Detailed Site Investigation

Maitahi Subdivision
7 Ralphine Way, Nelson

CCKV MAITAI DEV CO LP

December 2021

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Quality Assurance

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EXECUTIVE SUMMARY

Envirolink Limited (Envirolink) has been engaged by CCKV MAITAI DEV CO LP (the client) to produce a Detailed Site Investigation (DSI) for the property at 7 Ralphine Way, Nelson (the site). The site is a farm, currently stocking cattle, which is intended to be subdivided and developed as part of a large residential development. The proposed development includes standard residential lots, high-density residential properties, and reserve areas. Kaka Stream is intended to be redirected through an existing woolshed area.

The site appears on Nelson City Council's (NCC) HAIL[1] register as a result of the historical undertaking of livestock treatment. It is also understood that hop farming has historically been undertaken in the Maitai Valley and therefore part of the site may have been used for horticulture. The National Environmental Standard (NESCS) for Assessing and Managing Contaminants in Soil to Protect Human Health[2] requires a site investigation to be undertaken where certain hazardous activities and industries can be associated with the site.

The site has operated as a farm since the earliest available aerial photograph. A woolshed and associated sheep pens are present in much the same configuration as in the 1940s photograph and sheep treatment infrastructure has been observed on site. While no horticulture was noted in any aerial photographs, anecdotal evidence suggests that hops were grown at the site. A site investigation was undertaken to assess potential impacts from the identified HAIL activities historically undertaken in the area.

The investigation targeted the woolshed area as well the paddocks south of the woolshed, which are considered a likely location for hops to have been grown. No samples collected from the paddocks (excepting the samples associated with sheep exiting the treatment area) contained concentrations of contaminants above human health standards and soil from this area appears to be classifiable as cleanfill for disposal purposes.

The former sheep treatment area shows significant impact from arsenic and dieldrin with several samples containing concentrations above human health standards for recreational usage and ecological screening levels. As such, soil contamination in this area poses a potential risk to human health and ecological receptors given the proposal to reroute Kaka Stream through this area. Remediation and management will be required to mitigate these potential risks. It is considered likely that remediation measures taken to minimise human health risk will appropriately address potential ecological risks, in particular the removal of the most heavily contaminated soil around the treatment area.

As a "piece of land", the site will require a NESCS resource consent for subdivision, change of use, and/or soil disturbance. Due to the exceedance of NESCS standards in the area, the activity would likely be considered a restricted discretionary activity. A likely condition of a resource consent would be the preparation of a remediation action plan (RAP). The RAP should be prepared by a suitably qualified and experienced practitioner – contaminated land (SQEP). The RAP will provide a methodology to reduce potential risks posed to human health and environmental receptors to acceptable levels.

[1] Ministry for the Environment (MfE), 2011. Hazardous Activities and Industries List (HAIL).
[2] Resource Management (National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health) Regulations 2011.

Remedial options are highly dependent on the proposed development as the capping of contaminated soil may not be appropriate in the vicinity of watercourses. Some options that may be applicable to the development are:

- The excavation of soil exceeding human health standards; and
  - Off-site disposal and/or
  - Management in another part of the development (such as a recreational reserve) away from watercourses.
- Capping of soil exceeding human health standards with "clean" cover soil.
- Solidification and stabilisation of contaminated soil to prevent leaching and reduce bioavailability.
- The redesign of the development to minimise disturbance of contaminated soils.

If excavations of greater than 1 m depth are required, groundwater may be intercepted and require dewatering. Water pumped from excavations may require additional treatment to addressed dissolved-phase contaminants.

Appropriate soil management will be required to avoid cross-contamination of "clean" soil. It appears that the majority of the site has contaminant concentrations at background levels. The contamination of these areas as a result of soil mixing or management of soil from contaminated areas, may result in future planning constraints.

The remediation objectives and methodologies will be detailed in the RAP following discussions with the client and NCC.

To facilitate the residential development, we recommend to:

- Obtain a resource consent under the NESCS for the required works;
- Undertake additional site assessment to close the relevant data gaps and reduce cost uncertainties, as needed;
- Determine the most appropriate remediation methodology based on client and council requirements;
- Produce a RAP for council approval; and
- Undertaken earthworks in accordance with the RAP and resource consent conditions.

Further information may be required to better understand areas and media impacted to assist in managing development costs and constraints. Discussions should be held prior to scoping to determine the client's objectives regarding risk management.

1.0 INTRODUCTION

Envirolink Limited (Envirolink) has been engaged by CCKV MAITAI DEV CO LP (the client) to produce a Detailed Site Investigation (DSI) for the property at 7 Ralphine Way, Nelson (the site). The site is a farm, currently stocking cattle, which is intended to be subdivided and developed as part of a large residential development.

The proposed development includes standard residential lots, high-density residential properties, and reserve areas. Kaka Stream is intended to be redirected through the existing woolshed area.

The site appears on Nelson City Council's (NCC) HAIL[3] register as a result of the historical undertaking of livestock treatment. It is also understood that hop farming has historically been undertaken in the Maitai Valley and that part of the site may have been used for horticulture.

The National Environmental Standard (NESCS) for Assessing and Managing Contaminants in Soil to Protect Human Health[4] requires a site investigation to be undertaken on properties that are undergoing a subdivision, a change of land use or significant land disturbance on a potentially contaminated site. Before the local council can authorise such activities an assessment of the site must be undertaken. The land use history of the site is assessed against the HAIL. The HAIL is a list of activities and industries that have the potential to contaminate soil. The investigation will indicate whether the site is fit for the proposed purpose or if additional information is required.

This report assesses potentially contaminative historical usage of the property in the context of the NESCS and is intended to support a resource consent application.

[3] Ministry for the Environment (MfE), 2011. Hazardous Activities and Industries List.
[4] Resource Management (National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health) Regulations 2011.

2.0 OBJECTIVES AND SCOPE OF WORK

The objectives of this DSI are to:

- Identify potential historical and/or current sources of contamination within the site and immediate surrounding area;
- Identify potential contaminants of concern;
- Determine if an activity or industry described in the Hazardous Activities and Industries List is being undertaken, has been undertaken, or is more likely than not to have been undertaken on the site;
- If so, assess the likelihood of human health being at risk if the proposed activity is undertaken; and
- Provide sufficient information to determine if a consent under the NESCS is required.

The following scope was undertaken to achieve the above objectives:

- Desk-based review of available information including:
    - Regional geological and hydrological setting;
    - Historical aerial photography (available from NCC, Retrolens, and Land Information New Zealand (LINZ)); and
    - Any other relevant documents provided to Envirolink by the client.
- Site walkover/inspection;
- Collection and lab analysis of shallow soil samples in accordance with CLMG No. 5[5];
- Production of a conceptual site model to facilitate risk assessment;
- Production of this DSI report summarising the above and consistent with the requirements of CLMG No. 1[6].

The results and recommendations included in this investigation will accompany any resource or building consent applications that are required for future development and provide a reference to contractors and maintenance workers working on the property.

[5] The Ministry for the Environment, 2021. Contaminated Land Management Guidelines (CLMG) No. 5 – Site Investigation and Analysis of Soils.
[6] The Ministry for the Environment, 2021. Contaminated Land Management Guidelines (CLMG) No. 1 – Reporting on Contaminated Sites in New Zealand.

3.0 SITE CONDITIONS AND SURROUNDING ENVIRONMENT

3.1 Site Identification and Setting

Site address:	7 Ralphine Way, Maitai Valley
Locality:	Nelson 7010
Owner:	CCKV MAITAI DEV CO LP
Legal description:	Part Section 11 Brook Street and Maitai DIST
Site area:	Approx. 43.7 hectares
Map reference:	Latitude: -41.268176 Longitude: 173.310475

Seven Ralphine Way is located on the northern side of the Maitai River and Valley, approximately 2 km east of Nelson's central business district. While the site is indented to be redeveloped as a large residential subdivision, it is currently used as a cattle farm. The location and layout of the site are shown in Figures 1 and 2. Proposed development plans are presented in Appendix A.

Figure 1 - Site Location

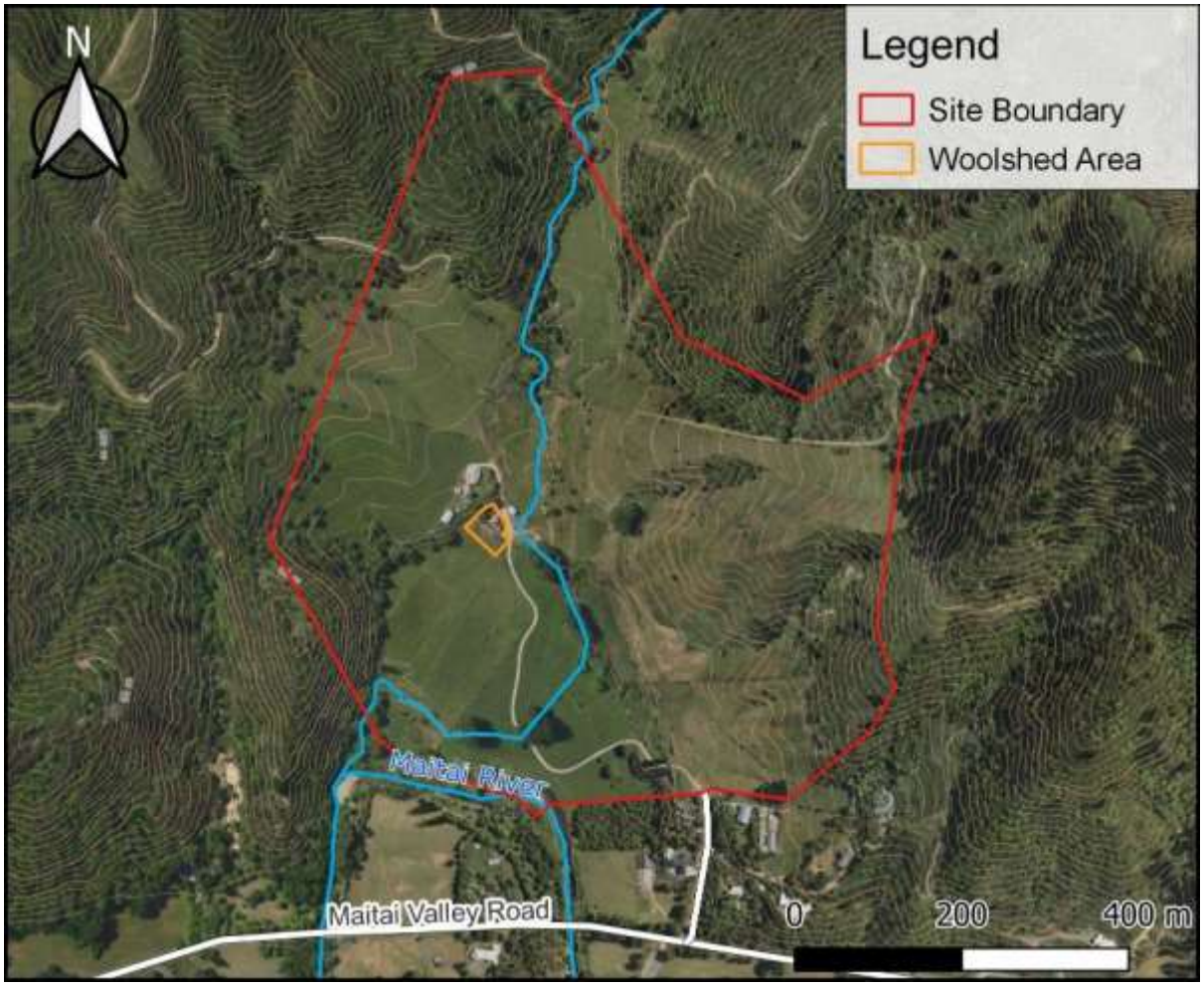

Figure 2 - Site Layout

As much of the property is steep hillside and is unlikely to have been used intensively in the past, this investigation focusses on the lower part of the property around the woolshed which was identified on NCC's HAIL register.

The site is currently zoned as *Rural - Higher Density Small Holdings Area* under the Nelson Resource Management Plan (NRMP). Adjacent properties are zoned as *Rural.* It is understood that the site is part of a current NRMP change application[7].

3.2 Site Description

Site investigations were carried out on 6 October and 3 November 2021. Selected photos are presented in Appendix B for reference.

The higher parts of the site are grazing land and vegetated hillside. The central part of the site contains the former woolshed, an implement shed and smaller auxiliary buildings. The farmhouse and additional farm related buildings are also located centrally but are located on a raised river terrace overlooking the former woolshed. The flatter area to the south of the woolshed is grazing paddock. The property mainly stocks cattle with some goats present.

[7] https://www.nelson.govt.nz/environment/nelson-resource-management-plan/nelson-resource-management-plan-2/private-plan-changes/private-plan-change-28-maitahi-bayview/

Kaka Stream runs north to south bisecting the site and cuts across the southernmost part of the site before draining into the Maitai River, which is present immediately south of the site. Several small overland flow paths, draining the lower paddocks toward the Maitai River, were noted.

The hillside areas of the site were not inspected as this DSI is predominately focussed on the lower area where livestock dipping/spraying and horticulture were most likely to have been undertaken.

An inspection of the area west of the woolshed revealed historical sheep treatment infrastructure including treatment and holding pads, chemical draining infrastructure and sump, and a standpipe which may have been used for water supply. A footbath was also observed to the south of the woolshed. These features are shown on Figure 3.

Figure 3 – Sheep Treatment Infrastructure

3.3 Geological and Hydrological Setting

The published site geology from the GNS Science 1:250k web map for New Zealand identifies the site to be underlain by four geological units as indicated on Figure 4. These are:

- Holocene river deposits described as '*Well sorted gravels forming modern flood plains and young fan gravels*'.

- Late Pleistocene river deposits described as '*Clay bound gravels and minor fan deposits forming lowest aggradation surfaces above major rivers'*.
- Basement metamorphic rocks (Wakapuaka Phyllonite) described as '*Fine grained well foliated phyllonite tectonised breccia and sandstone'*.
- Basement sedimentary rocks (Grampian Formation (Brook Street Volcanics Group) described as '*Bedded sandstone commonly tuffaceous and calcareous minor sandstone and breccia sparse fossils'*.

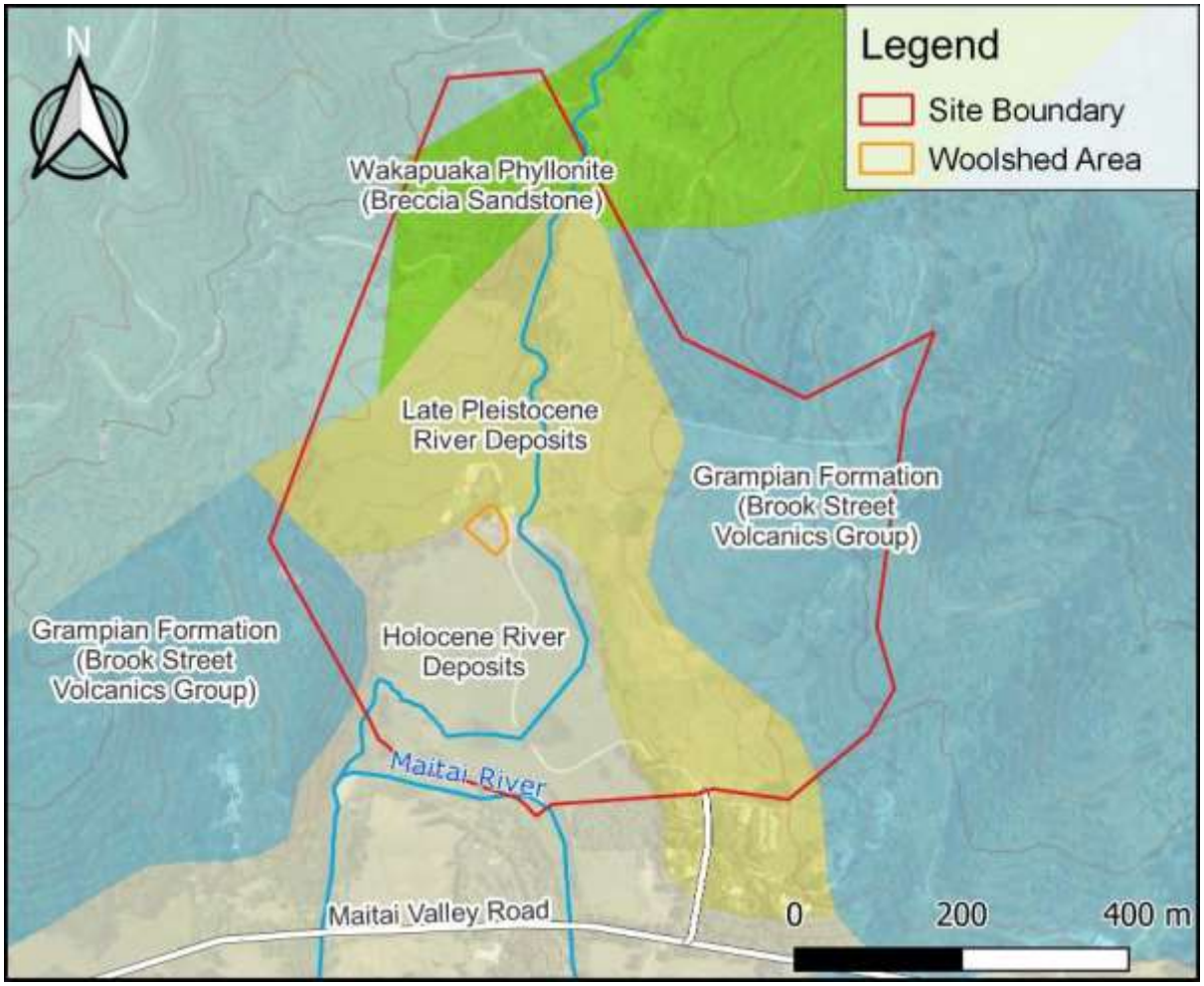

Figure 4 – Site Geology and Hydrology

NCC data[8] indicates that there are no water takes within 1000 m of the site.

