IWIK TRUST

SOIL CONTAMINATION PRELIMINARY & DETAILED SITE INVESTIGATION REPORT OF 21A MANUKA STREET, CASTLECLIFF, WANGANUI.

Project Reference: 15383
28 February 2019

Table of Contents

Executive Summary

A contamination preliminary and detailed site investigation (PSI & DSI) has been conducted for the site legally described as Lot 1 DP 3943, Lot 2 DP 3943, Lot 3 DP 3943, Lot 4 DP 3943, Part Lot 2 B 166, and Part Lot 2 B 166 and located on 21a Manuka Street, Castlecliff, Whanganui.

The objectives of the assessment were to identify any potential sources of contamination from past and present land use activities at the site and surrounding area, to determine the contamination status of soils at the site, and to subsequently assess compliance with the National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health in regards to the proposed change of land use (from recreational to residential) at the site.

The investigation comprised a PSI (i.e. site history review) and DSI (i.e. intrusive soil sampling investigation). The site has been used as a bowling green for the past 100 years therefore soil sampling was carried out to quantify the level of contamination in the soil (if any) resulting from persistent pesticide use.

All contaminant concentrations in the soil samples were below MfE's soil contaminant standards for a '*Residential 10% produce'* land use scenario applicable to the proposed change of land use at the site.

Due to the presence of arsenic above typical background concentrations as well as detections of OCPs (albeit below concentrations applicable to '*residential 10% produce*' land use), a resource consent is required under the NES for the subdivision from the Whanganui District Council for a 'controlled activity' if the proposed development were to proceed.

1 Introduction

Land Development & Exploration (LDE) Ltd has been engaged by IWIK Trust to undertake a combined soil contamination Preliminary and Detailed Site Investigation (PSI and DSI) of the site legally described as as Lot 1 DP 3943, Lot 2 DP 3943, Lot 3 DP 3943, Lot 4 DP 3943, Part Lot 2 B 166, and Part Lot 2 B 166 and located on 21a Manuka Street, Castlecliff, Whanganui and herein referred to as '*the site'.*

The PSI will identify if there were any historical or current activities that could have caused soil to become contaminated. This will be useful to identify potential risks associated with future use of the property. The PSI will also identify if the National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health (NES) applies to the site and whether the investigation would need to accompany the consent application for the proposed change of land use under the NES.

This investigation has been carried out in general accordance with the *Contaminated Land Management Guidelines No.1- Reporting on Contaminated Sites in New Zealand* (Revised 2011) and *Contaminated Land Management Guidelines No.5: Site Investigation and Analysis of Soils (revised 2011).*

The two-part investigation included a PSI and a DSI. The PSI included a review of available historic photographs showing the site, site-specific council records, and a walkover/inspection of the site. The DSI component of the investigation included the collection and analysis of soil samples taken at the site.

The objectives of the investigation were to:

- Identify any potential sources of contamination from past and present land use activities at the site which are listed on the Ministry for the Environment's (MfE) Hazardous Activities and Industries List (HAIL) (MfE, 2011),
- Assess compliance with the soil contaminant standards for a *'Residential 10% produce'* land use scenario,
- Assess applicability with the NES for the change of land use at the site.

2 Site Details & Setting

2.1 Proposed Site Development

Our client is proposing to develop the site changing the landuse from a bowling green into residential lifestyle village concept with up to 12 units in total. No subdivision scheme plan is currently available at this early stage.

2.2 Site Identification and Zoning

The site is approximately 6kms to the west of Whanaganui City (Figure 1 below) and is zoned '*Reserve'* in the Whanganui District Plan.

Figure 1: Annotated location map showing the site. Source: WDC GIS

2.3 Site Description and Current Land Use

The site is located to the north of Manuka Street, Whanganui, approximately 6km to the west of Whanganui city centre and comprises approximately 4000m^2. The site is surrounded by residential properties.

The site comprises flat topography, including a clubhouse, various sheds and two large bowling greens. The ground cover at the site is generally grass with concrete pathways and the clubhouse comprising the remainder of the site. Refer to Figure 2 showing a recent aerial image with the legal boundaries for the site and surrounding area.

Figure 2: Site location shown by the red border. Source WDC GIS District Plan (annotated image).

