at this site. WRC, on request from the Ministry of Education, has commissioned this work because elevated concentrations of arsenic (and in some other cases antimony, lead and thallium) were found in surface soils on the roadside verges near the Thames Early Childhood Education Centre and Moanataiari School.

The aim of this investigation was to use a screening method (XRF) to identify areas of low, medium and high trace element concentrations (particularly arsenic) to assist with the prioritisation of sites for further investigation.

2.0 Methodology

To determine the concentration of trace elements, an XRF instrument was used to test the surface soils. All XRF measurements were undertaken by a licensed XRF operator.

The XRF measurements were not undertaken in accordance with US EPA protocol 6200. Rationale for this is because the purpose of this investigation was only to identity areas of high trace element concentrations from areas of low trace element concentrations. Specifically, measurements were taken in-situ rather than being collected and sieved through a minus 2 mm sieve and dried before XRF measurements were undertaken. The consequence of the methodology undertaken is that the in-situ soils will likely have higher moisture content than laboratory analysed samples and may have included material greater than 2 mm (i.e. gravels). Furthermore, higher moisture content of the in-situ soils and the presence of gravels in the sample may result in the XRF measurements being slightly reduced. Thus the results provided should be regarded as only indicative of the concentration of target elements in the soils.

A total of five XRF measurements were carried out by PDP and were taken from the front grassed play area of the Kindergarten on 29 November 2011.

Figure I1 shows all XRF measurement locations with arsenic readings.

As discussed above, the XRF is only a field screening tool and due to the methodology used (compared with the standard methodology), there is a higher level of measurement uncertainty (greater than 30%). Results obtained should therefore not been compared to any New Zealand (or where applicable International) soil guidelines or standards for human health assessments to assess compliance or non-compliance with the soil guideline or standard. To assess both potential health risks; and compliance with any applicable soil guideline value or standard for human health protection, soil sampling will need to be undertaken and sent to an IANZ accredited laboratory for analysis.

The XRF measurement locations were recorded using a GPS (x-y positional RMS error less than 10 m). GPS locations were obtained so that any sampling site could be revisited should further sampling be required (for example, an area with elevated arsenic concentrations (known as a hotspot[1]).

A small hole 0.1m in diameter was dug to a depth of approximately 0.1m to expose the soil below the root zone of the grass. The portable XRF instrument was placed on the exposed soil to ensure that the X-ray window was in full contact with the soil. XRF readings were taken for a minimum 90 seconds. The X-ray window was cleaned between sampling locations in accordance with the XRF manufacturer's Manual.

3.0 Results

For the trace elements which were reliably detected by the XRF (arsenic, copper, chromium, iron, lead, manganese and zinc) only arsenic and lead were found to exceed New Zealand (or where applicable international) soil guidelines or standards for human health assessments. The concentrations of arsenic and lead have therefore only been compiled and discussed in this report (see Table I1). An electronic copy of the full multi-element analysis has been provided to Waikato Regional Council (WRC file reference DM2093695) and is not included in this report.

The XRF data collected during this survey was from one area of distinct use, based on soil type and likely exposure scenario. The single area of distinct use was the front grassed play area of the kindergarten (tkg01 to tkg05).

3.1 Traffic Light Assessment

The aim of this work is to assess the site as either a low, medium or high priority area for further investigation. For child care centres, the term 'further investigation' may include the possibility of developing a site specific soil contaminant standard. To present these results, a 'traffic light" assessment tool has been developed to rank the sample locations. The traffic light system is based upon the likelihood that the average concentration, obtained from XRF measurements for a given assessment area, is likely to exceed Soil Contaminant Standard (SCS) values based on the 'Methodology for Deriving Standards for Contaminants in Soil to Protect Human Health (MfE, 2011).

MfE, 2011 does not provide a specific standard for schools or childcare centres. Thus, for the purposes of carrying out a first "screening" comparison it has been assumed that one of the standard guideline scenarios is valid for this investigation. For example, a residential value has been used for a childcare centre or primary school. A residential value is anticipated to provide a conservative analysis because it assumes more frequent exposure to soil than the exposure that is likely to occur at a school or childcare centre (seven days per week for most weeks in a year rather than the maximum five days per week at a school or childcare centre). This assumption also includes a greater allowance for exposure to home-grown produce than is likely to occur even if a school has a vegetable garden. Similarly, the recreational guideline value has been used for a secondary school playing field (MfE, 2011) on the basis that human contact with the soil of the playing field is more appropriate to recreational use than residential use.