Shallow groundwater flow is likely to be generally to the south, following the topography and surface watercourses.

Kaka Stream is said to have been realigned from its original course: through the woolshed area and along the base of the hill[9].

[8] Obtained from NCC's Top of the South Maps GIS Platform: https://www.topofthesouthmaps.co.nz/
[9] Young, A. 2020. Historical and Archaeological Assessment for CCKV Maitai Dev Co LP and Bayview Nelson Limited. Dated 17 December 2020.

4.0 SITE HISTORY AND RECORD SEARCH

4.1 Historical Aerial Photographs

A review of historical aerial photographs (1940s to 2019) available from NCC, Retrolens, and LINZ was undertaken as part of this assessment. Aerial photography assessed is presented in Appendix C.

The following can be surmised from the reviewed photographs:

Table 1 - Historical Aerial Photograph Descriptions

Date	Wider Site
1940s	The site is in agricultural usage and is a mix of cultivated fields and vegetation. No obvious horticulture is noted. The woolshed and pens are present in their current location and a farmhouse is present to the northeast of the woolshed.
1960	There are no major changes noted to the site. A small structure has been constructed to the rear of the farmhouse.
1967	No notable changes (poor quality image).
1969	No notable changes.
1970s	The sheep pens are obvious in this high-quality image. A building (possibly a barn/shed) has been constructed to the northwest of the woolshed.
1977	No notable changes (poor quality image).
1981	No notable changes.
1983	No notable changes.
1980s	The access road to the farm has been rerouted to Ralphine Way. No other changes noted.
2008-2009	The possible barn northwest of the woolshed appears to be a residential structure. Two new structures are present; likely a garage and barn/shed. An implement shed has been constructed just northeast of the woolshed on the other side of the farm track. The former homestead northeast of the woolshed has been demolished/removed.
2014	No notable changes.
2018-2019	No notable changes.

The site has operated as a farm since the earliest available aerial photograph. Older photos suggest the site was used predominately for livestock grazing with few changes over the years. The woolshed and associated sheep pens have been present over the period reviewed. Between the 1980s and 2008, the old farmhouse was removed and a new one constructed northwest of the woolshed.

4.2 Historical Assessment Report Summary

A historical and archaeological assessment (Young, 2020) was produced to support the proposed plan change. This assessment indicates that part of the woolshed was previously used as a hop kiln and the conversion to a woolshed occurred by the early 1900s.

Hops are said to have been grown by no later than 1897, possibly earlier.

To the rear of the former homestead area on the terrace northeast of the woolshed is said to be the site of a ca. 1842 cob cottage which was surrounded by stone walls and burned down in 1991. The chimney which is present is said to be the associated with this cottage.

4.3 Summary of Potentially Contaminative Land Uses

A review of the site's history indicates that the following HAIL activities possibly occurred on the site:

Table 2 - HAIL Site Usage

Activity	HAIL Category	Associated Contaminants	Status
Sheep Dip/Spray	A8: Livestock dip or spray race operations	Arsenic, copper, zinc Organochlorine pesticides (OCP)	Confirmed
Horticulture	A10: Persistent pesticide bulk storage or use including sport turfs, market gardens, orchards, glass houses or spray sheds	Arsenic, copper, & lead	Possible, but not noted on aerial photographs
House fire	I: Any other land that has been subject to the intentional or accidental release of a hazardous substance in sufficient quantity that it could be a risk to human health or the environment	Heavy metals, asbestos	Possible

The site has been used as a farm for many years, stocking sheep and cattle and possibly growing hops in the 1800s.

As any significant horticulture is unlikely to have occurred since the 1940s, organic pesticides are discounted. The most likely ones which may have been used are lead arsenate or copper. Given the topography of the site, it is considered unlikely that intensive horticulture was undertaken outside of the lower, flatter areas.

Operations related to sheep dipping/spraying are likely confined to the wider area of the current sheep pens/woolshed, which has been present since the earliest aerial photograph from the 1940s. The presence of a sheep spray has been observed during a site walkover. Given the above, and the long history of the farm operation, it is likely that sheep have been treated with arsenic and OCP-based solutions. Additionally, zinc and copper are commonly used to control foot rot and are included as contaminants of concern.

The area of the former homestead was inspected during a site walkover. No remnants of former structures were noted other than a chimney to the rear of the former homestead and a pile of stone wall fragments. This area will be addressed prior to Stage 2 of the development commencing.

No waste burning or burial areas have been noted in this assessment, but as these are commonly found on large farm properties, accidental discovery protocols should be in place during development earthworks in case they are encountered.

5.0 SAMPLING AND ANALYSIS PROGRAMME

Soil samples were collected over two sampling events undertaken on 6 October 2021 and 3 November 2021 to determine whether the previously identified HAIL usages of the site may have negatively impacted soil quality.

Samples collected during the first event were intended to determine if the sheep dipping/spray operation had impacted the site and to assess the paddock area for potential pesticide usage. After elevated contaminant concentrations were noted from these samples, additional samples were collected to delineate the areas impacted by sheep treatment and to further assess the paddock areas.

In order to assess impacts related to sheep treatment, samples were collected from around the treatment area and likely "run-out" areas following treatment. Surface samples were collected from twenty-six locations at a depth of 0-75 mm below ground level (bgl). Samples of the underlying subsoil (typically 200-275 mm bgl) were collected from four of those locations (KV1-KV4) as the current farmer indicated that the sheep may have exited the treatment area to the north and this is the first area they would likely be held after dipping.

Samples KV27 and KV28 were collected from the paddock to assess whether pesticides may have been historically applied. Following the detection of arsenic in one of these samples at a concentration above human health standards, it was decided to collect additional samples from the paddocks. Twenty shallow (0-75mm bgl) samples were collected from two grids of ten samples at approximately 20m spacing.

Additional samples (KV33-KV42) were collected from surface soil in the sheep pens to further assess the lateral impact of dipping-related contamination. Samples KV29-KV32 were collected from subsoil near surface sample locations containing elevated contaminant concentrations. These samples were typically collected from a depth of up to 0.5m bgl, but a hand auger was advanced at KV29 to refusal at a depth of 1.4m bgl.

Ground conditions prevented the collection of deeper samples using hand tools.

Sample locations are shown on Figure 5 and Figure 6.

Two water "grab" samples were collected during the second sampling event on 3 November 2021 in order to understand disposal requirements. One sample was collected from the concrete sump in the treatment area, which was full of water. The other was collected from a metal standpipe which appears to be connected to groundwater. The static water level within the pipe was approximately 1.3 m below the surface. It was initially thought the pipe may be connected to an underground storage tank, but when 'dipped', it did not appear to enter a larger structure.

Legend

- Sample Locations (6Oct21)
- Sample Locations (3Nov21)
- Treatment Infrastructure

Notes:
1) This drawing indicates the approximate location of soil samples collected within the woolshed area.
2) The location of treatment infrastructure is approximate and based on site obeservations. The runout area shown is not intended to indicate the extent of soil contamination.
3) See Figure 3 for treatment infrastructure labels.
4) For information only. Not to be used for construction.

0 6 12 18

meters

Scale 1:300 @ A4

Project: Maitahi Subdivision - Detailed Site Investigation

Figure: 5 - Woolshed Sample Locations

envirolink
Nga tangata ki pūtaiao

Map CRS: EPSG:2193
Coordinate Units: Meters
Map Scale: 1:300
Page Size: A4
Drawn By: David Duncan
Production Date: 2021-11-25
Made with: QGIS 3.22 on Windows

Legend

- Sample Locations (6Oct21)
- Sample Locations (3Nov21)
- Site Boundary

Notes:
1) This drawing indicates the approximate location of soil samples collected within the paddock area. Samples from the woolshed area are shown without labels for reference.
2) For information only. Not to be used for construction.

0 30 60 90

meters

Scale 1:1750 @ A4

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Figure: 6 - Paddock Sample Locations

envirolink
Nga tangata ki pūtaiao

Map CRS: EPSG:2193
Coordinate Units: Meters
Map Scale: 1:1,750
Page Size: A4
Drawn By: David Duncan
Production Date: 2021-11-25
Made with: QGIS 3.22 on Windows

5.1 Observations and Laboratory Analysis

Soil was generally free of anthropogenic material; however, some metal wire and glass fragments were noted in samples collected from around the sheep treatment area. No organoleptic evidence of contamination was noted. Shallow soil in the sheep pens appeared to be river gravels presumably placed to improve surface drainage. The area is elevated slightly compared to the surrounding paddocks.

The soil types encountered are summarised in Table 3.

Table 3 – Ground Conditions Encountered

Unit		Typical Depth (mm bgl)	Typical Description	Notes
Topsoil		0-100	Dark brown organic sandy gravelly SILT	Encountered around treatment area and in paddocks
Hardfill		0-250	Orangish brown slightly silty cobbly sandy GRAVEL	Likely imported river gravels. Encountered in sheep pens
River Deposits	Granular deposits	250-800	Orangish brown (slightly) silty sandy GRAVEL.	River deposit depth and composition likely to be variable across the woolshed and paddock areas.
	Cohesive deposits	800–1400+*	Soft orangish brown sandy (slightly) gravelly CLAY	
Ground conditions based on observations from deeper samples collected at KV29-32. * (bottom depth not encountered)				

The soil encountered is considered to be generally consistent with the local geology. A layer of hardfill, likely river gravels, has been placed across the sheep pens, presumably to improve drainage and reduce 'pugging' within the pens. Topsoil was encountered in the treatment area, likely due to the accumulation of leaf litter and other organics during the long period in which it has not been in usage.

A dark grey clayey sand with brick fragments was encountered in KV29 from approximately 200-500 mm bgl. This may be associated with the installation of the below ground treatment infrastructure nearby.

Soil in KV29 was damp from approximately 1 m bgl. Groundwater was not encountered in any other locations. The paddock was noted to be waterlogged in lower areas.

Selected samples were analysed for heavy metals and OCP by IANZ-accredited Hill Laboratories. Other samples were held at the laboratory in the event that further analysis is required. Analytical scheduling was based on professional judgement and site observations.

Topsoil and subsoil samples from KV1-KV4 were composited for analysis as they were all collected from the same small pen and appear to have been significantly disturbed by cattle

over many years. The topsoil samples from the adjacent pen (KV5-KV8) were also composited for analysis.

Toxicity Characteristic Leaching Procedure (TCLP) testing was undertaken for selected samples with elevated contaminant concentrations to satisfy landfill acceptance requirements.

5.2 Quality Assurance/Quality Control

Samples were collected using a stainless-steel trowel or hand auger. Field staff wore clean disposable gloves when collecting each sample to minimise the potential for cross-contamination. All sampling equipment was cleaned in Decon 90 and rinsed in freshwater before collecting each sample.

The water sample from the sump was bailed and decanted into a sample container using a decontaminated stainless-steel vessel. The water sample from the pipe was collected using plastic tubing.

Samples were couriered to Hill Laboratories under chain of custody documentation.

Four duplicate soil samples were collected and scheduled for metals analysis. The data quality of the duplicate samples collected for quality control purposes is evaluated by reference to the Relative Percentage Difference (RPD). RPD is used to determine the precision/reproducibility of the results. Table 4 shows the results and RPD for the duplicate sample collected during the investigation.

Table 4 - RPD Results for Field Duplicate Samples

	Arsenic	Cadmium	Chromium	Copper	Lead	Nickel	Zinc
KV10	108	10.4	89	81	200	73	5500
KV-Dup1	78	13.7	83	67	155	88	4700
% RPD	**32.3**	**27.4**	**7.0**	**18.9**	**25.4**	**18.6**	**15.7**
KV25	49	0.26	173	85	35	197	760
KV-Dup2	46	0.26	148	86	38	200	570
% RPD	**6.3**	**0.0**	**15.6**	**1.2**	**8.2**	**1.5**	**28.6**
KVP1/6	12	< 0.2	126	58	13.3	55	88
KVP1-Dup	11	0.16	121	59	12.3	56	84
% RPD	**8.7**	**-**	**4.0**	**1.7**	**7.8**	**1.8**	**4.7**
KVP2/5	5	0.15	143	51	7.9	66	67
KVP2-Dup	5	0.15	139	52	7.5	69	66
% RPD	**0.0**	**0.0**	**2.8**	**1.9**	**5.2**	**4.4**	**1.5**

The precision of the laboratory analytical results is deemed to be suitable if the RPD values fall within the recommended range of 30% RPD where one or both values were greater than 10x the laboratory limit of reporting or 50% RPD where one or both values are less than 10x the laboratory limit of reporting. The RPD values for the soil samples collected as part of this investigation are within those limits with the exception of one which slightly exceeded 30%. Overall, the values are considered acceptable.

5.3 Trigger Values

5.3.1 Background

Heavy metals results are compared to the background criteria listed in Cavanagh (2015)[10] in order to provide an indication of resource consent requirements. For DDT assessment, the background concentration is taken from Gaw (2003)[11].

5.3.2 Human Health

Soil sample results are compared to the soil contaminant standards (SCS) listed in Tables B2 and B3 (soil contaminant standards for health for inorganic and organic substances) of the NESCS. Residential (10% produce), high-density residential, and recreational exposure scenarios are all relevant to the proposed development as shown on Figure 7 and in the development plans in Appendix A.

For analytes that are not listed as priority contaminants in the NESCS, CLMG No. 2[12] provides guidance. Lindane assessment criteria is taken from the *Sheep Dip Guidelines*[13]. For nickel and zinc, the Australian NEPM Health Investigation Level[14] values are used.

The woolshed is located in an area intended for recreational usage, while the adjacent paddock is to be a mixture of recreational and high-density residential. The identified potential HAIL areas are not located in areas intended for standard residential (10% produce) usage.

5.3.3 Waste Classification

Results are compared to waste acceptance criteria to provide an indication of the likely classification of soil should it need to be removed from site.

Cleanfill acceptance for heavy metals is based on recommended cleanfill criteria in Table 5 from Cavanagh (2015)[10]. Cleanfill acceptance criteria (for Class 5 landfills) for DDT is from WasteMINZ (2018)[15]. A cleanfill level for dieldrin has not been set by NCC and the suitability for dieldrin-contaminated soil to be disposed of in a cleanfill will be subject to further assessment.

Results exceeding cleanfill criteria are also compared to the York Valley Landfill screening criteria. Where these values are exceeded, leachate analysis of soil samples may be required by the receiving facility prior to confirming waste acceptance. As a result, leachate analysis was undertaken, and results are compared to York Valley Landfill acceptance limits.

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[10] Cavanagh, J., 2015. Background concentrations of trace elements and options for managing soil quality in the Tasman and Nelson Districts. Envirolink Advice Grant: 1555-TSDC110.
[11] Gaw, S, K., 2003. Historic Pesticide Residues in Horticultural and Grazing Soils in the Tasman District, TDC Rural Soils Report.
[12] The Ministry for the Environment, 2011. Contaminated Land Management Guidelines (CLMG) No. 2 – Hierarchy and Application in New Zealand of Environmental Guideline Values.
[13] MfE, 2006. Identifying, Investigating, and Managing Risks Associated with Former Sheep-dip Sites: A guide for local authorities.
[14] National Environment Protection (Assessment of Site Contamination) Measure 1999 (revised 2013). Schedule B1 Guideline on Investigation Levels for Soil and Groundwater, Table 1A(1).
[15] Waste Management Institute New Zealand, 2018. Technical Guidelines for Disposal to Land Appendices: Tables C-2 and C-3.

York Valley's consent does not specify limits for aldrin, dieldrin, or DDT. As such, Class A landfill acceptance criteria are used for those analytes[16].

5.3.4 Ecological Protection (Soil)

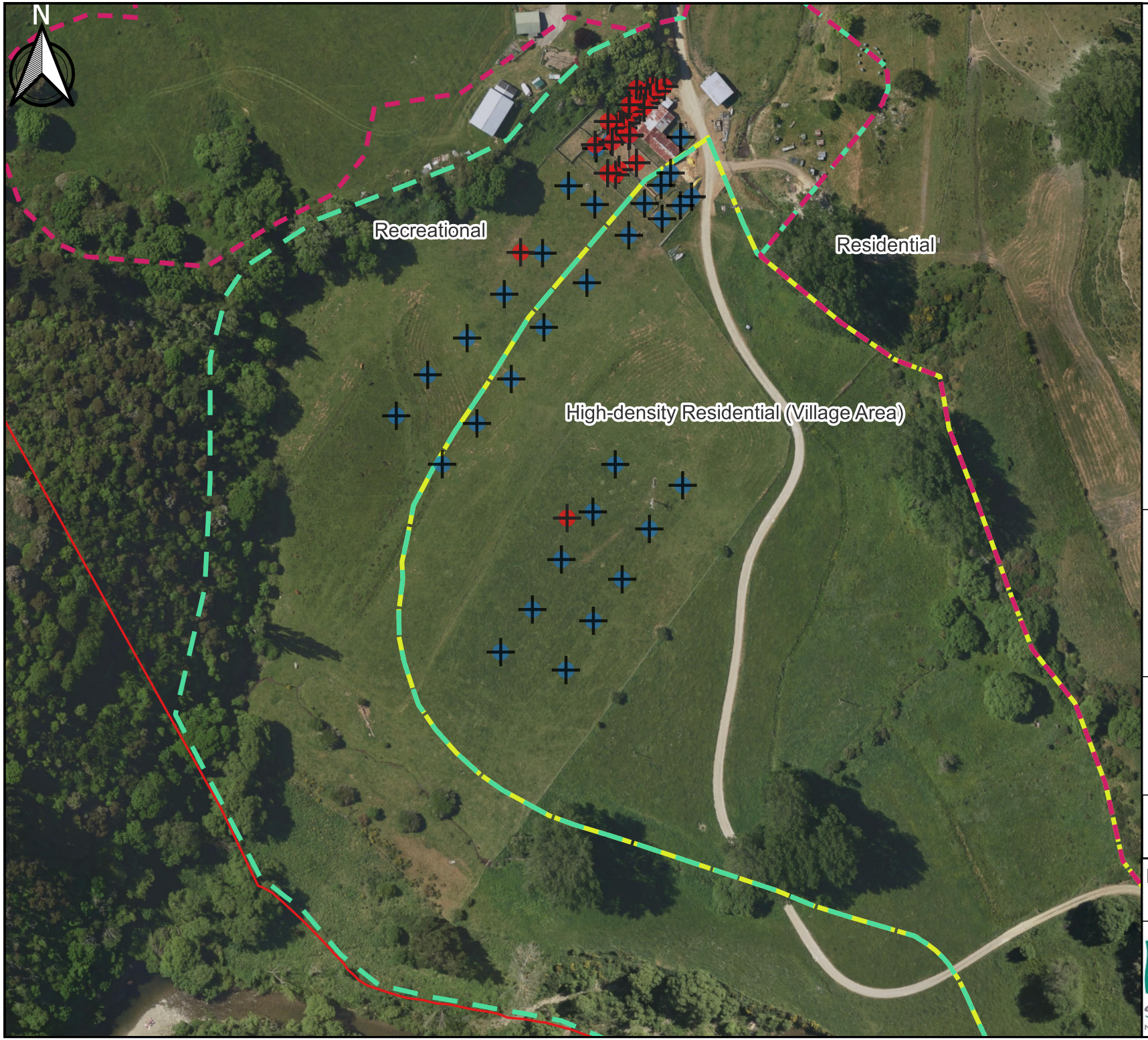
It is understood that Kaka Stream is to be redirected through the current woolshed area as part of the proposed development. Given the potential for a surface watercourse to be in contact with contaminated soil, it is considered appropriate to assess soil contaminant concentrations against ecological-soil guideline values (Eco-SGV)[17]. The values for residential/recreational usage for typical soils with aged contamination are used. Where Eco-SGVs were not available, as is the case for nickel, dieldrin, and lindane, the ANZECC[18] sediment quality guidelines (SQG) were used.