2.4 Geology

The New Zealand Geology Web Map by GNS[1] science identifies the site as being underlain by 'Qls1 (Holocene) stable dune deposits.

2.5 Hydrology

The Whanganui River is the nearest body of water from the site and is located approximately 700m southwest of the site.

3 Preliminary Site Investigation

A PSI was undertaken to identify potential past or present HAIL activities, or potential contaminants at the site.

The following information was reviewed to establish the history of the site:

- Search of Council records.
- Historical aerial photographs.

[1]GNS Science New Zealand Geology Web Map: http://data.gns.cri.nz/geology/. Retrieved Feb 2019.

3.1 Search of Council Records

A review of the property file did not show any issues related to contamination.

3.2 Historic Aerial Imagery

Aerial images from 1960 to 2017 have been analysed as part of this investigation. A summary of our review of these images is shown below.

1960 Photograph: This is the earliest available image of the site which shows one of the greens in place with part of the current clubhouse also present. The remainder of the site is vacant comprising vegetation.

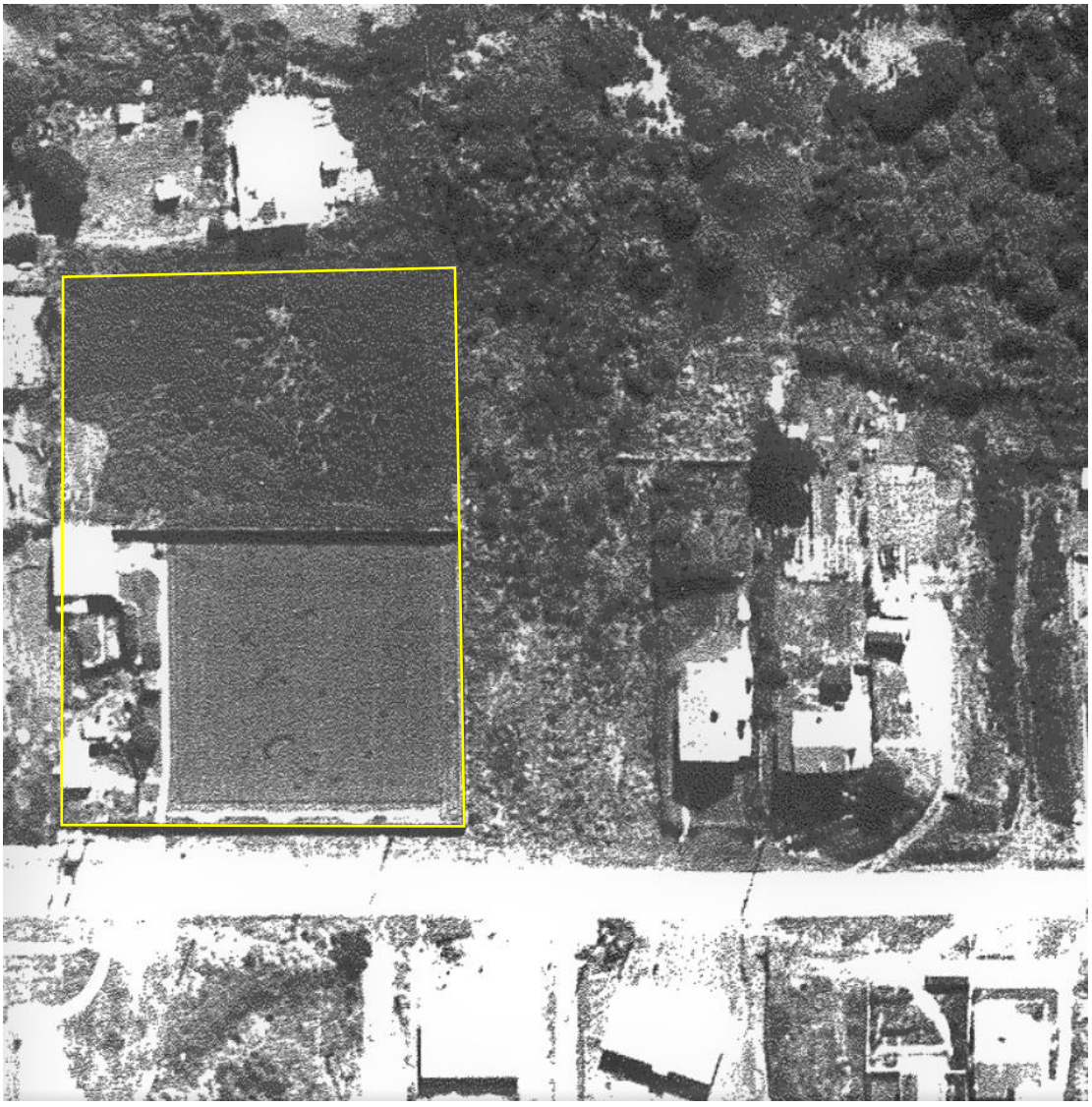


Figure 3: 1960 aerial photograph (source: Whanganui District Council)

1968 Photograph: This is the earliest available image of the site which shows one of the greens in place with part of the current clubhouse also present at the south of the site. The remainder of the site is vacant.

Figure 4: 1968 aerial photograph (source: Whanganui District Council)

2005, Photograph: Both greens are present, and the clubhouse is in the present day state as well the addition of the groundsman and implement shed.

Figure 5: 2005 aerial photograph (source: Google Earth)