[1] For the purpose of this report a hotspot is any value which; is either more than three times the SCS or when the average of the site exceeds the SCS; or any value which is more than 3.5 times the average concentration of that exposure area.

3.1.1 Green: Low Priority for Further Investigation

A sample that represents a "green status" indicates that the results obtained by XRF suggest that arsenic concentrations are likely to be low, and if soil samples were analysed by the conventional method, they would be likely to fall below the SCS for recreational areas (parks) (for secondary schools) or the standard for residential soils (primary schools).

3.1.2 Orange: Medium Priority for Further Investigation

An "orange status" is assigned to a sample location when results by XRF suggest that arsenic concentrations are moderately elevated for that land use, and may equal or marginally exceed the SCS for recreational areas (for secondary schools) or the SCS for residential areas (primary schools). Due to the measurement uncertainty of the XRF method used in this investigation, 'moderately elevated' is defined by the average of readings that appear to exceed the nominated standard by up to 20 mg/kg – i.e. up to 40 mg/kg for a primary school and up to 100 mg/kg for a secondary school.

3.1.3 Red: High priority for Further Investigation

A "red status" is given when indicative results by XRF suggest that either:

- Average arsenic concentrations across all samples from a school are likely to be a multiple of the SCS; and
- One or more 'hot spot' sites are located on the school where samples are likely to be a multiple of the SCS.

4.0 Discussion

The results obtained from this investigation have been compiled together into one area of distinct use (see Section 3.0). The average arsenic and lead concentrations for this area of distinct use have then been calculated. When concentrations of arsenic or lead were below the instrumental detection limit then the value of the published detection limit (9 mg/kg for arsenic and 13 mg/kg for lead) has been used to calculate the average concentration of that element in soils. The interpretation of the area of distinct use is discussed below.

4.1 The Grassed Area

The concentrations of arsenic in three of the samples collected from the grassed area were lower than the XRF instrument's detection limit (approximately 9 mg/kg). The average arsenic and lead concentrations measured over the five XRF samples was 16 mg/kg (ranging from below the limit of detection (9 mg/kg) to 40 mg/kg) and 40 mg/kg (ranging from below the limit of detection (13 mg/kg) to 111 mg/kg) respectively. Four samples showed very low levels of arsenic, with just one sample of tkg01 (40 mg/kg) being above the residential standard of 20 mg/kg. The average concentration of lead was lower than the SCS for lead in residential soils of 210 mg/kg. For these reasons, a very conservative approach has been taken and an **Orange light** has been assigned.

5.0 Conclusion

An XRF survey of the front grassed play area of Thames Kindergarten was undertaken in November 2011. The survey found that the front grassed play area is a low to medium priority for further investigations (orange light).

6.0 References

MfE, 2011. *Methodology for Deriving Standards for Contaminants in Soil to Protect Human Health* Office of the Minister for the Environment.

Yours faithfully

PATTLE DELAMORE PARTNERS LIMITED

Georgina Chase

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Director

Table I1: X-Ray Fluoresence (XRF) Raw Data Thames Kindergarten				
Location	**Sample**	**Units**	**Arsenic (As)**	**Lead (Pb)**
Grassed area	tkg01	ppm	40	111
	tkg02	ppm	10	37
	tkg03	ppm	9	13
	tkh04	ppm	9	21
	tkh05	ppm	9	20
Statisitical Analysis of Raw XRF Data from Thames Kindergarten				
Location	**Statistic**	**Units**	**Arsenic (As)**	**Lead (Pb)**
Grassed area	COUNT		5	5
	AVERAGE	ppm	16	40
	MIN	ppm	<LOD	<LOD
	MAX	ppm	40	111

Notes:

Measurement below the level of measurement of the XRF. The value is set as equal to the estimated detection limit.

Count = number of samples

<LOD = below limit of detection

SOURCE: AERIAL IMAGERY SUPPLIED BY THAMES–COROMANDEL DISTRICT COUNCIL.
CADASTRAL INFORMATION DERIVED FROM LINZ DATA.

FIGURE I1 : THAMES KINDERGARTEN XRF SAMPLING LOCATIONS WITH ARSENIC RESULTS