5.3.5 Ecological Protection (Water)

Water "grab" samples are compared to ANZECC 2000 freshwater screening values[19]. Values for 80% species protection were used due to the highly modified nature of the surrounding environment.

These values relate to surface water quality and are presented to provide context to contaminant concentrations recorded in water samples. As the water sampled is not from or directly adjacent to a surface waterbody, these values are not appropriate for risk assessment. Additionally, the source of the waters sampled are not well understood and may not be representative of groundwater in the area.

[16] MfE, 2004. Module 2: Hazardous Waste Guidelines – Landfill Waste Acceptance Criteria and Landfill Classification.
[17] Cavanaugh, J, 2016. User Guide: Background soil concentrations and soil guideline values for the protection of ecological receptors (Eco-SGVs) – Consultation Draft. And
Cavanaugh, J, 2019. Updating the Ecological Soil Guideline Values (Eco-SGVs).
[18] Australian and New Zealand Environment and Conservation Council (ANZECC), 2013. Revision of the ANZECC/ARMCANZ Sediment Quality Guidelines.
[19] Based on ANZECC, 2000. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Retrieved from: https://www.waterquality.gov.au/anz-guidelines/guideline-values/default/water-quality-toxicants



Legend

- Sample Locations (6Oct21)
- Sample Locations (3Nov21)
- Site Boundary

Development Zones

- Recreational
- High-density Residential
- Residential

Notes:
1) This drawing indicates the approximate location of soil samples collected and proposed future land usage.
2) Future land use is approximate and based on the plans presented in Appendix A.
3) For information only. Not to be used for construction.

0 30 60 90

meters

Scale 1:1750 @ A4

Project: Maitahi Subdivision - Detailed Site Investigation

Figure: 7 - Proposed Future Land Usage

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Map CRS: EPSG:2193
Coordinate Units: Meters
Map Scale: 1:1,750
Page Size: A4
Drawn By: David Duncan
Production Date: 2021-11-29
Made with: QGIS 3.22 on Windows

5.4 Analytical Results

A summary of analytical results for the woolshed area are presented in Table 5.

In addition to heavy metals, DDT and the sum of 'drins' (aldrin, dieldrin, and endrin) are shown. While DDT has been detected in the treatment area, dieldrin is the primary contaminant of concern. Endrin was likely to be present at much lower concentrations in treatment chemicals as an isomer/"contaminant" of dieldrin production. Though aldrin has not been detected at high concentrations, it may have been used as a treatment chemical prior to dieldrin. As aldrin degrades to dieldrin, it is difficult to know to what extent it was used. As the three compounds present a similar risk profile, they can be assessed together.

Lindane (gamma-hexachlorocyclohexane(HCH)) was detected around the treatment area. The dominant isomer detected is beta-HCH, likely due to its relatively greater resistance to biodegradation relative to the other isomers[20]. Lindane and its isomers are presented in the results table as 'total HCH'. While the isomers have slightly different risk profiles, comparison to the lindane screening value is considered appropriate for an initial screen.

A summary of analytical results for the paddock area are presented in Table 6.

The results of TCLP analysis are presented in Table 7.

The results for the water grab samples are presented in Table 8.

The Hill Laboratories certificates of analysis is attached as Appendix D.

[20] Agency for Toxic Substances and Disease Registry (ATSDR). 2005. Toxicological profile for Hexachlorocyclohexane. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Table 5 - Summary of Analytical Results – Woolshed Area

Sample Location	Depth (mm)	Arsenic	Cadmium	Chromium	Copper	Lead	Nickel	Zinc	Total DDT	Total HCH@	Total 'drins'^
KV1-4 (Composite)	0-75	20	0.42	88	58	31	89	340	< 0.08	< 0.013	< 0.013
KV1-4-SS (Composite)	200-275	8	0.25	158	42	22	410	193	< 0.07	< 0.011	< 0.011
KV5-8 (Composite)	0-75	32	0.4	111	44	34	155	250	< 0.11	< 0.018	0.13
KV9	0-75	17	0.19	77	55	20	63	188	< 0.08	< 0.013	0.024
KV10	0-75	108	10.4	89	81	200	73	5,500	< 0.15	< 0.03	3.2
KV11	0-75	450	9.8	98	96	390	90	610	0.27	0.329	78.707
KV12	0-75	580	16.3	104	124	152	82	480	4.2	0.301	243.52
KV13	0-75	270	3.6	107	72	179	53	900	0.34	0.018	36.36
KV14	0-75	420	15.6	109	67	176	89	750	1.19	0.26	633.8
KV15	0-75	158	11.5	85	96	200	65	1,440	3.5	0.049	154.28
KV29-2	300-375	810	1.12	128	97	460	73	400	0.12	0.077	22.42
KV29-3	600-700	141	0.2	96	67	7.6	47	210	< 0.07	< 0.012	3.151
KV16	0-75	-	-	-	-	-	-	-	5.3	8.297	407.3
KV17	0-75	31	0.42	142	51	37	210	550	-	-	
KV18	0-75	35	0.34	87	49	22	147	300	< 0.09	< 0.015	0.153
KV19	0-75	31	0.3	124	43	19	195	190	< 0.08	< 0.013	0.074
KV20	0-75	89	0.49	127	97	31	240	260	< 0.09	0.016	4.016
KV32-2	350-425	63	0.2	120	190	69	163	124	< 0.07	< 0.012	0.59
KV21	0-75	90	0.52	113	88	50	185	230	< 0.10	< 0.016	9.536
KV31-2	300-375	430	0.28	130	130	134	82	193	< 0.08	< 0.012	4.725
KV22	0-75	53	1.1	119	119	137	128	680	-	-	
KV30-1	0-75	-	-	-	-	-	-	-	< 0.07	< 0.012	1.48
KV30-2	300-375	71	0.19	120	107	54	78	194	< 0.07	< 0.012	0.099
KV24	0-75	86	0.32	149	450	43	200	590	-	-	
KV25	0-75	49	0.26	173	85	35	197	760	-	-	
KV26	0-75	39	0.3	123	108	29	200	670	-	-	
KV33	0-75	16	0.5	95	54	67	42	198	-	-	
KV34	0-75	18	0.43	123	60	40	146	230	-	-	
KV36	0-75	16	0.19	125	65	26	98	136	-	-	
KV38	0-75	19	0.2	154	77	33	177	200	-	-	
KV41	0-75	32	0.23	130	69	46	61	149	-	-	
KV42	0-75	59	0.37	121	120	32	164	200	< 0.08	< 0.013	1.32
Assessment Criteria	**Background**	11	0.90	183	41.5	33	274.4	141.5	0.48	0	0
	NCC Cleanfill	12	0.75	183	83	86	274.4	300	0.7~	-	-
	York Valley Landfill Screening Criteria	100	10	100#	200	100	200	200		8	.4
	Ecological Guideline Value	55	17	390	240	1,300	52*	300	4.8	7*	1.4*
	NESCS – Residential	20	3	460#	>10,000	210	400	7,400	70	140	2.6
	NESCS – Residential (High-density)	45	230	1,500	>10,000	500	1,200	60,000	240	700	45
	NESCS – Recreational	80	400	2,700#	>10,000	880	1,200	30,000	400	1,400	70

Notes: - All concentrations expressed as mg/kg.
- Grey shading indicates depth samples.
^ Total 'drins' is the sum of aldrin, dieldrin, and endrin.
@ Total HCH is the sum of Lindane and its isomers.
* ANZECC SQG-H value used in absence of an Eco-SGV. Screening value for chromium is based on chromium (III).
# Screening value for chromium (VI).

Table 6 - Summary of Analytical Results – Paddock Area

Sample Location	Depth (mm)	Arsenic	Cadmium	Chromium	Copper	Lead	Nickel	Zinc
KV27	0-75	30	0.29	70	55	84	53	176
KVP 1/2	0-75	25	0.19	112	62	21	66	125
KVP 1/1	0-75	6	0.22	79	46	59	81	149
KVP 1/3	0-75	5	0.2	87	44	47	94	121
KVP 1/4	0-75	9	0.23	76	48	60	49	148
KVP 1/5	0-75	7	0.15	96	51	19.5	57	95
KVP 1/6	0-75	12	< 0.2	126	58	13.3	55	88
KVP 1/7	0-75	5	0.21	140	57	6.4	62	68
KVP 1/8	0-75	6	0.17	116	59	5.3	56	68
KVP 1/9	0-75	3	0.18	135	55	5.6	62	77
KVP 1/10	0-75	4	0.15	138	47	5.8	68	65
KV28	0-75	5	0.13	148	54	6.3	69	68
KVP 2/1	0-75	5	0.17	132	58	6.9	56	63
KVP 2/2	0-75	5	0.15	117	47	10.7	56	64
KVP 2/3	0-75	6	0.16	144	61	9	63	72
KVP 2/4	0-75	5	0.19	140	54	7.6	73	70
KVP 2/5	0-75	5	0.15	143	51	7.9	66	67
KVP 2/6	0-75	5	0.15	161	57	12.5	97	75
KVP 2/7	0-75	4	0.14	148	57	7.4	69	61
KVP 2/8	0-75	5	0.17	181	64	10.6	128	76
KVP 2/9	0-75	5	0.13	151	57	5.5	87	61
KVP 2/10	0-75	5	0.19	200	57	7.3	172	77
Paddock Area - 95% UCL of the mean		**6.4**	**0.18**	**145.1**	**56.2**	**32.8**	**87.9**	**92.4**
Assessment Criteria	**Background**	11	0.90	183	41.5	33	274.4	141.5
	NCC Cleanfill	12	0.75	183	83	86	274.4	300
	York Valley Landfill Screening Criteria	100	10	100#	200	100	200	200
	Ecological Guideline Value	55	17	390	240	1,300	52*	300
	NESCS – Residential	20	3	460#	>10,000	210	400	7,400
	NESCS – Residential (High-density)	45	230	1,500	>10,000	500	1,200	60,000
	NESCS – Recreational	80	400	2,700#	>10,000	880	1,200	30,000

Notes: - All concentrations expressed as mg/kg
Screening value for chromium (VI)
* ANZECC SQG-H value used in absence of an Eco-SGV. Screening value for chromium is based on chromium (III).

Table 7 - Summary of Analytical Results – TCLP/Leachate Analysis

Sample Location	Depth (mm)	Arsenic	Cadmium	Chromium	Copper	Lead	Nickel	Zinc	Aldrin	Dieldrin	Endrin	Total DDT	Total HCH@
KV10	0-75	0.046	0.029	-	-	0.0122	-	14.3	-	-	-	-	-
KV11	0-75	0.26	-	-	-	0.0122	-	0.9	< 0.00010	0.037	0.00037	< 0.0002	< 0.0002
KV12	0-75	0.47	0.051	< 0.011	-	0.01	-	0.77	< 0.00010	0.059	0.00107	< 0.0002	< 0.0002
KV14	0-75	0.163	0.022	< 0.011	-	0.021	-	2.2	0.00036	0.099	0.00064	< 0.0002	0.0004
KV20	0-75	-	-	< 0.011	-	-	0.046	-	< 0.00010	0.00156	< 0.00010	< 0.0002	< 0.0002
KV21	0-75	-	-	-	-	-	-	-	< 0.00010	0.0023	< 0.00010	< 0.0002	< 0.0002
KV22	0-75	-	-	-	-	0.007	-	2.9	-	-	-	-	-
KV24	0-75	-	-	< 0.011	0.195	-	0.169	1.92	-	-	-	-	-
KV26	0-75	-	-	< 0.011	-	-	0.04	1.27	-	-	-	-	-
KV29-2	300-375	0.57		< 0.011		0.0116		0.85	< 0.00010	0.02	0.00021	< 0.0002	< 0.0002
York Valley Landfill Acceptance Limit		5	0.5	5	10	5	10	10	0.00008*	0.4*	0.02	NA*^	0.4

Notes: - All concentrations expressed as mg/L
* Class A landfill limits (MfE 2004)
^ No leachate value set. Acceptance limit is a soil concentration of 500 mg/kg.

Table 8 - Water Sample Results

Sample Location	As	Cd	Cr	Cu	Pb	Ni	Zn	Aldrin	DDT	Dieldrin	Lindane
Sump (KVS1)	< 21	2.5	< 11	< 11	6.8	< 11	164	< 0.4	< 0.4	< 0.4	< 0.4
Standpipe (KTV2)	2,400	181	340	760	9,900	310	540,000	29	< 0.4	3.6	< 0.4
Guideline Value	140	0.8	40	2.5	9.4	17	31	0.001	0.04	0.01	1

Notes: - All concentrations expressed as µg/L
- Water samples were analysed for total metals, rather than filtered.
- Guideline values are the Australian and New Zealand Guidelines for Fresh and Marine Water Quality. The 80% species protection levels were used.

Please note that these results are being presented for reference purposes only but should not be fully relied on as the configuration of the standpipe and the method of sampling were not formally undertaken

5.5 Discussion

5.5.1 Woolshed Area

Soil Samples

The former treatment area shows significant impact from arsenic and dieldrin. Several results around the treatment and runout areas exceed recreational human health standards by an order of magnitude. The highest concentrations were recorded in the vicinity of the sump. Arsenic, dieldrin, and zinc are the contaminants most commonly recorded at significantly elevated concentrations. Concentrations of arsenic and dieldrin around the woolshed area are presented in Figure 8 and Figure 9, respectively.

The depth of impact has not been fully delineated in this phase of investigation. Exceedances of recreational SCS were recorded in the deepest samples collected from the sump (600-700 mm bgl) and runout areas (300-375). In some areas, arsenic appears to have migrated through the hardfill layer into the upper river deposits where concentrations have been recorded in excess of surface concentrations. In contrast to arsenic, dieldrin's affinity for organic matter seems to have reduced its downward migration with all depth samples showing reduced concentrations relative to those at surface.

Contaminant concentrations were also compared to residential standards to determine the soil's suitability for reuse on residential parts of the site. Shallow soil from the majority of the area is not considered suitable for shallow usage on normal residential lots. Some may be suitable for usage in high-density residential areas.

All samples analysed exceed cleanfill acceptance criteria for at least one analyte, indicating that no shallow soil from the woolshed area is suitable for disposal to a cleanfill facility.

Several samples exceed the ecological guideline values, indicating that some of the soil may not be suitable for usage in a riparian environment, such as that envisaged by the proposed development. As the ecological guideline values are similar to human health standards, it is likely that remediation required to address potential human health risks will also address potential ecological risks.

The results indicate that naturally elevated concentrations of nickel, chromium, and possibly copper are present at the site. Nickel and chromium are not usually associated with sheep dip or spray use. Nickel is naturally occurring on the site at concentrations above ecological guideline value of 52 mg/kg. Where analytes are not elevated above background levels, they are not considered to pose a potential ecological risk.

As several soil samples exceeded landfill screening levels, leachate analysis was carried out. The results indicate that most of the soil is suitable for disposal at York Valley Landfill; however, two samples from the treatment area exceeded acceptance limits.

Water Samples

Analysis of the water results suggests that the water contained within the concrete sump is not grossly contaminated and requires no special disposal, though it should not be discharged directly to a surface watercourse. The tank was full of water to the ground surface on both site visits. During the collection of deeper soil samples on 3 November 2021, it was noted that the groundwater table was unlikely to be a depth shallower than 1 m bgl. The level of the sump water above groundwater likely indicates that there is limited, if any, connectivity with groundwater and that the sump has filled with rainwater over the years.

Water collected from the standpipe has elevated concentrations of all analytes above ANZECC values. It is noted that the high sediment load in the sample combined with analysis of total (rather than filtered) analytes is likely to have resulted in unrepresentatively high contaminant concentrations in the water.

The results indicate that further assessment of groundwater may be necessary to inform treatment requirements should dewatering of excavations be required during earthworks. In addition to chemical analysis of groundwater, it is recommended that hydraulic conductivity be assessed in order to more accurately estimate flow rates and volumes that may require treatment.

As the development plan involves redirecting Kaka Stream through this area, it is likely that excavations will intersect the groundwater table.