2017 Photograph: No changes identified.

Figure 6: 2018 aerial photograph (source: Google Earth)

4 Site Walkover Assessment

A walkover assessment was undertaken at the site on 28 January 2019. Refer to Figures 7 to 9.

The site comprises flat topography, including a clubhouse, various sheds and two large bowling greens. The ground cover at the site is generally the grassed greens with concrete pathways and the clubhouse comprising the remainder of the site.

All sheds including the Groundsman's shed are situated on concrete slabs (not bare earth). We understand that historically, while the site was used as a bowling club, sprays used in the upkeep of the greens would have been stored here.

No asbestos roofing or structures were noted.

Figure 7: Photograph taken facing southwest across the greens towards the clubhouse and groundsman shed (right).

Figure 8: Photograph showing the clubhouse and greens to the right.

Figure 9: Soil sampling of the greens.

5 Conceptual Site Model

The potential effects of the proposed activity of the site from contaminated soils are outlined in a preliminary site Conceptual Site Model (CSM) in Figure 10. The following is an analysis of potential contaminants, receptors and pathways.

5.1 Hazardous Substances and Potential Contaminants of Concern

Hazardous substances may potentially exist at the site because of past activities.

- Heavy metals, mercury, and / or organochlorine pesticides (OCPs) as a result of past sprays used on the greens.

5.2 Potential Receptors

Potential receptors include:

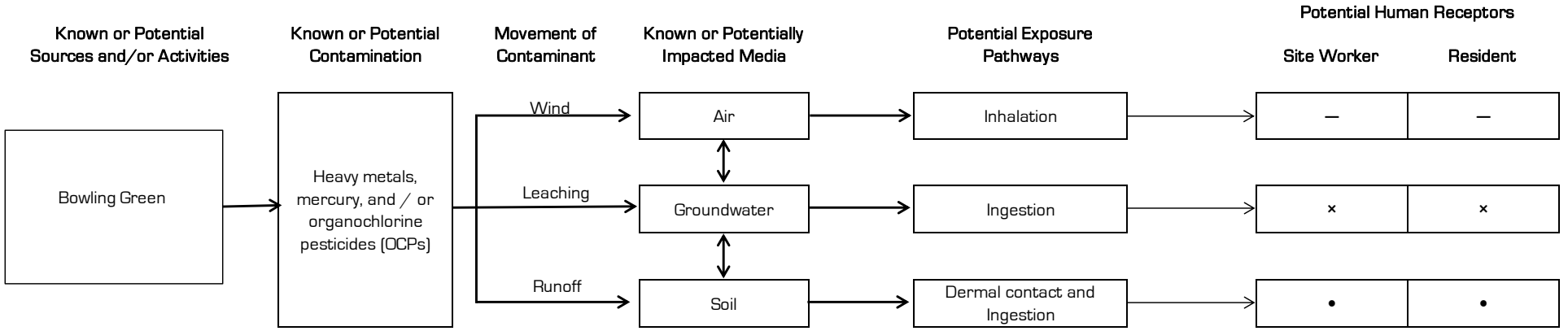
- Future users of the site such as property owners/residents;
- Excavation and construction workers during redevelopment of the Site.