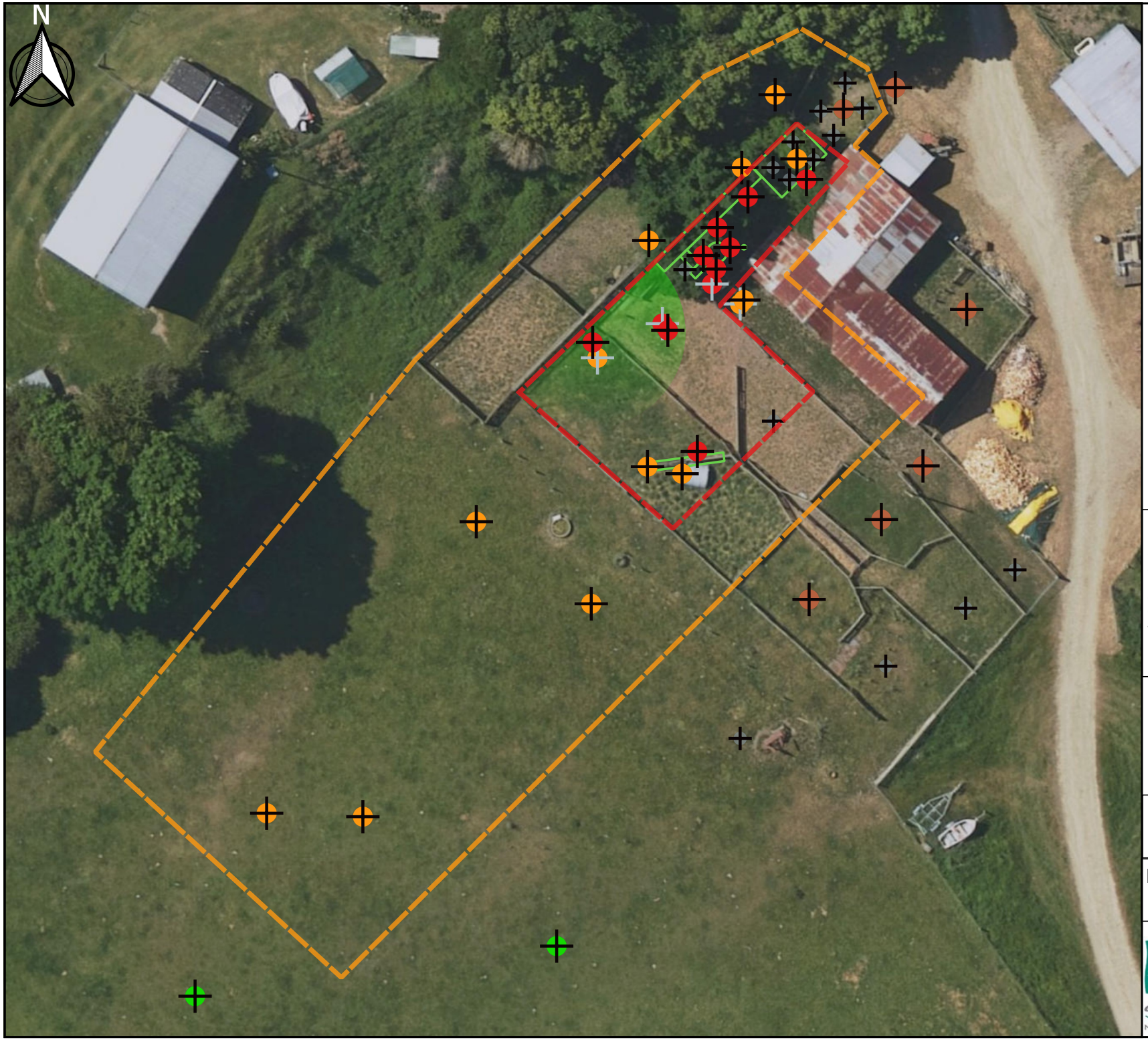
5.5.2 Paddock Area

Two samples, both located in the northwest corner of the paddock, exceed residential human health standards for arsenic, but not recreational standards. These two samples are likely to be associated with the run-out area from the sheep pens and will be included in the woolshed area for subsequent discussion.

The remainder of the samples are below NESCS standards. Some analytes, particularly chromium and nickel, appear to be naturally elevated. Only one chromium result marginally exceeds the region's higher background levels for naturally elevated areas. As chromium is unlikely to be of anthropogenic origin, it is most likely to be chromium (III) rather than chromium (VI). All copper results exceed background levels but are below cleanfill criteria or human health standards. This may be the result of naturally elevated levels or historical application of copper-based pesticides.

The 95% upper confidence limit (UCL) of the mean has been calculated by the ProUCL statistical software package in order to assess the likelihood of chromium concentrations in site topsoil exceeding the cleanfill acceptance. The 95% UCL was also calculated for other heavy metals. These calculations exclude samples KV27 and KVP1/2 as they are to be included in the woolshed area. ProUCL worksheets are included as Appendix E.

On the basis of the results and 95%UCL calculations, the paddock soil is suitable for classification as cleanfill. While nickel concentrations exceed ecological guideline values, they are at background levels, so are not considered to pose a potential risk to ecological receptors.



Legend

Treatment Infrastructure

Arsenic Concentrations (mg/kg)

- 0 - 11 (Background)
- 11 - 12 (Cleanfill)
- 12 - 20 (Above Cleanfill)
- 20 - 80 (Above NESCS Residential)
- 80+ (Above NESCS Recreational)
- Not Analysed

Arsenic Hotspots

- Unsuitable for recreational usage
- Unsuitable for residential usage

Notes:
1) This drawing indicates arsenic concentrations for soil samples collected within the woolshed area.
2) Symbols with grey crosses indicate depth samples.
3) Hotspot areas are indicative only and based on available laboratory data. Actual areas with soil concentrations exceeding guideline values may vary.
4) For information only. Not to be used for construction.

0 8 16 24

meters

Scale 1:400 @ A4

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Figure: 8 - Arsenic Concentrations in Soil

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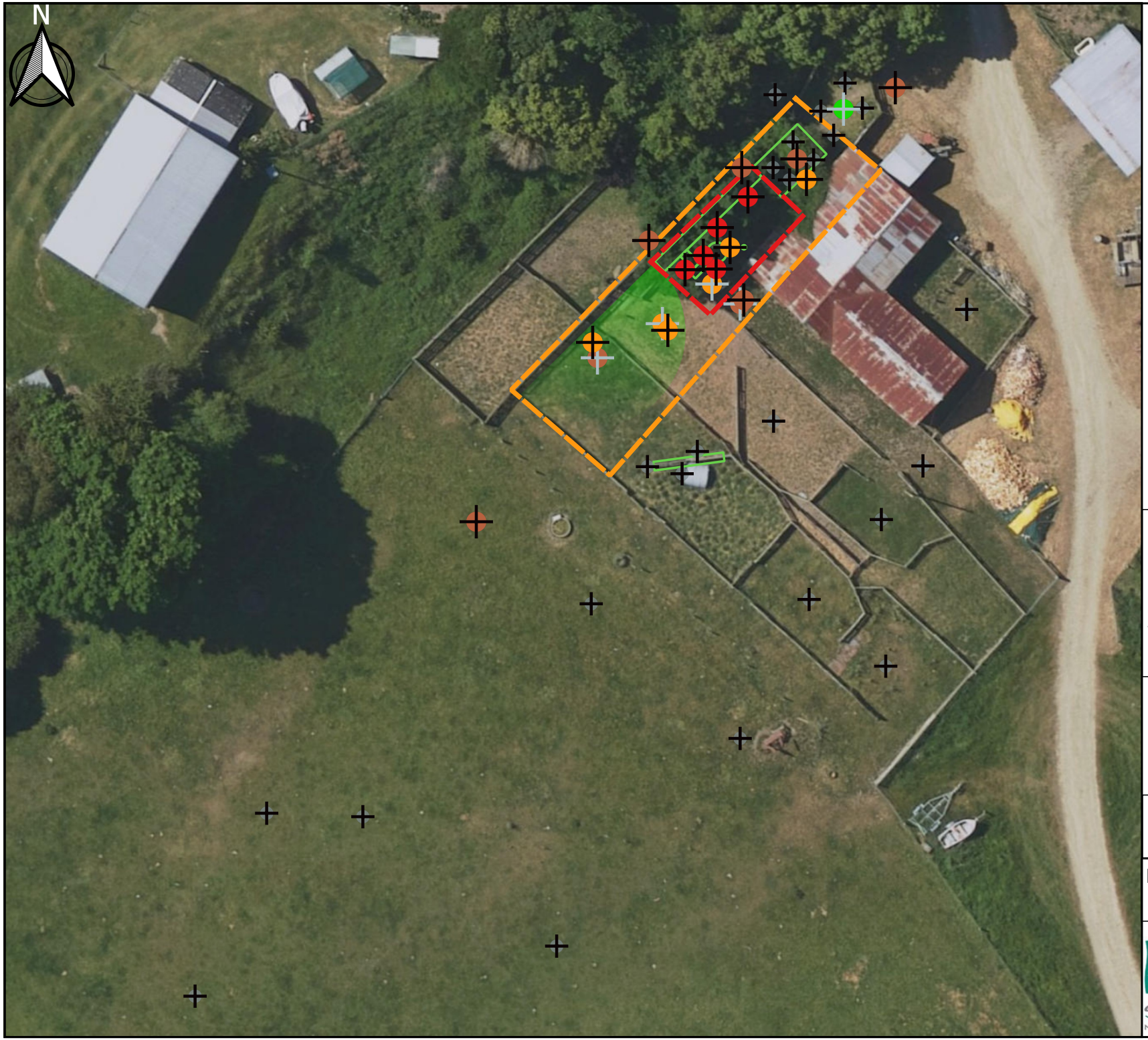
Map CRS: EPSG:2193
Coordinate Units: Meters
Map Scale: 1:400
Page Size: A4
Drawn By: David Duncan
Production Date: 2021-11-25
Made with: QGIS 3.22 on Windows



Legend

Treatment Infrastructure

Dieldrin Concentrations (mg/kg)

- Not detected (Background)
- 0 - 2.6 (Above Cleanfill)
- 2.6 - 70 (Above NESCS Residential)
- 70+(Above NESCS Recreational)
- Dieldrin — Not Analysed

Dieldrin Hotspots

- Unsuitable for recreational usage
- Unsuitable for residential usage

Notes:
1) This drawing indicates dieldrin concentrations for soil samples collected within the woolshed area.
2) Symbols with grey crosses indicate depth samples.
3) Hotspot areas are indicative only and based on available laboratory data. Actual areas with soil concentrations exceeding guideline values may vary.
4) For information only. Not to be used for construction.

0 8 16 24

meters

Scale 1:400 @ A4

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Figure: 9 - Dieldrin Concentrations in Soil

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Map CRS: EPSG:2193
Coordinate Units: Meters
Map Scale: 1:400
Page Size: A4
Drawn By: David Duncan
Production Date: 2021-11-26
Made with: QGIS 3.22 on Windows

6.0 CONCEPTUAL SITE MODEL

The conceptual site model (CSM) has been developed from an assessment of contaminant sources, potential exposure pathways, and feasible receptors. A risk is present if a complete pathway is present between the source of contamination and the receptors.

Future site users are considered to be the primary on-site receptors from a human health perspective. The woolshed area is intended for recreational usage and the paddock area is to be a mix of recreational and high-density residential usage. Should the development plan change, potential risk should be reassessed.

Chronic risk to construction workers is not considered under the NESCS as long-term exposures are considered negligible. Good hygiene practices and appropriate PPE should minimise risk posed where construction workers may encounter contaminated soil. Current site usage as production land is not considered under the NESCS.

Risk to human health via groundwater ingestion has been discounted as there appears to be no abstraction of downgradient groundwater for human consumption. Groundwater is, thus, only considered as a contaminant pathway to surface water receptors.

Table 9 presents the potential contaminant exposure linkages for the woolshed area. For the purposes of this assessment, the samples in the northwest corner of the paddock are included in the woolshed area as the arsenic concentrations are likely associated with sheep treatment rather than horticultural usage.

Table 9 - Conceptual Site Model - Linkage Assessment – Sheep Pen Area

Source (HAIL Category)	Primary Contaminants of concern	Pathway	Receptor	Linkage Active?
Sheep Treatment – A8	• Arsenic • Zinc • Dieldrin	• Inhalation • Ingestion • Dermal Contact	• Future site users	Yes, concentrations of arsenic and dieldrin exceed human health standards for recreational usage.
		• Leaching of contaminants into water if soil disposed of improperly	• Surface water	Possibly, cleanfill criteria widely exceeded. Excavated soil will require appropriate management to mitigate potential risks.
		• Dissolution and migration of soluble contaminants from in-situ soil	• Surface water	Possibly, depending on the final development plant.

Table 10 presents the potential contaminant exposure linkages for the paddock area.

Table 10 - Conceptual Site Model - Linkage Assessment - Paddock Area

Source (HAIL Category)	Associated Contaminants	Pathway	Receptor	Linkage Active?
Horticulture – A10 (unconfirmed)	• Chromium • Copper • Lead • Nickel • Zinc	• Inhalation • Ingestion • Dermal Contact • Consumption of homegrown produce	• Future site users	No, contaminants of concern present at concentrations below NESCS standards.
		• Leaching of contaminants into water if soil disposed of improperly	• Surface water	Unlikely, cleanfill assessment criteria not exceeded.
		• Dissolution and migration of soluble contaminants from in-situ soil	• Surface water	No, contaminants of concern typically present at concentrations below background levels.

The CSM for the former homestead area has not been updated as this area was not investigated but will be undertaken prior to Stage 2 of the development commencing.

On the basis of the proposed development plan, remediation will be required in the woolshed area in order to reduce potential risk posed to future recreational users of the area by concentrations of arsenic and dieldrin in soil. Due to its affinity for organic matter and reduced solubility, elevated dieldrin concentrations appear to be less widespread than arsenic. Their differing fate and transport characteristics mean that both will require consideration when assessing remediation options.

The development plan involves rerouting Kaka Stream through the woolshed area, which has the potential to put a watercourse in direct contact with contaminated soil. As such, the potential ecological risk posed by contaminants in soil has been assessed. The area with soil contaminant concentrations in excess of ecological criteria is similar to the area with arsenic values above recreational human health standards. The area assessed to potentially pose ecological risk, on the basis of the data collected to date, is presented in Figure 10 and Figure 11.

Generally, it is likely remediation to minimise human health risk will also address potential ecological risk.

The paddock area does not contain any contaminant concentrations posing potential human health risk based on the development plan.