5.3 Exposure Pathways

A human health risk can only occur where there is a complete pathway between contaminant sources and a receptor. Building floors, paved areas and grass will largely or completely

prevent contact with soil and therefore direct exposure pathways are or will be incomplete for such areas. Potential complete pathways are:

- Direct contact (dermal) with soil;
- Direct contact and inhalation of dusts and soil during construction and ongoing site maintenance and/or subsurface maintenance works.



LEGEND:

—	Pathway is not complete, no evaluation required
×	Pathway is or may be complete, but is judged to be minor or unlikely. Quantitative data collection not required.
•	Pathway is or may be complete, collect quantitative data.

Figure 10: Conceptual Site Model at the PSI stage.

6 PSI Conclusions

The PSI identified that the part of site has been used as a bowling green for the past 100 years and the remainder was vacant land before being converted into a bowling green also. Therefore, it is highly likely that persistent pesticide use has occurred on the site as part of the general upkeep of the greens.

We therefore consider that **HAIL A10:** *'Persistent pesticide bulk storage or use including sport turfs, market gardens, orchards, glasshouses or spray sheds'* has more likely than not to have occurred at the site.

LDE considers that the NES applies under Regulation 5(6) due to the proposed change of land use at the site. As HAIL A10 has been identified to have possibly occurred, occurred or is occurring on the site, a Detailed Site Investigation (including specific site sampling) was therefore required to establish any actual human health risks associated with future land use at the site.

7 Detailed Site Investigation

Based on the findings of the PSI, further investigation was required to establish if contamination is present at the site. Our investigation was designed to establish if the site soil exhibit contaminant concentrations exceeding the soils contaminant standards applicable to residential land use scenario, and to determine the type of consent that will be required for the proposed change of land use at the site.

7.1 Contaminants of Concern

Potential contamination sources identified in the PSI are associated with pesticide use on the greens. Heavy metals, mercury, and organochlorine pesticides (OCPs) may have been used as part of the bowling green spray program.

7.2 Field Investigation

The field investigation was undertaken on 28 January 2019 by an LDE environmental scientist.

The sample locations were selected to represent the contaminant status of the two greens including the different soil strata at depth. Discrete surface samples (S1 0-100 – S6 0-100) were collected at depths of 0 to 0.1m below ground level (bgl)representing the topsoil layer, subsurface sample (S5 100-200) was collected at depths of 0.1m to 0.2m bgl representing

the orange clay layer, and subsurface sample (S6 200-300) was collected 0.2 to 0.3m bgl representing the underlying natural sand layer (see sampling plan Figure 11)

At each soil sample location, samples were collected using a pre-cleaned spade and hand trowel. The equipment was cleaned using water and a plant-based cleaning product and were dried between samples to prevent cross contamination.

All samples were placed into labelled jars supplied by Analytica Laboratories. Following collection, the samples were sent with chain of custody documentation on to Analytica Laboratories located in Hamilton for analysis. The Chain of Custody documentation is attached in Appendix A.