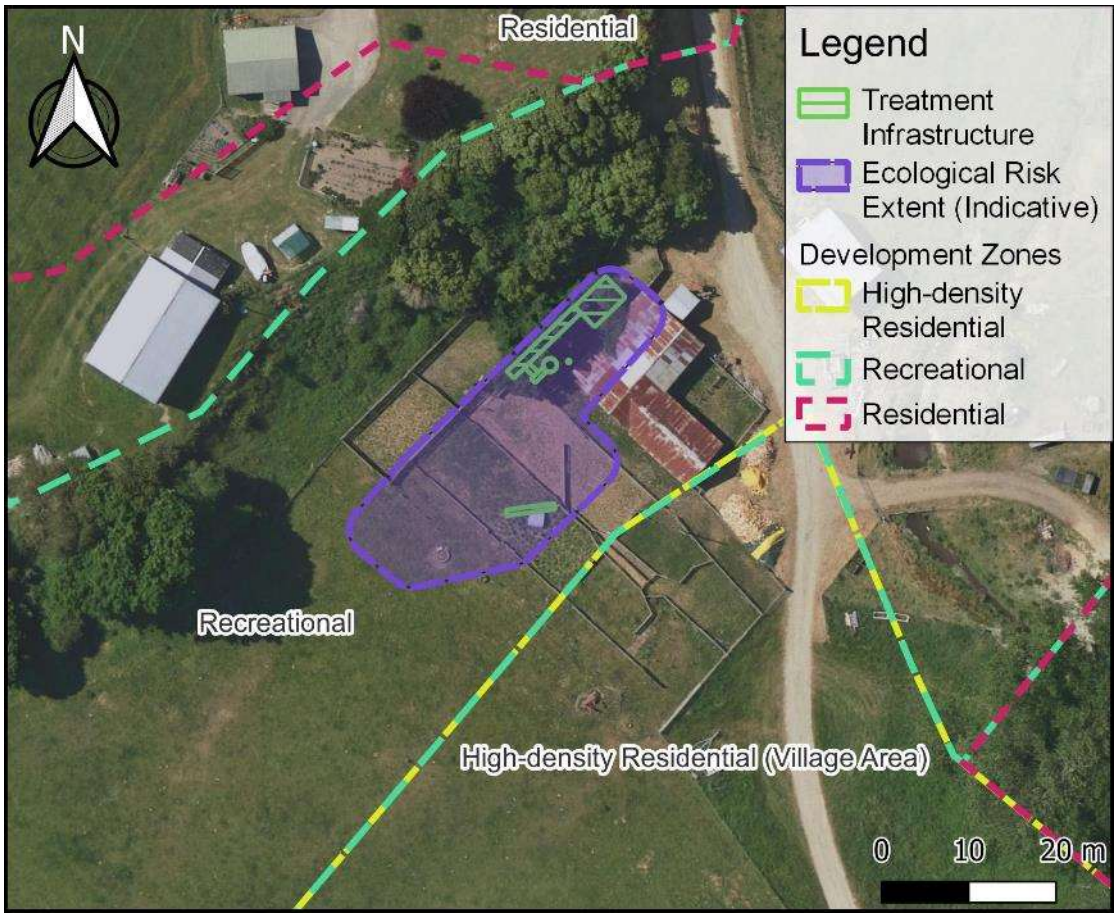


Figure 10 – Potential Ecological Risk Extent – Aerial Basemap

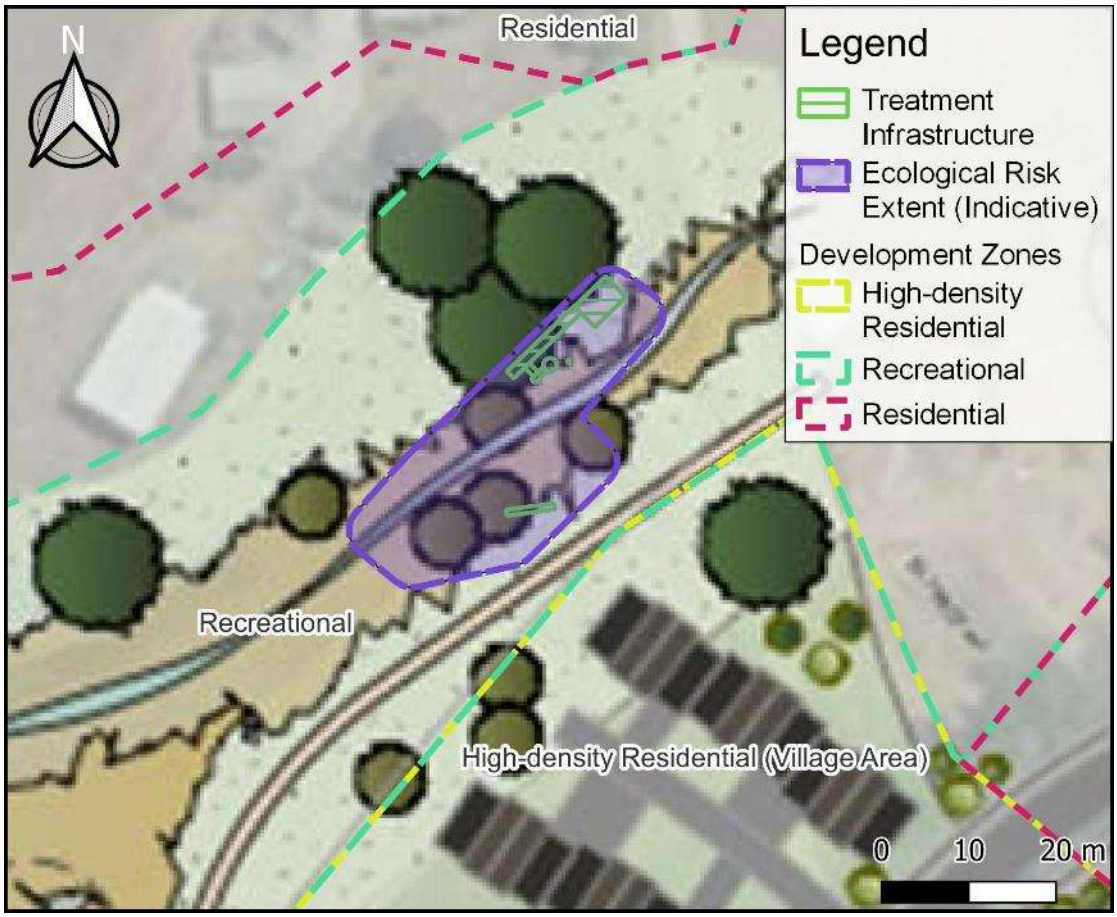


Figure 11 – Potential Ecological Risk Extent – Development Plan

6.1 Soil Management

No samples from the woolshed area are classifiable as cleanfill and the only realistic off-site disposal option for this soil would be York Valley Landfill if it cannot be retained on-site. Soil in the hotspot areas exceeds York Valley's initial screening criteria. TCLP testing indicates that most soil is suitable for disposal at York Valley; however, two samples from around the treatment area exceed acceptance limits for aldrin and zinc. Pre-treatment of soil from that area may be required before landfill acceptance.

If soil exceeding recreational human health standards was to be retained on site, it would need to be managed in a way to minimise risks posed to human health and the environment.

Soil from the woolshed area not requiring remediation should not be reused in residential areas without further assessment.

Naturally elevated concentrations of chromium and nickel are noted, though observed concentrations were generally below cleanfill acceptance limits. Soil in the paddock area appears to be classifiable as cleanfill.

It is considered likely that the village area of the development may need to be raised for flood risk mitigation. If soil from the woolshed area, meeting residential standards, can be re-used, this may reduce the volume of excess soil requiring management.

7.0 PLANNING CONSIDERATIONS

This report has identified HAIL activities having been undertaken on the site and, as such, it is considered to be a '*piece of land*' under the NESCS.

The DSI indicates that contaminants in soil exceed the NESCS soil contaminant standards in the woolshed area. As such, subdivision, change of use, and soil disturbance are considered to be restricted discretionary activities under Regulation 10 of the NESCS and a resource consent is therefore required.

As contaminant concentrations exceed human health standards, a remediation action plan (RAP) will be a likely condition of a resource consent. The RAP will provide a methodology to reduce potential risks posed to human health and environmental receptors to acceptable levels.

The NESCS may likely remain applicable to activities carried out on the developed lots unless it can be demonstrated that soil contaminant concentrations do not exceed background levels. Demonstration that the concentrations of heavy metals recorded in the paddock area represent naturally elevated may be worthwhile to avoid future planning requirements for the village area. Given, the concentrations of contaminants in the woolshed area, remediation to background would likely to be both very expensive and difficult, and therefore is not advisable.

The standard residential lots are located outside the area of identified HAIL activities and activities in these areas should not require NESCS resource consents.

The appropriate management of contaminated soil during redevelopment works will be essential to ensure that cross-contamination of "clean" areas does not occur as this may impose future constraints on them.

If soil with significantly elevated contaminant concentrations is to be managed on-site, a resource consent for contaminant discharge under the NRMP may be required.

It should also be noted that while the existing buildings and associated curtilage areas have not been assessed as part of this investigation as they have not been directly associated with any hazardous activities or industries. However, prior to removing any building outside of the area that has been assessed, it is recommended the buildings are surveyed for the presence of asbestos, by a suitably qualified company, before they are demolished or removed. Likewise, the former homestead area on the terrace to the northeast of the woolshed has not been investigated. Shallow soil samples should be collected from the area to assess potential impacts related to the demolition (possible fire) of the former structures.

8.0 ASSESSMENT OF REMEDIAL OPTIONS

As arsenic and dieldrin concentrations in soil exceed the relevant guideline values, a potential risk is posed to future site users. Mitigation measures are, therefore, required to manage the risk. As treatment options for arsenic and dieldrin are limited, the most practical approaches for risk mitigation are the removal of the contaminant or the prevention of site users being exposed to it by covering the contaminant with a layer of pavement or soil.

The extent of remediation required is partially dependant on the client's objectives. Based on the current development plan, significant excavation will be required in the woolshed area to reroute Kaka Stream. Once the contaminated soil is excavated, it could either be disposed of at York Valley Landfill or placed in a containment cell on the site.

Soil exceeding recreational standards and retained on site would need to be placed in such a way that site users would not be exposed to it. Additionally, it would need to be placed away from watercourses and the groundwater table to avoid leaching of contaminants into groundwater and surface waters. The site has not been assessed for the siting of a possible containment cell but would likely need to be placed on an elevated part of the site. Given the other development constraints and a shortage of flat land at higher elevation, off-site disposal may be the most cost-effective option.

Pre-treatment of the soil in the vicinity of the sump may be required before it can be accepted by a landfill. As exceedances were only recorded in two samples, blending of the soil from the area may be sufficient to reduce contaminant concentrations in leachate. If blending was not sufficient, additions of organic matter and/or pH adjustment would likely be required to reduce contaminant leachability. Any pre-treatment would require benchtop trials to confirm its effectiveness before implementation.

The shallow hardfill in the woolshed area is noted to contain a significant fraction of coarse-grained content. Contaminants are typically found adsorbed to finer-grained soil particles and organic matter. There may be an opportunity to "sieve" soil on site to recover the coarse fraction for re-use on site, leaving a reduced volume requiring treatment and off-site disposal. This approach would require further assessment and benchtop trials as well as appropriate site plant to implement.

Excavations associated with contaminated soil removal and the rerouting of Kaka Stream may intersect the groundwater table. Given the contaminant concentrations recorded in soil and in the water sample collected from the standpipe, treatment of water pumped from excavations will likely be required prior to discharge. Should dewatering be necessary, further assessment of contaminants in groundwater in the hotspot area should be undertaken to inform treatment requirements. As both heavy metals and organics are likely to be present, a combination of coagulation/flocculation and filtration through a reactive media (activated carbon) is likely to be the most effective treatment method if required.

The area and depth of soil requiring remediation has not been fully delineated due to the soil type and limits of hand excavation. Further investigation is recommended to reduce uncertainty around scope and costs.

If any soil with contaminant concentrations above human health standards remains on site (in the case of management using a capping layer), an 'ongoing site management plan' will be required and future activities in those areas may require resource consents.

Further details on remediation and validation requirements will be included in the RAP once a remediation strategy is chosen. The RAP should be prepared by a suitably qualified and experienced practitioner – land contamination (SQEP).

9.0 CONCLUSIONS AND RECOMMENDATIONS

9.1 Conclusions

The site has operated as a farm since the earliest available aerial photograph (1940s); previously stocking sheep and cattle. A woolshed and associated sheep pens are present in much the same configuration as in the 1940s photograph and sheep treatment infrastructure has been observed on site. While no horticulture was noted in any aerial photographs, anecdotal evidence suggests that hops were grown at the site.

A site investigation was undertaken to assess potential impacts from the identified HAIL activities historically undertaken in the area. The investigation targeted the woolshed area as well the paddocks south of the woolshed, which is considered a likely location for crops to have been grown.

Samples were collected from topsoil in both areas and analysed for the relevant contaminants of concern. Additional samples were collected from shallow subsoil in the woolshed area to assist in delineating elevated contaminant concentrations.

No samples collected from the paddock (excepting the samples associated with sheep exiting the treatment area) contained concentrations of contaminants above human health standards. Some metals, particularly nickel, appear to be naturally elevated, but within background levels.

The former sheep treatment area shows significant impact from arsenic and dieldrin with several samples containing concentrations above human health standards for recreational usage and ecological screening levels. As such, soil contamination in this area poses a potential risk to human health and ecological receptors given the proposal to reroute Kaka Stream through this area. Remediation and management will be required to mitigate these potential risks. The affected area includes some of the pens around the woolshed. The area which soil would be unsuitable for residential usage extends out into the paddock, likely from where treated sheep exited the pens.

It is considered likely that remediation measures taken to minimise human health risk will appropriately address potential ecological risks, in particular the removal of the most heavily contaminated soil around the treatment area. For this reason, further assessment of the ecological risk posed by contaminated soil would only be recommended if the soil were to remain in-situ.

As a “piece of land”, the site will require a NESCS resource consent for subdivision, change of use, and/or soil disturbance. Due to the exceedance of NESCS standards in the area, the activity would likely be considered a restricted discretionary activity. A likely condition of a resource consent would be the preparation of a RAP. The RAP should be prepared by a SQEP.

The RAP will provide a methodology to reduce potential risks posed to human health and environmental receptors to acceptable levels.

Remedial options are highly dependent on the proposed development as the capping of contaminated soil may not be appropriate in the vicinity of watercourses.

Some options that may be applicable to the development are:

- The excavation of soil exceeding human health standards; and
  - Off-site disposal and/or
  - Management in another part of the development (such as a recreational reserve) away from watercourses.
- Capping of soil exceeding human health standards with “clean” cover soil.
- Solidification and stabilisation of contaminated soil to prevent leaching and reduce bioavailability.
- The redesign of the development to minimise disturbance of contaminated soils.

If excavations of greater depth than 1 m are required, groundwater may be intercepted and require dewatering. Water pumped from excavations may require additional treatment to addressed dissolved-phase contaminants. Contaminant concentrations in groundwater have not been assessed.

It may be possible to reduce the volume of soil requiring off-site disposal by “sieving out” the coarse (gravel) fraction of the hardfill in the sheep pens. Further soil analysis would be required to assess the feasibility of this option and it may not be cost-effective.

Discussions should be held with the project’s geotechnical consultant to assess the feasibility of re-using soil from the assessed areas in other areas of the development.

Appropriate soil management will be required to avoid cross-contamination of “clean” soil. It appears that the majority of the site has contaminant concentrations at background levels. The contamination of these areas by the mixing or managing of soil from contaminated areas may result in future planning constraints.

The remediation objectives and methodologies will be detailed in the RAP following discussions with the client and NCC.

9.2 Recommendations

To facilitate the residential development, we recommend to:

- Obtain a resource consent under the NESCS for the required works;
- Undertake additional site assessment to close the relevant data gaps and reduce cost uncertainties;
- Determine the most appropriate remediation methodology based on client and council requirements;
- Produce a RAP for council approval; and
- Undertaken earthworks in accordance with the RAP and resource consent conditions.

Further site investigation is recommended to better understand areas and media impacted to assist in managing development costs and constraints. Discussions should be held prior to scoping to determine the client’s objectives regarding risk management.

The following are data gaps that may be required to support specific remediation options and better define financial implications:

- The maximum depth of soil requiring remediation is unknown.
    - While excavation deeper than 600 mm below finished ground level is not likely to be necessary to manage human health risk, it may be required as part of the development with regard to the realignment of Kaka Stream. Understanding the cost of managing this soil would reduce uncertainties.
- Contaminant concentrations in shallow groundwater are unknown;
    - Where excavations in the woolshed area intersect groundwater, dewatering may be necessary. An understanding of contaminant concentrations in groundwater as well as the likely yield would allow planning and budgeting for required treatment.
- The treatability of shallow soil has not been investigated.
    - Physical separation may reduce off-site disposal costs. Particle size assessment and chemical analysis of the different size fractions would be required to determine the feasibility of this option.
    - The most contaminated soil may require pre-treatment in order to be accepted by York Valley Landfill. Pre-treatment would likely consist of solidification and stabilisation of soil to reduce leachability of contaminants. A "bench trial" would be required to determine the effectiveness of this option prior to full-scale implementation.
- Potential contaminants in shallow soil in the former or current homestead area have not been assessed as part of this investigation.
    - Shallow soil should be sampled and analysed for potential contaminants associated with the possible fire and demolition of the former homestead and associated structures prior to the disturbance of this area.

To facilitate the construction of non-HAIL parts of the site, it is recommended that the consents associated with the development include a condition stating that:

- No construction work will be undertaken in the woolshed area until the RAP is submitted to Council for approval. The woolshed area is defined as the area exceeding residential standards as indicated in Figure 8;
- No construction work will be undertaken in the former or current homestead area (shown in Figure 12, below) until the RAP, including assessment of this area, is submitted to Council for approval.
- Construction work associated with the development outside of the woolshed and former homestead areas can continue.

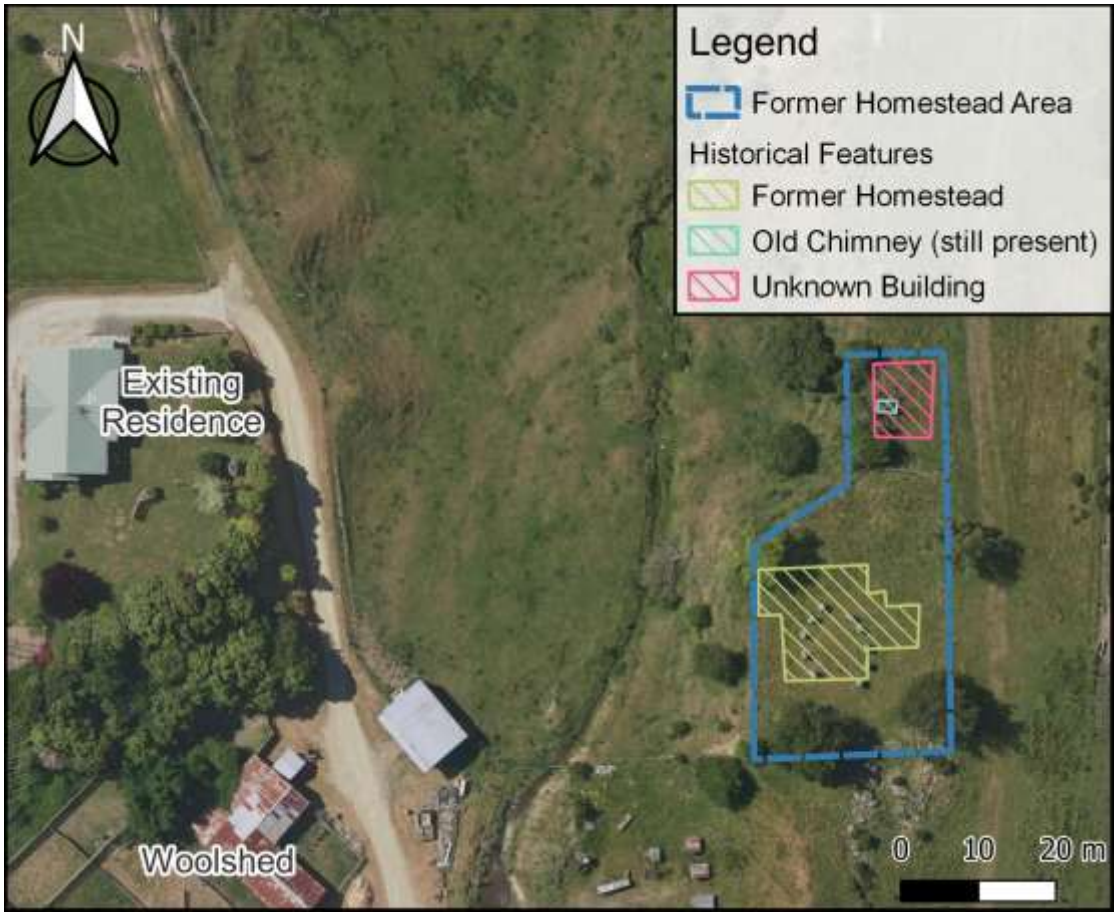


Figure 12 – Former Homestead Area

10.0 LIMITATIONS

This report has been prepared solely for the purposes of CCKV MAITAI DEV CO LP and Nelson City Council. The information contained herein is confidential and shall not be passed on to any third party without prior written permission of Envirolink. No responsibility is accepted for any use outside the scope of this report.

This report has been prepared based on site conditions as they exist at the time of the investigation. If subsequent investigations or remedial actions are undertaken from the date of this report then certain aspects of this report may no longer be relevant or require amendment. In addition, if HAIL activities occur on the site after the date of this report, then the conclusions and recommendations presented in this report may no longer be relied on.

Discussion on the sampling methods and results in this report are based on current recognised guidelines and trigger values. These methods and assessment criteria may change and concentrations of a contaminant, which are currently deemed acceptable, may in the future become subject to new or updated standards. This may cause the contaminant concentrations to become unacceptable and require further management or remediation to enable the site to be deemed suitable for existing or proposed land use activities.

It is not practicable for any investigation to be so complete that it can accurately detect all contaminants and establish a detailed record of their concentrations throughout a site. However, the current investigation has been carried out to provide a level of characterisation commensurate with an acceptable assessment of site conditions.

This investigation was carried out solely for the purpose of assessing contaminants in the soil associated with the land being suitable for human occupation only. It has purposely not assessed the possible impacts of contaminants on ecological values that may be associated with the site. Any other investigations that are required to determine the suitability of this property are outside the scope of this report.

Appendix A
Proposed Development Plans

rough & milne landscape architects

MAITAHI VILLAGE

CONCEPT PLAN OVERLAY

Appendix B
Site Photographs

Photo 1: View of the woolshed and paddock areas from the terrace containing the former homestead.

Photo 2: Area of the former homestead.

Photo 3: Building material in the vicinity of the former homestead, presumably stone walls.

Photo 4: View of the paddock area facing west.

Photo 5: View of the paddock from the approximate area of sample KV27, facing south.

Photo 6: The woolshed and pens, facing north. The treatment area is on the left (western) side. The footbath is out of the photo, to the right.

Photo 7: View of the pre-treatment holding area, facing north.

Photo 8: The treatment area. The concreted area on the right is likely the spray area. A grass-covered concrete sump is present in the foreground of the photo.

Photo 9: The treatment area facing southwest. The orange oval indicates the location of the standpipe. The red oval indicates the location of the sump.

Photo 10: The treatment area facing northeast. The orange oval indicates the location of the standpipe. The red oval indicates the location of the sump.

Photo 11: The footbath in front of the woolshed.

Photo 12: Sample locations KV22 and KV30.

Photo 13: Hardfill from KV30.

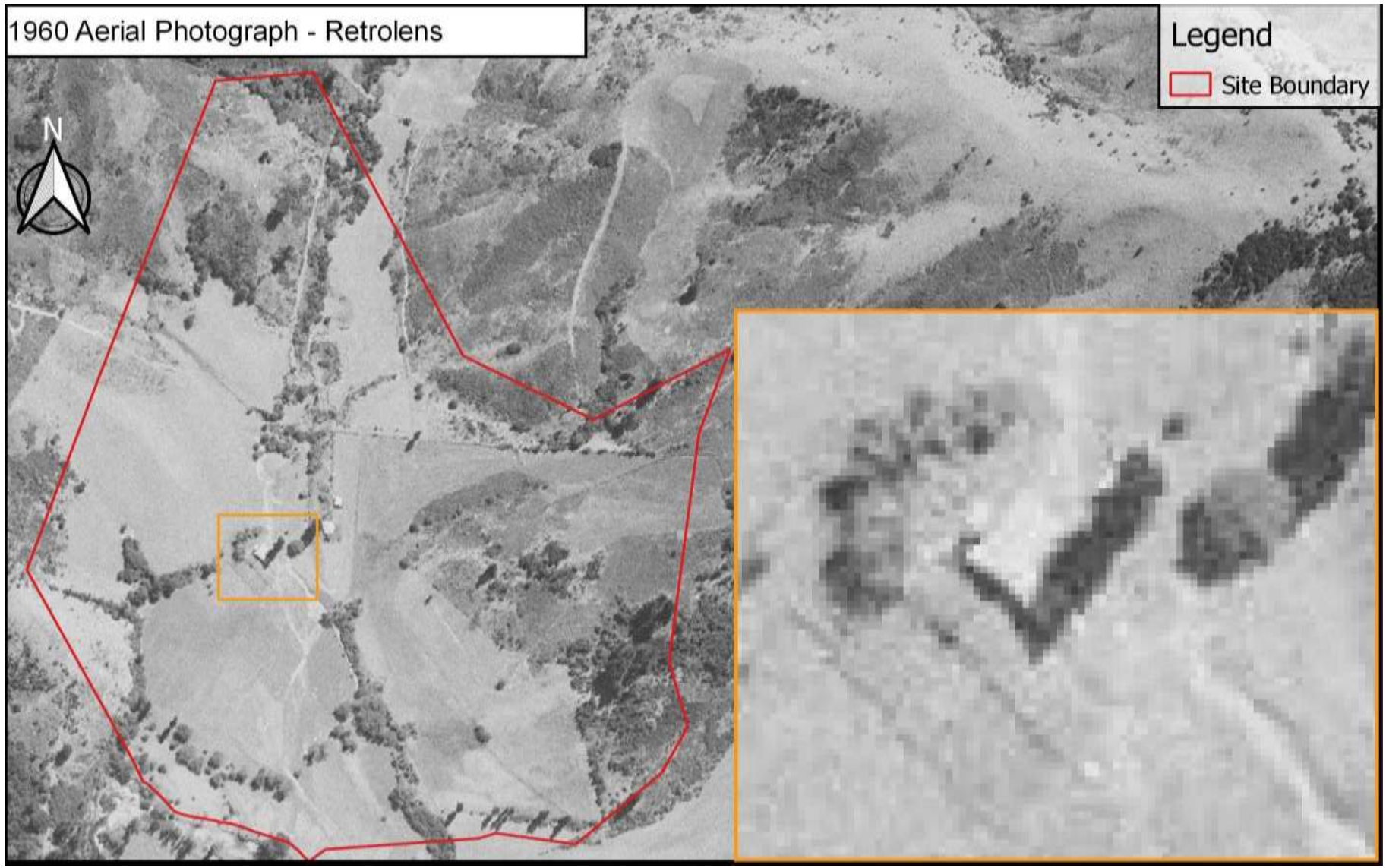
Photo 14: KV30 0-500 mm below ground level.

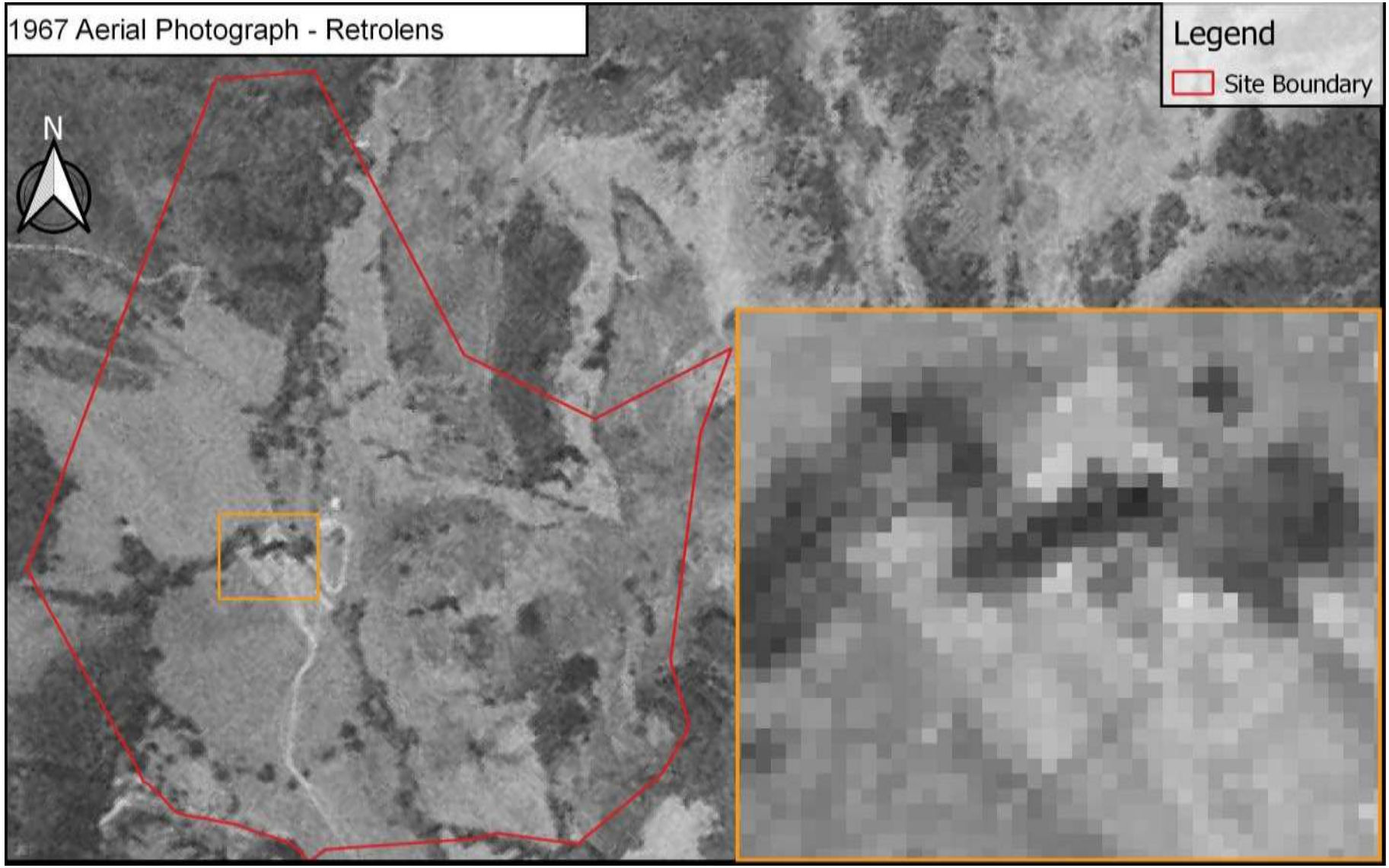
Photo 15: Sample locations KV20 and KV32.

Photo 16: Hardfill from KV32.