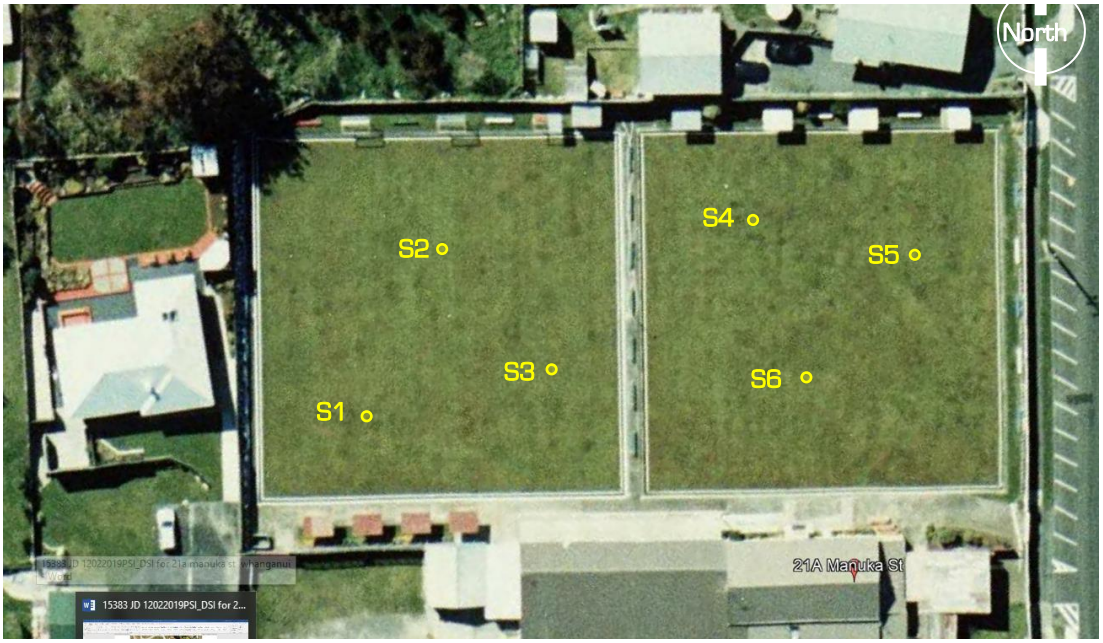


Figure 11: Soil sampling site plan. Approximate soil sample locations shown in yellow.

7.3 Exposure Scenario

Based on the conceptual site model and taking into consideration the methodology for deriving soil contaminant standards (SCS) and the proposed development of the site, a '*Residential 10% produce'* land use is applicable to the site.

7.4 Selected Soil Contaminant Standards and Guideline Values

The NES references the *Methodology for Deriving Standards for Contaminants in Soil to Protect Human Health* (MfE, 2011) with regard to establishing a national risk-based methodology for deriving soil contaminant concentrations protective of human health.

Following the guidance, the Soil Contaminant Standards (SCS) for selected priority contaminants for non- priority contaminants guidelines values were selected following the Contaminated Land Management Guidelines No. 2: Hierarchy and Application in New Zealand of Environmental Guideline Values (Revised 2011) as screening criteria for the risk to humans at the site and to inform on-site management actions. If exceeded, further investigation and a Tier 2 assessment would be considered.

No applicable New Zealand guideline criteria exist for some of the tested metals (i.e. nickel and zinc) and therefore Health Investigation Level (HIL) values form the Australian Guideline on the Investigation Levels for Soil and Groundwater have been used under the residential land use scenario as outlined in the MfE document.

The soil samples were tested at the laboratory for total chromium. However, the Methodology document distinguishes between the stable chromium III and the potentially toxic and less stable chromium VI. For the purposes of this analysis all total chromium results have been conservatively compared to the chromium VI.

We note that there is no database for natural background concentrations of trace elements in soils for Whanganui.

7.5 Soil Sample Results

Table 1 summarises the laboratory results for soils tested for metals heavy metals, mercury and OCP. All concentrations were below the respective SCSs for a '*residential 10% produce'* land use. However, we consider that soil sample S5 is slightly above background levels for arsenic and samples S4 and S5 have slightly elevated lead concentrations. Sample S6 (200-300mm) indicates that trace contaminants are confined to the upper soils. The full lab results are included in Appendix B.

Table 1: laboratory tests (heavy metal suite, mercury and OCP) compared against the soil contaminant standards (SCS) for a 'residential' land use.

Sample Name	Depth	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn	DDT (total)	Dieldrin
S1	0-100mm	3.35	0.28	17.8	18.6	0.087	9.31	13.9	82.7	-	-
S2	0-100mm	3.92	0.29	17.3	32.7	0.1	10.2	17.6	128	-	-
S3	0-100mm	3.32	0.38	16.4	19.1	0.077	8.86	15	85.3	-	-
S4	0-100mm	8.94	0.42	18.7	20.2	0.068	9.35	45.8	89.4	-	-
S5	0-100mm	8.47	0.43	18.1	20	0.076	9.39	48.2	88	-	-
S6	0-100mm	8.82	0.38	17.7	19.3	0.068	9.43	48.5	84.8	-	-
S5	100-200mm	12.3	0.21	20.5	17	0.05	9.5	49.6	95.3	-	-
S6	200-300mm	2.36	0.046	13.1	10.3	<0.025	7	6.22	58.6	-	-
Composite (S1-S3)	0-100mm	-	-	-	-	-	-	-	-	0.14	0.14
Composite (S4-S6)	0-100mm	-	-	-	-	-	-	-	-	0.31	0.13
SCS		20	3	460	NL[5]	310	400[4]	210	7400[4]	70	2.6
Background[6]		12	0.65	125	90	0.45	320	65	1160	-	-

1. All results, standard values and background concentrations are presented in mg/kg

2. All metals tested for 'Total Recoverable' at screen level
3. Methodology for Deriving Soil Guideline Values Protective of Human Health (MfE, 2011)
4. 'Residential A' values - Guideline on the Investigation Levels for Soil and Groundwater (NEPC, 2013)
5. NL – 'No Limit'. Derived value exceeds 10,000 mg/kg.

8 Conclusions

MfE HAIL A10 was identified at the site during the PSI Phase of the investigation. Potential contamination sources identified in the PSI are associated with possible pesticide use on the greens. Heavy metals, mercury, and organochlorine pesticides may have been used as part of the green spray program. Soil sampling and analysis was undertaken as part of the DSI phase to identify if this land use activity has contributed to soil contamination that would be unacceptable for the proposed land use.

The testing indicates that no soil is present at the site that exceeds soil contaminant standards applicable to residential land use and no further testing is considered necessary.

9 Recommendations

Based on the findings of the preliminary and detailed site investigations we consider that the proposed development on the piece of land is suitable.

The test results show that no soil is present at the site that exceeds soil contaminant standards applicable to residential (10% produce) land use.

This indicates that the use of persistent pesticides on the greens has had limited impact on the site. The soil contaminant concentration of soil sample S5 (being slightly above typical background concentrations for arsenic, as well as slightly elevated levels of lead and trace level detections of OCPs), signifies possible impacts (albeit minor) resulting from applications of horticultural chemicals containing lead, arsenic and OCPs.

Because a change of land use will occur at the site from recreational (bowling green) to residential (lifestyle village) Regulation 5(6) of the NES (2011) applies to the site. Due to the presence of arsenic above typical background concentrations as well as detections of OCPs (albeit below concentrations applicable to '*residential 10% produce*' land use), the proposed activity would therefore be considered a "Controlled activity" under Regulation 9 of the NES.

Any soil being disposed offsite will need to be disposed at a managed fill (Class B) landfill as it does not meet cleanfill status.

This report shall be submitted to the Whanganui District Council.

10 Report Limitations

This investigation presents a preliminary and detailed site investigations of the potential for ground contamination, prepared exclusively for IWIK Trust with respect to the particular brief given to us.

Information, opinions and recommendations contained in it cannot be used for any other purpose or by any other entity without our review and written consent. Land Development & Exploration Ltd accepts no liability or responsibility whatsoever for or in respect of any use or reliance upon this report by any third party.

Opinions given in this report are based on a review of existing data, evidence gathered during a site walkover, anecdotal information and specific soil sampling at discrete locations. There is still some possibility that contaminating activities have taken place or contamination at the site is in excess of that described in this report and we should be contacted immediately if the conditions are suspected to differ from that described.

For and on behalf of LDE Ltd

Report prepared by:

Jeff Davenport
Senior Environmental Scientist (SQEP)

Report authorised by:

Georg Winkler
MIPENZ, CPEng
Principal Engineering Geologist-Geotechnical Engineer

\\LDE-App01\Projects\15300 to 15399\15383 21a manuka st whanganui\Report\15383 JD 12022019PSI_DSI for 21a manuka st whanganui.docx

APPENDIX A: CHAIN OF CUSTODY

0635531445

19-02432

ENVIRONMENTAL TESTING:
CHAIN OF CUSTODY

ANALYTICA LABORATORIES

CLIENT INFORMATION		Lab ID (Lab use only)	19-02432	Registered By	MA	Date Registered	31/1/19
Client	LDE	Customer Comments/Instructions					
Address							
Project Leader	Jeff D						
Project ID	15383						
Site	Manuka St						
Sampler	JD						
Phone	022120120	221210120					
Email							
Invoice Email							