Appendix C
Historical Aerial Photography

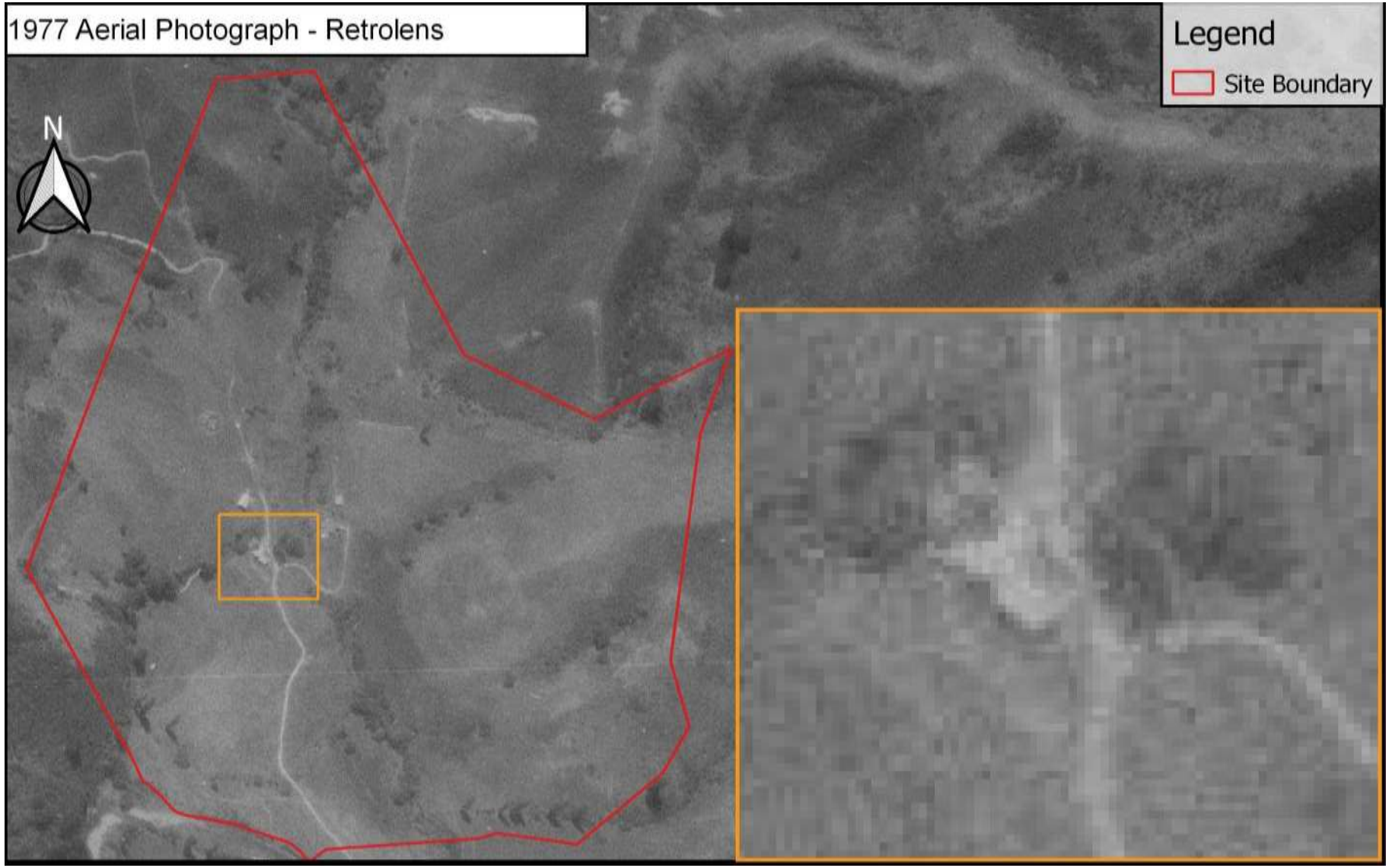

1940s Aerial Photograph - Nelson City Council
Legend
Site Boundary
N


1960 Aerial Photograph - Retrolens
Legend
Site Boundary
N


1967 Aerial Photograph - Retrolens
Legend
Site Boundary
N


1969 Aerial Photograph - Retrolens
Legend
Site Boundary
N


1970s Aerial Photograph - Nelson City Council
Legend
Site Boundary
N


1977 Aerial Photograph - Retrolens
Legend
Site Boundary
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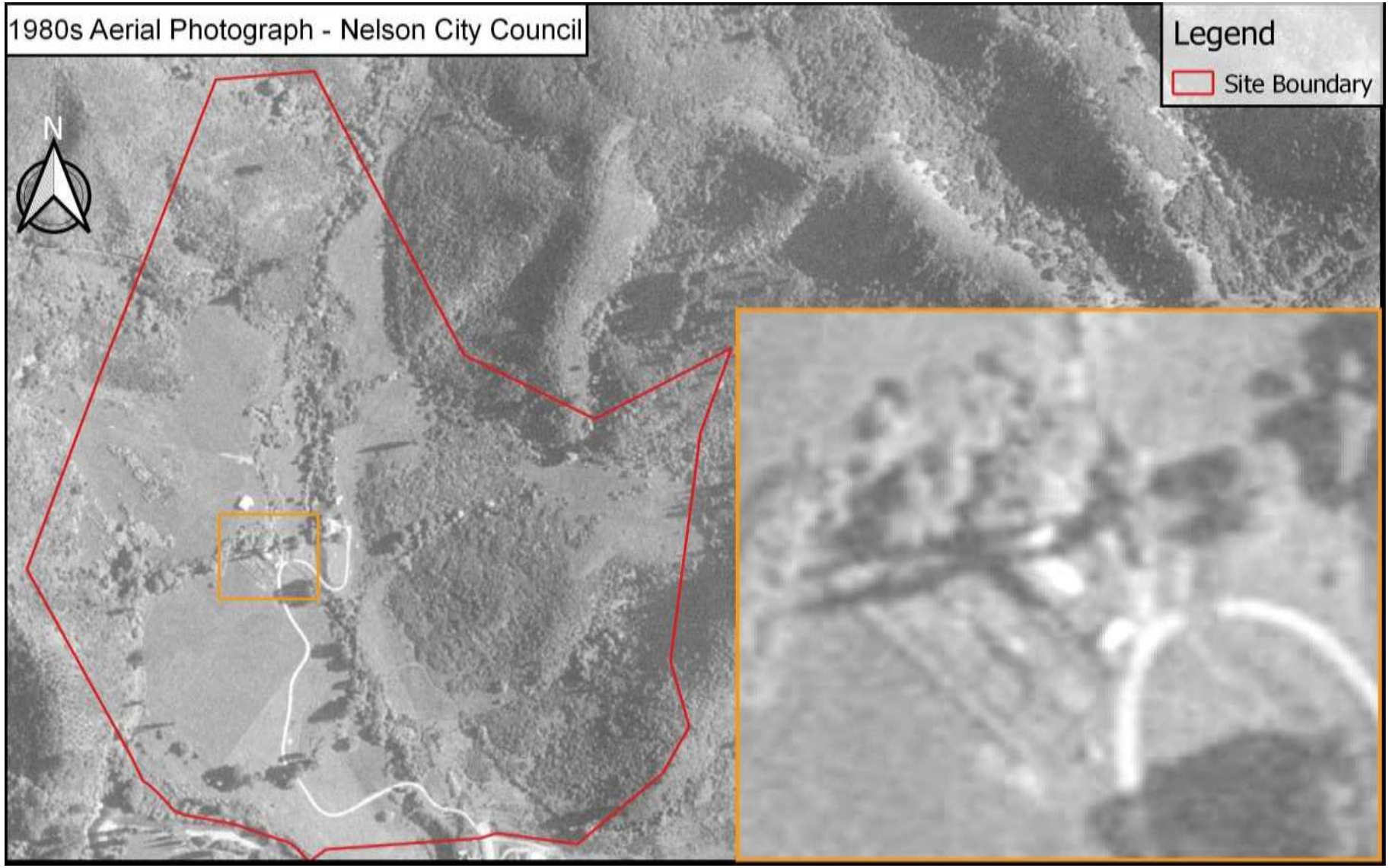
1980s Aerial Photograph - Nelson City Council
Legend
Site Boundary
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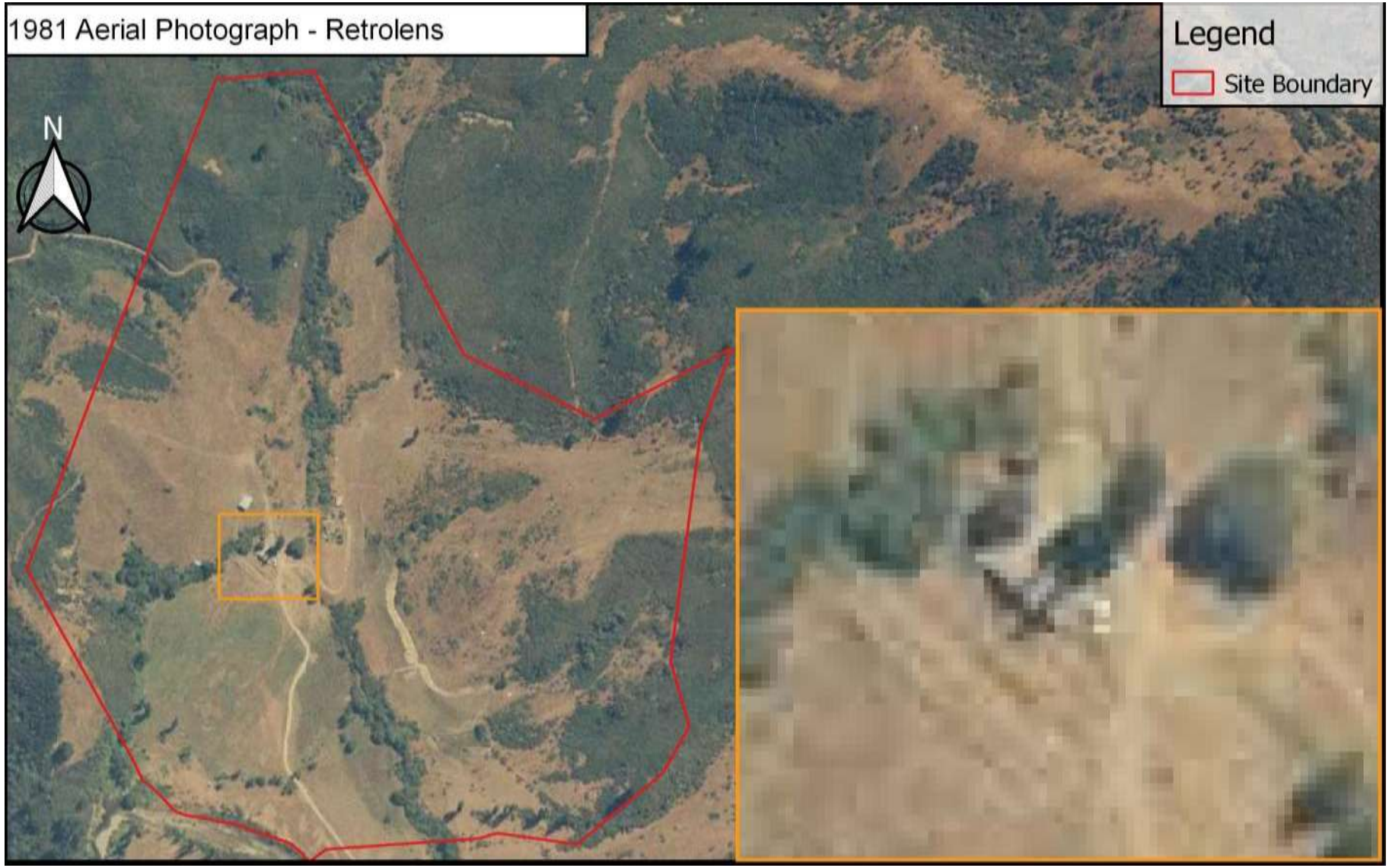
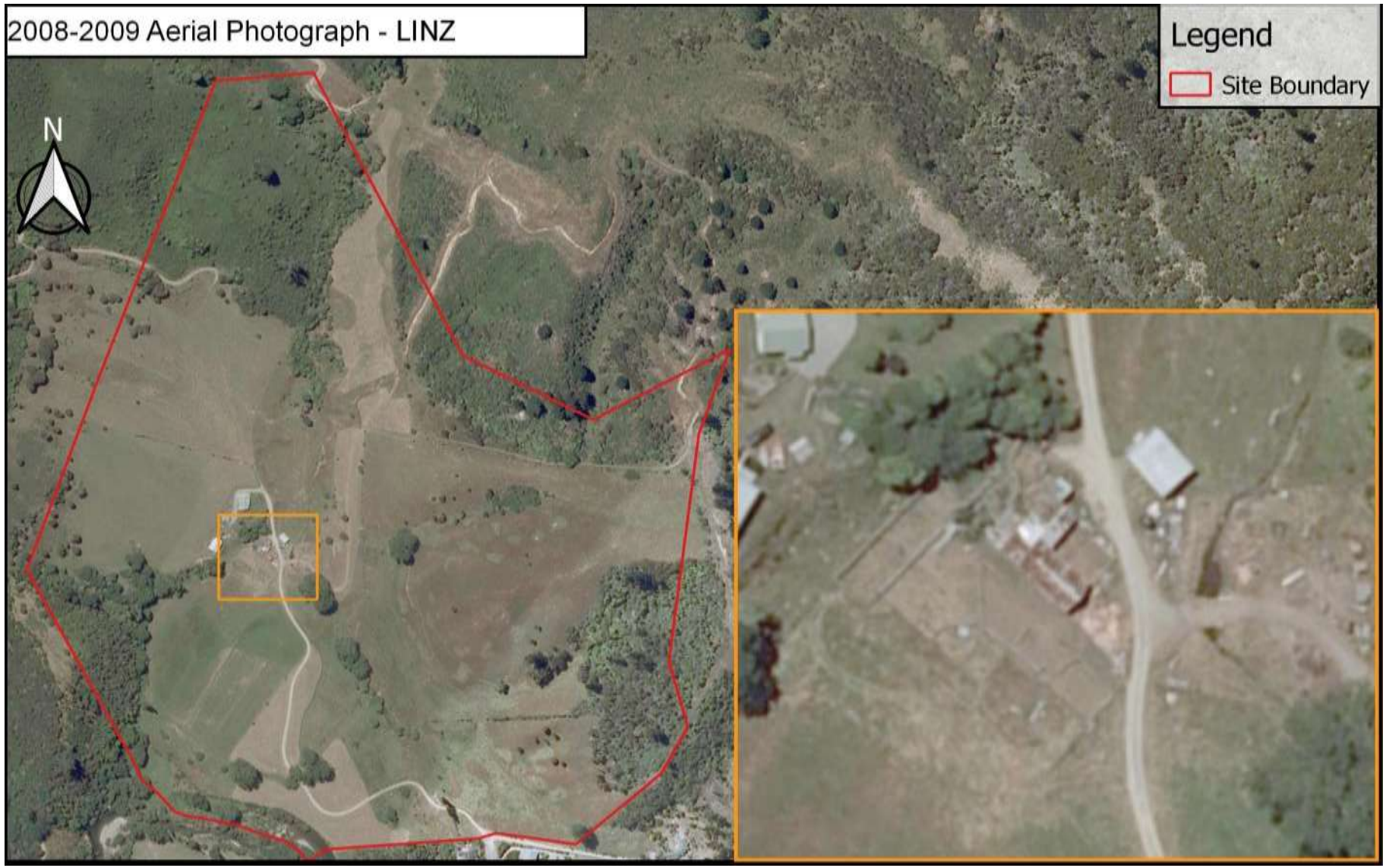

1981 Aerial Photograph - Retrolens
Legend
Site Boundary
N


1983 Aerial Photograph - Retrolens
N
Legend
Site Boundary


2008-2009 Aerial Photograph - LINZ
Legend
Site Boundary
N


2014 Aerial Photograph - LINZ
Legend
Site Boundary
N


2018-2019 Aerial Photograph - LINZ
Legend
Site Boundary
N

Appendix D
Laboratory Certificates of Analysis

Hill Laboratories
TRIED, TESTED AND TRUSTED

R J Hill Laboratories Limited
28 Duke Street Frankton 3204
Private Bag 3205
Hamilton 3240 New Zealand

T 0508 HILL LAB (44 555 22)
T +64 7 858 2000
E mail@hill-labs.co.nz
W www.hill-laboratories.com

Certificate of Analysis

Client:	Envirolink Limited	**Lab No:**	2730159	SPv3
Contact:	Marty O'Cain	**Date Received:**	08-Oct-2021	
	C/- Envirolink Limited	**Date Reported:**	01-Dec-2021	**(Amended)**
	20 Stafford Drive	**Quote No:**	114280	
	Ruby Bay	**Order No:**		
	Mapua 7005	**Client Reference:**	J000300 - Kaka Valley	
		Submitted By:	David Duncan	

Sample Type: Soil

Sample Name:		KV9 06-Oct-2021	KV10 06-Oct-2021	KV11 06-Oct-2021	KV12 06-Oct-2021	KV13 06-Oct-2021
Lab Number:		2730159.13	2730159.14	2730159.15	2730159.16	2730159.17
Individual Tests						
Dry Matter	g/100g as rcvd	77	42	76	65	68
TCLP Weight of Sample Taken	g	-	50	50	50	-
TCLP Initial Sample pH	pH Units	-	7.0	7.2	7.4	-
TCLP Acid Adjusted Sample pH	pH Units	-	1.9	1.7	1.7	-
TCLP Extractant Type*		-	NaOH/Acetic acid at pH 4.93 +/- 0.05	NaOH/Acetic acid at pH 4.93 +/- 0.05	NaOH/Acetic acid at pH 4.93 +/- 0.05	-
TCLP Extraction Fluid pH	pH Units	-	4.9	4.9	4.9	-
TCLP Post Extraction Sample pH	pH Units	-	5.0	5.0	5.0	-
Heavy Metals, Screen Level						
Total Recoverable Arsenic	mg/kg dry wt	17	108	450	580	270
Total Recoverable Cadmium	mg/kg dry wt	0.19	10.4	9.8	16.3	3.6
Total Recoverable Chromium	mg/kg dry wt	77	89	98	104	107
Total Recoverable Copper	mg/kg dry wt	55	81	96	124	72
Total Recoverable Lead	mg/kg dry wt	20	200	390	152	179
Total Recoverable Nickel	mg/kg dry wt	63	73	90	82	53
Total Recoverable Zinc	mg/kg dry wt	188	5,500	610	480	900
Organochlorine Pesticides Screening in Soil						
Aldrin	mg/kg dry wt	< 0.013	< 0.03	0.077	0.62	0.020
alpha-BHC	mg/kg dry wt	< 0.013	< 0.03	0.129	0.131	< 0.015
beta-BHC	mg/kg dry wt	< 0.013	< 0.03	0.143	0.124	0.018
delta-BHC	mg/kg dry wt	< 0.013	< 0.03	0.024	0.018	< 0.015
gamma-BHC (Lindane)	mg/kg dry wt	< 0.013	< 0.03	0.033	0.028	< 0.015
cis-Chlordane	mg/kg dry wt	< 0.013	< 0.03	< 0.013	< 0.015	< 0.015
trans-Chlordane	mg/kg dry wt	< 0.013	< 0.03	< 0.013	< 0.015	< 0.015
2,4'-DDD	mg/kg dry wt	< 0.013	< 0.03	0.037	0.46	0.080
4,4'-DDD	mg/kg dry wt	< 0.013	< 0.03	0.033	0.127	0.040
2,4'-DDE	mg/kg dry wt	< 0.013	< 0.03	< 0.013	< 0.015	< 0.015
4,4'-DDE	mg/kg dry wt	< 0.013	< 0.03	0.068	0.80	0.064
2,4'-DDT	mg/kg dry wt	< 0.013	< 0.03	0.025	0.150	0.025
4,4'-DDT	mg/kg dry wt	< 0.013	< 0.03	0.103	2.7	0.135
Total DDT Isomers	mg/kg dry wt	< 0.08	< 0.15	0.27	4.2	0.34
Dieldrin	mg/kg dry wt	0.024	3.2	78	240	36
Endosulfan I	mg/kg dry wt	< 0.013	< 0.03	< 0.013	< 0.015	< 0.015
Endosulfan II	mg/kg dry wt	< 0.013	< 0.03	< 0.013	< 0.015	< 0.015
Endosulfan sulphate	mg/kg dry wt	< 0.013	< 0.03	< 0.013	< 0.015	< 0.015
Endrin	mg/kg dry wt	< 0.013	< 0.03	0.63	2.9	0.34
Endrin aldehyde	mg/kg dry wt	< 0.013	< 0.03	< 0.013	< 0.015	< 0.015
Endrin ketone	mg/kg dry wt	< 0.013	< 0.03	0.29	0.64	0.183

Sample Type: Soil						
Sample Name:		KV9 06-Oct-2021	KV10 06-Oct-2021	KV11 06-Oct-2021	KV12 06-Oct-2021	KV13 06-Oct-2021
Lab Number:		2730159.13	2730159.14	2730159.15	2730159.16	2730159.17
Organochlorine Pesticides Screening in Soil						
Heptachlor	mg/kg dry wt	< 0.013	< 0.03	< 0.013	< 0.015	< 0.015
Heptachlor epoxide	mg/kg dry wt	< 0.013	< 0.03	< 0.013	< 0.015	< 0.015
Hexachlorobenzene	mg/kg dry wt	< 0.013	< 0.03	< 0.013	< 0.015	< 0.015
Methoxychlor	mg/kg dry wt	< 0.013	< 0.03	< 0.013	< 0.015	< 0.015

Sample Name:		KV14 06-Oct-2021	KV15 06-Oct-2021	KV16 06-Oct-2021	KV17 06-Oct-2021	KV18 06-Oct-2021
Lab Number:		2730159.18	2730159.19	2730159.20	2730159.21	2730159.22
Individual Tests						
Dry Matter	g/100g as rcvd	71	55	74	-	69
TCLP Weight of Sample Taken	g	100	-	-	-	-
TCLP Initial Sample pH	pH Units	6.3	-	-	-	-
TCLP Acid Adjusted Sample pH	pH Units	1.8	-	-	-	-
TCLP Extractant Type*		NaOH/Acetic acid at pH 4.93 +/- 0.05	-	-	-	-
TCLP Extraction Fluid pH	pH Units	4.9	-	-	-	-
TCLP Post Extraction Sample pH	pH Units	4.9	-	-	-	-
Heavy Metals, Screen Level						
Total Recoverable Arsenic	mg/kg dry wt	420	158	-	31	35
Total Recoverable Cadmium	mg/kg dry wt	15.6	11.5	-	0.42	0.34
Total Recoverable Chromium	mg/kg dry wt	109	85	-	142	87
Total Recoverable Copper	mg/kg dry wt	67	96	-	51	49
Total Recoverable Lead	mg/kg dry wt	176	200	-	37	22
Total Recoverable Nickel	mg/kg dry wt	89	65	-	210	147
Total Recoverable Zinc	mg/kg dry wt	750	1,440	-	550	300
Organochlorine Pesticides Screening in Soil						
Aldrin	mg/kg dry wt	9.9	0.69	1.50	-	< 0.015
alpha-BHC	mg/kg dry wt	0.050	< 0.019	0.67	-	< 0.015
beta-BHC	mg/kg dry wt	0.21	0.049	7.4	-	< 0.015
delta-BHC	mg/kg dry wt	< 0.014	< 0.019	0.096	-	< 0.015
gamma-BHC (Lindane)	mg/kg dry wt	< 0.014	< 0.019	0.131	-	< 0.015
cis-Chlordane	mg/kg dry wt	< 0.014	< 0.019	< 0.013	-	< 0.015
trans-Chlordane	mg/kg dry wt	< 0.014	< 0.019	< 0.013	-	< 0.015
2,4'-DDD	mg/kg dry wt	0.81	1.96	0.36	-	< 0.015
4,4'-DDD	mg/kg dry wt	0.145	0.96	0.102	-	< 0.015
2,4'-DDE	mg/kg dry wt	< 0.014	< 0.019	< 0.013	-	< 0.015
4,4'-DDE	mg/kg dry wt	0.081	0.36	1.23	-	< 0.015
2,4'-DDT	mg/kg dry wt	< 0.014	< 0.019	0.195	-	< 0.015
4,4'-DDT	mg/kg dry wt	0.150	0.184	3.4	-	< 0.015
Total DDT Isomers	mg/kg dry wt	1.19	3.5	5.3	-	< 0.09
Dieldrin	mg/kg dry wt	620	153	400	-	0.153
Endosulfan I	mg/kg dry wt	< 0.014	< 0.019	< 0.013	-	< 0.015
Endosulfan II	mg/kg dry wt	< 0.014	< 0.019	< 0.013	-	< 0.015
Endosulfan sulphate	mg/kg dry wt	< 0.014	< 0.019	< 0.013	-	< 0.015
Endrin	mg/kg dry wt	3.9	0.59	5.8	-	< 0.015
Endrin aldehyde	mg/kg dry wt	< 0.014	< 0.019	< 0.013	-	< 0.015
Endrin ketone	mg/kg dry wt	1.25	0.21	0.50	-	< 0.015
Heptachlor	mg/kg dry wt	< 0.014	< 0.019	< 0.013	-	< 0.015
Heptachlor epoxide	mg/kg dry wt	< 0.014	< 0.019	< 0.013	-	< 0.015
Hexachlorobenzene	mg/kg dry wt	< 0.014	< 0.019	< 0.013	-	< 0.015
Methoxychlor	mg/kg dry wt	< 0.014	< 0.019	< 0.013	-	< 0.015

Sample Name:		KV19 06-Oct-2021	KV20 06-Oct-2021	KV21 06-Oct-2021	KV22 06-Oct-2021	KV24 06-Oct-2021
Lab Number:		2730159.23	2730159.24	2730159.25	2730159.26	2730159.28