- HM's (8 suite). (8 tests).
- OCP's (2 tests only).
extra sample S2 100-200
Hold Cold as pe Jeff MA
31/1/19

CLIENT REQUESTS (Please Tick)									
Routine		Priority		Urgent		ESDAT		QC Report	

TESTS REQUESTED

	Sample ID	Depth	Sampling Date	Time	Matrix (Please Circle)	Analysis Requests/Suites [Enter Test Code Below]					Sample Comments (ie: extra test requests, high odour, bulk material)
1	S1 1	0-100	29.1	12m	S	Hm }					
2	S2 2	"	"	"	"	Hm } OCP					OCP 3pt composite
3	S3 3	"	"	"	"	Hm }					
4											
5	S4 4	0-100	"	"	"	Hm }					
6	S5 5	"	"	"	"	Hm } OCP					OCP 3pt composite
7	S6 6	"	"	"	"	Hm }					
8											
9	S5 7	100-200	"	"	"	Hm	XXXX				Keep on ice after test
10											
11	S6 8	200-300	"	"	"	Hm	XXXX				Keep on ice after test.
12											Scall me if this is an issue.
13	S2 9	100-200			HOLD COLD						
14											
15											
16											
17											
18											
19											

Matrix Key	S (Solids)	CW (Clean Water)	SW (Saline Water)	WW (Waste Water)
	All soils, sediment, sludge	Potable, Ground, Bore, Surface, Fresh	Sea Water, Geothermal	Effluent, Trade Waste, Leachate

Sender Name	Jeff Davonport	Received by (Lab Staff)		Courier company		Courier #			
Date Sent		Time sent		Date Received		Time Received		Seal Status		Sample Chilled	

Page _____ of _____

Analytica Laboratories Ltd
Ruakura Research Centre
10 Bisley Road, Private Bag 3123
Hamilton 3240, New Zealand
Phone +64 7 974 4740
Email enviro.reception@analytica.co.nz
analytica.co.nz

APPENDIX B: NES SEARCH OF COUNCIL RECORDS

ANALYTICA LABORATORIES

Analytica Laboratories Limited
Ruakura Research Centre
10 Bisley Road
Hamilton 3214, New Zealand
Ph +64 (07) 974 4740
sales@analytica.co.nz
www.analytica.co.nz

Certificate of Analysis

Land Development & Exploration
28 Constellation Drive
Auckland
Attention: Jeff Davenport
Phone: 022 1210120
Email: j.davenport@lde.co.nz

Lab Reference: 19-02432
Submitted by: JD
Date Received: 31/01/2019
Date Completed: 4/02/2019
Order Number:
Reference: 15383

Sampling Site: Manuka St

Report Comments

Samples were collected by yourselves (or your agent) and analysed as received at Analytica Laboratories. Samples were in acceptable condition unless otherwise noted on this report.

Heavy Metals in Soil

Client Sample ID			S1 0-100	S2 0-100	S3 0-100	S4 0-100	S5 0-100
Date Sampled							
Analyte	Unit	*Reporting Limit*	19-02432-1	19-02432-2	19-02432-3	19-02432-4	19-02432-5
Arsenic	mg/kg dry wt	*0.125*	3.35	3.92	3.32	8.94	8.47
Cadmium	mg/kg dry wt	*0.005*	0.28	0.29	0.38	0.42	0.43
Chromium	mg/kg dry wt	*0.125*	17.8	17.3	16.4	18.7	18.1
Copper	mg/kg dry wt	*0.075*	18.6	32.7	19.1	20.2	20.0
Lead	mg/kg dry wt	*0.05*	13.9	17.6	15.0	45.8	48.2
Mercury	mg/kg dry wt	*0.025*	0.087	0.10	0.077	0.068	0.076
Nickel	mg/kg dry wt	*0.05*	9.31	10.2	8.86	9.35	9.39
Zinc	mg/kg dry wt	*0.05*	82.7	128	85.3	89.4	88.0

Heavy Metals in Soil

Client Sample ID			S6 0-100	S5 100-200	S6 200-300
Date Sampled					
Analyte	Unit	*Reporting Limit*	19-02432-6	19-02432-7	19-02432-8
Arsenic	mg/kg dry wt	*0.125*	8.82	12.3	2.36
Cadmium	mg/kg dry wt	*0.005*	0.38	0.21	0.046
Chromium	mg/kg dry wt	*0.125*	17.7	20.5	13.1
Copper	mg/kg dry wt	*0.075*	19.3	17.0	10.3
Lead	mg/kg dry wt	*0.05*	48.5	49.6	6.22
Mercury	mg/kg dry wt	*0.025*	0.068	0.050	<0.025
Nickel	mg/kg dry wt	*0.05*	9.43	9.50	7.00
Zinc	mg/kg dry wt	*0.05*	84.8	95.3	58.6

IANZ ACCREDITED LABORATORY

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

Report ID 19-02432-[R00] **Page** 1 of 2 **Report Date** 4/02/2019

Organochlorine Pesticides - Soil

	Client Sample ID		Composite S1-S3	Composite S4-S6
	Date Sampled			
Analyte	Unit	*Reporting Limit*	19-02432-10	19-02432-11
2,4'-DDD	mg/kg dry wt	*0.005*	<0.005	0.007
2,4'-DDE	mg/kg dry wt	*0.005*	<0.005	<0.005
2,4'-DDT	mg/kg dry wt	*0.005*	0.015	0.036
4,4'-DDD	mg/kg dry wt	*0.003*	0.006	0.017
4,4'-DDE	mg/kg dry wt	*0.005*	0.103	0.199
4,4'-DDT	mg/kg dry wt	*0.005*	0.015	0.046
Total DDT	mg/kg dry wt	*0.02*	0.14	0.31
alpha-BHC	mg/kg dry wt	*0.005*	<0.005	<0.005
Aldrin	mg/kg dry wt	*0.005*	<0.005	<0.005
beta-BHC	mg/kg dry wt	*0.005*	<0.005	<0.005
cis-Chlordane	mg/kg dry wt	*0.005*	<0.005	<0.005
cis-Nonachlor	mg/kg dry wt	*0.01*	<0.01	<0.01
delta-BHC	mg/kg dry wt	*0.005*	<0.005	<0.005
Dieldrin	mg/kg dry wt	*0.05*	0.14	0.13
Endosulfan I	mg/kg dry wt	*0.005*	<0.005	<0.005
Endosulfan II	mg/kg dry wt	*0.01*	<0.01	<0.01
Endosulfan sulphate	mg/kg dry wt	*0.005*	0.008	0.020
Endrin	mg/kg dry wt	*0.05*	<0.05	<0.05
Endrin aldehyde	mg/kg dry wt	*0.01*	<0.01	<0.01
Endrin ketone	mg/kg dry wt	*0.005*	<0.005	<0.005
gamma-BHC	mg/kg dry wt	*0.005*	<0.005	<0.005
Heptachlor	mg/kg dry wt	*0.005*	<0.005	<0.005
Heptachlor epoxide	mg/kg dry wt	*0.005*	<0.005	<0.005
Hexachlorobenzene	mg/kg dry wt	*0.005*	<0.005	<0.005
Methoxychlor	mg/kg dry wt	*0.01*	<0.01	<0.01
trans-nonachlor	mg/kg dry wt	*0.01*	<0.01	<0.01
trans-Chlordane	mg/kg dry wt	*0.01*	<0.01	<0.01
Chlordane (sum)	mg/kg dry wt	*0.02*	<0.020	<0.020
TCMX (Surrogate)	%	*1*	102.4	106.3

Method Summary

Elements in Soil	Acid digestion followed by ICP-MS analysis. (US EPA method 200.8). Results are based on a dried sample passed through a 2 mm sieve.
OCP in Soil	Samples are extracted with hexane, pre-concetrated then analysed by GC-MSMS.(In-house procedure). (Chlordane (sum) is calculated from the main actives in technical Chlordane: Chlordane, Nonachlor and Heptachlor)
Total DDT	Sum of DDT, DDD and DDE (4,4' and 2,4 isomers)

Sharelle Frank, B.Sc. (Tech)
Technologist

Nathan Howse, B.Sc.
Senior Technician

Tom Featonby, M.Sc.
Technologist