Sample Type: Soil						
Sample Name:		KV19 06-Oct-2021	KV20 06-Oct-2021	KV21 06-Oct-2021	KV22 06-Oct-2021	KV24 06-Oct-2021
Lab Number:		2730159.23	2730159.24	2730159.25	2730159.26	2730159.28
Individual Tests						
Dry Matter	g/100g as rcvd	81	68	63	-	-
TCLP Weight of Sample Taken	g	-	50	100	50	50
TCLP Initial Sample pH	pH Units	-	6.3	6.4	6.6	6.1
TCLP Acid Adjusted Sample pH	pH Units	-	1.7	1.8	1.6	1.5
TCLP Extractant Type*		-	NaOH/Acetic acid at pH 4.93 +/- 0.05	NaOH/Acetic acid at pH 4.93 +/- 0.05	NaOH/Acetic acid at pH 4.93 +/- 0.05	NaOH/Acetic acid at pH 4.93 +/- 0.05
TCLP Extraction Fluid pH	pH Units	-	4.9	4.9	4.9	4.9
TCLP Post Extraction Sample pH	pH Units	-	4.9	4.9	4.9	4.9
Heavy Metals, Screen Level						
Total Recoverable Arsenic	mg/kg dry wt	31	89	90	53	86
Total Recoverable Cadmium	mg/kg dry wt	0.30	0.49	0.52	1.10	0.32
Total Recoverable Chromium	mg/kg dry wt	124	127	113	119	149
Total Recoverable Copper	mg/kg dry wt	43	97	88	119	450
Total Recoverable Lead	mg/kg dry wt	19.0	31	50	137	43
Total Recoverable Nickel	mg/kg dry wt	195	240	185	128	200
Total Recoverable Zinc	mg/kg dry wt	190	260	230	680	590
Organochlorine Pesticides Screening in Soil						
Aldrin	mg/kg dry wt	< 0.013	< 0.015	< 0.016	-	-
alpha-BHC	mg/kg dry wt	< 0.013	< 0.015	< 0.016	-	-
beta-BHC	mg/kg dry wt	< 0.013	0.016	< 0.016	-	-
delta-BHC	mg/kg dry wt	< 0.013	< 0.015	< 0.016	-	-
gamma-BHC (Lindane)	mg/kg dry wt	< 0.013	< 0.015	< 0.016	-	-
cis-Chlordane	mg/kg dry wt	< 0.013	< 0.015	< 0.016	-	-
trans-Chlordane	mg/kg dry wt	< 0.013	< 0.015	< 0.016	-	-
2,4'-DDD	mg/kg dry wt	< 0.013	< 0.015	< 0.016	-	-
4,4'-DDD	mg/kg dry wt	< 0.013	< 0.015	< 0.016	-	-
2,4'-DDE	mg/kg dry wt	< 0.013	< 0.015	< 0.016	-	-
4,4'-DDE	mg/kg dry wt	< 0.013	< 0.015	< 0.016	-	-
2,4'-DDT	mg/kg dry wt	< 0.013	< 0.015	< 0.016	-	-
4,4'-DDT	mg/kg dry wt	< 0.013	< 0.015	< 0.016	-	-
Total DDT Isomers	mg/kg dry wt	< 0.08	< 0.09	< 0.10	-	-
Dieldrin	mg/kg dry wt	0.074	4.0	9.5	-	-
Endosulfan I	mg/kg dry wt	< 0.013	< 0.015	< 0.016	-	-
Endosulfan II	mg/kg dry wt	< 0.013	< 0.015	< 0.016	-	-
Endosulfan sulphate	mg/kg dry wt	< 0.013	< 0.015	< 0.016	-	-
Endrin	mg/kg dry wt	< 0.013	0.016	0.036	-	-
Endrin aldehyde	mg/kg dry wt	< 0.013	< 0.015	< 0.016	-	-
Endrin ketone	mg/kg dry wt	< 0.013	0.018	0.057	-	-
Heptachlor	mg/kg dry wt	< 0.013	< 0.015	< 0.016	-	-
Heptachlor epoxide	mg/kg dry wt	< 0.013	< 0.015	< 0.016	-	-
Hexachlorobenzene	mg/kg dry wt	< 0.013	< 0.015	< 0.016	-	-
Methoxychlor	mg/kg dry wt	< 0.013	< 0.015	< 0.016	-	-

Sample Name:		KV25 06-Oct-2021	KV26 06-Oct-2021	KV27 06-Oct-2021	KV28 06-Oct-2021	KV-DUP1 06-Oct-2021
Lab Number:		2730159.29	2730159.30	2730159.31	2730159.32	2730159.33
Individual Tests						
TCLP Weight of Sample Taken	g	-	50	-	-	-
TCLP Initial Sample pH	pH Units	-	6.2	-	-	-
TCLP Acid Adjusted Sample pH	pH Units	-	1.5	-	-	-
TCLP Extractant Type*		-	NaOH/Acetic acid at pH 4.93 +/- 0.05	-	-	-
TCLP Extraction Fluid pH	pH Units	-	4.9	-	-	-
TCLP Post Extraction Sample pH	pH Units	-	4.9	-	-	-

Sample Type: Soil						
Sample Name:		KV25 06-Oct-2021	KV26 06-Oct-2021	KV27 06-Oct-2021	KV28 06-Oct-2021	KV-DUP1 06-Oct-2021
Lab Number:		2730159.29	2730159.30	2730159.31	2730159.32	2730159.33
Heavy Metals, Screen Level						
Total Recoverable Arsenic	mg/kg dry wt	49	39	30	5	78
Total Recoverable Cadmium	mg/kg dry wt	0.26	0.3	0.29	0.13	13.7
Total Recoverable Chromium	mg/kg dry wt	173	123	70	148	83
Total Recoverable Copper	mg/kg dry wt	85	108	55	54	67
Total Recoverable Lead	mg/kg dry wt	35	29	84	6.3	155
Total Recoverable Nickel	mg/kg dry wt	197	200	53	69	88
Total Recoverable Zinc	mg/kg dry wt	760	670	176	68	4,700

Sample Name:		KV-DUP2 06-Oct-2021	Composite of KV1, KV2, KV3 and KV4	Composite of KV1-SS, KV2-SS, KV3-SS and KV4-SS	Composite KV5, KV6, KV7 and KV8	
Lab Number:		2730159.34	2730159.35	2730159.36	2730159.37	
Individual Tests						
Dry Matter	g/100g as rcvd	-	76	90	56	-
Heavy Metals, Screen Level						
Total Recoverable Arsenic	mg/kg dry wt	46	20	8	32	-
Total Recoverable Cadmium	mg/kg dry wt	0.26	0.42	0.25	0.4	-
Total Recoverable Chromium	mg/kg dry wt	148	88	158	111	-
Total Recoverable Copper	mg/kg dry wt	86	58	42	44	-
Total Recoverable Lead	mg/kg dry wt	38	31	22	34	-
Total Recoverable Nickel	mg/kg dry wt	200	89	410	155	-
Total Recoverable Zinc	mg/kg dry wt	570	340	193	250	-
Organochlorine Pesticides Screening in Soil						
Aldrin	mg/kg dry wt	-	< 0.013	< 0.011	< 0.018	-
alpha-BHC	mg/kg dry wt	-	< 0.013	< 0.011	< 0.018	-
beta-BHC	mg/kg dry wt	-	< 0.013	< 0.011	< 0.018	-
delta-BHC	mg/kg dry wt	-	< 0.013	< 0.011	< 0.018	-
gamma-BHC (Lindane)	mg/kg dry wt	-	< 0.013	< 0.011	< 0.018	-
cis-Chlordane	mg/kg dry wt	-	< 0.013	< 0.011	< 0.018	-
trans-Chlordane	mg/kg dry wt	-	< 0.013	< 0.011	< 0.018	-
2,4'-DDD	mg/kg dry wt	-	< 0.013	< 0.011	< 0.018	-
4,4'-DDD	mg/kg dry wt	-	< 0.013	< 0.011	< 0.018	-
2,4'-DDE	mg/kg dry wt	-	< 0.013	< 0.011	< 0.018	-
4,4'-DDE	mg/kg dry wt	-	< 0.013	< 0.011	< 0.018	-
2,4'-DDT	mg/kg dry wt	-	< 0.013	< 0.011	< 0.018	-
4,4'-DDT	mg/kg dry wt	-	< 0.013	< 0.011	< 0.018	-
Total DDT Isomers	mg/kg dry wt	-	< 0.08	< 0.07	< 0.11	-
Dieldrin	mg/kg dry wt	-	< 0.013	< 0.011	0.130	-
Endosulfan I	mg/kg dry wt	-	< 0.013	< 0.011	< 0.018	-
Endosulfan II	mg/kg dry wt	-	< 0.013	< 0.011	< 0.018	-
Endosulfan sulphate	mg/kg dry wt	-	< 0.013	< 0.011	< 0.018	-
Endrin	mg/kg dry wt	-	< 0.013	< 0.011	< 0.018	-
Endrin aldehyde	mg/kg dry wt	-	< 0.013	< 0.011	< 0.018	-
Endrin ketone	mg/kg dry wt	-	< 0.013	< 0.011	< 0.018	-
Heptachlor	mg/kg dry wt	-	< 0.013	< 0.011	< 0.018	-
Heptachlor epoxide	mg/kg dry wt	-	< 0.013	< 0.011	< 0.018	-
Hexachlorobenzene	mg/kg dry wt	-	< 0.013	< 0.011	< 0.018	-
Methoxychlor	mg/kg dry wt	-	< 0.013	< 0.011	< 0.018	-

Sample Type: Aqueous						
Sample Name:		KV10 [TCLP extract]	KV11 [TCLP extract]	KV12 [TCLP extract]	KV14 [TCLP extract]	KV20 [TCLP extract]
Lab Number:		2730159.38	2730159.39	2730159.40	2730159.41	2730159.42
Individual Tests						
Total Arsenic	g/m^3	0.046	0.26	0.47	0.163	-
Total Cadmium	g/m^3	0.029	-	0.051	0.022	-

Sample Type: Aqueous						
Sample Name:		KV10 [TCLP extract]	KV11 [TCLP extract]	KV12 [TCLP extract]	KV14 [TCLP extract]	KV20 [TCLP extract]
Lab Number:		2730159.38	2730159.39	2730159.40	2730159.41	2730159.42
Individual Tests						
Total Chromium	g/m³	-	-	< 0.011	< 0.011	< 0.011
Total Lead	g/m³	0.0122	0.0122	0.0100	0.021	-
Total Nickel	g/m³	-	-	-	-	0.046
Total Zinc	g/m³	14.3	0.90	0.77	2.2	-
Organochlorine Pesticides Screening in Water, By Liq/Liq						
Aldrin	g/m³	-	< 0.00010	< 0.00010	0.00036	< 0.00010
alpha-BHC	g/m³	-	< 0.0002	< 0.0002	< 0.0002	< 0.0002
beta-BHC	g/m³	-	< 0.0002	< 0.0002	0.0004	< 0.0002
delta-BHC	g/m³	-	< 0.0002	< 0.0002	< 0.0002	< 0.0002
gamma-BHC (Lindane)	g/m³	-	< 0.0002	< 0.0002	< 0.0002	< 0.0002
cis-Chlordane	g/m³	-	< 0.00010	< 0.00010	< 0.00010	< 0.00010
trans-Chlordane	g/m³	-	< 0.00010	< 0.00010	< 0.00010	< 0.00010
2,4'-DDD	g/m³	-	< 0.0002	< 0.0002	< 0.0002	< 0.0002
4,4'-DDD	g/m³	-	< 0.0002	< 0.0002	< 0.0002	< 0.0002
2,4'-DDE	g/m³	-	< 0.0002	< 0.0002	< 0.0002	< 0.0002
4,4'-DDE	g/m³	-	< 0.0002	< 0.0002	< 0.0002	< 0.0002
2,4'-DDT	g/m³	-	< 0.0002	< 0.0002	< 0.0002	< 0.0002
4,4'-DDT	g/m³	-	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Dieldrin	g/m³	-	0.037	0.059	0.099	0.00156
Endosulfan I	g/m³	-	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Endosulfan II	g/m³	-	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Endosulfan sulphate	g/m³	-	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Endrin	g/m³	-	0.00037	0.00107	0.00064	< 0.00010
Endrin aldehyde	g/m³	-	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Endrin ketone	g/m³	-	0.0007	0.0010	0.0013	< 0.0002
Heptachlor	g/m³	-	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Heptachlor epoxide	g/m³	-	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Hexachlorobenzene	g/m³	-	< 0.0008	< 0.0008	< 0.0008	< 0.0008
Methoxychlor	g/m³	-	< 0.00010	< 0.00010	< 0.00010	< 0.00010

Sample Name:		KV21 [TCLP extract]	KV22 [TCLP extract]	KV24 [TCLP extract]	KV26 [TCLP extract]	
Lab Number:		2730159.43	2730159.44	2730159.45	2730159.46	
Individual Tests						
Total Chromium	g/m³	-	-	< 0.011	< 0.011	-
Total Copper	g/m³	-	-	0.195	-	-
Total Lead	g/m³	-	0.0070	-	-	-
Total Nickel	g/m³	-	-	0.169	0.040	-
Total Zinc	g/m³	-	2.9	1.92	1.27	-
Organochlorine Pesticides Screening in Water, By Liq/Liq						
Aldrin	g/m³	< 0.00010	-	-	-	-
alpha-BHC	g/m³	< 0.0002	-	-	-	-
beta-BHC	g/m³	< 0.0002	-	-	-	-
delta-BHC	g/m³	< 0.0002	-	-	-	-
gamma-BHC (Lindane)	g/m³	< 0.0002	-	-	-	-
cis-Chlordane	g/m³	< 0.00010	-	-	-	-
trans-Chlordane	g/m³	< 0.00010	-	-	-	-
2,4'-DDD	g/m³	< 0.0002	-	-	-	-
4,4'-DDD	g/m³	< 0.0002	-	-	-	-
2,4'-DDE	g/m³	< 0.0002	-	-	-	-
4,4'-DDE	g/m³	< 0.0002	-	-	-	-
2,4'-DDT	g/m³	< 0.0002	-	-	-	-
4,4'-DDT	g/m³	< 0.0002	-	-	-	-
Dieldrin	g/m³	0.0023	-	-	-	-
Endosulfan I	g/m³	< 0.0002	-	-	-	-
Endosulfan II	g/m³	< 0.0002	-	-	-	-

Sample Type: Aqueous						
Sample Name:		KV21 [TCLP extract]	KV22 [TCLP extract]	KV24 [TCLP extract]	KV26 [TCLP extract]	
Lab Number:		2730159.43	2730159.44	2730159.45	2730159.46	
Organochlorine Pesticides Screening in Water, By Liq/Liq						
Endosulfan sulphate	g/m³	< 0.0002	-	-	-	-
Endrin	g/m³	< 0.00010	-	-	-	-
Endrin aldehyde	g/m³	< 0.00010	-	-	-	-
Endrin ketone	g/m³	< 0.0002	-	-	-	-
Heptachlor	g/m³	< 0.00010	-	-	-	-
Heptachlor epoxide	g/m³	< 0.00010	-	-	-	-
Hexachlorobenzene	g/m³	< 0.0008	-	-	-	-
Methoxychlor	g/m³	< 0.00010	-	-	-	-

Analyst's Comments

Amended Report: This certificate of analysis replaces report '2730159-SPv2' issued on 08-Nov-2021 at 10:26 am.
Reason for amendment: At the client's request, TCLPs have been added.

Summary of Methods

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively simple matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis. A detection limit range indicates the lowest and highest detection limits in the associated suite of analytes. A full listing of compounds and detection limits are available from the laboratory upon request.
Unless otherwise indicated, analyses were performed at Hill Laboratories, 28 Duke Street, Frankton, Hamilton 3204.

Sample Type: Soil			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
Individual Tests			
Environmental Solids Sample Drying*	Air dried at 35°C Used for sample preparation. May contain a residual moisture content of 2-5%.	-	13-19, 21-26, 28-37
Dry Matter (Env)	Dried at 103°C for 4-22hr (removes 3-5% more water than air dry) , gravimetry. (Free water removed before analysis, non-soil objects such as sticks, leaves, grass and stones also removed). US EPA 3550.	0.10 g/100g as rcvd	13-20, 22-25, 35-37
Heavy Metals, Screen Level	Dried sample, < 2mm fraction. Nitric/Hydrochloric acid digestion US EPA 200.2. Complies with NES Regulations. ICP-MS screen level, interference removal by Kinetic Energy Discrimination if required.	0.10 - 4 mg/kg dry wt	13-19, 21-26, 28-37
Organochlorine Pesticides Screening in Soil	Sonication extraction, GC-ECD analysis. Tested on as received sample. In-house based on US EPA 8081.	0.010 - 0.06 mg/kg dry wt	13-20, 22-25, 35-37
TCLP Profile*	Extraction at 30 +/- 2 rpm for 18 +/- 2 hours, (Ratio 1g sample : 20g extraction fluid). US EPA 1311.	-	14-16, 18, 24-26, 28, 30
TCLP Profile			
TCLP Weight of Sample Taken	Gravimetric. US EPA 1311.	0.1 g	14-16, 18, 24-26, 28, 30
TCLP Initial Sample pH	pH meter. US EPA 1311.	0.1 pH Units	14-16, 18, 24-26, 28, 30
TCLP Acid Adjusted Sample pH	pH meter. US EPA 1311.	0.1 pH Units	14-16, 18, 24-26, 28, 30
TCLP Extractant Type*	US EPA 1311.	-	14-16, 18, 24-26, 28, 30
TCLP Extraction Fluid pH	pH meter. US EPA 1311.	0.1 pH Units	14-16, 18, 24-26, 28, 30
TCLP Post Extraction Sample pH	pH meter. US EPA 1311.	0.1 pH Units	14-16, 18, 24-26, 28, 30

Sample Type: Aqueous			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
Individual Tests			
Total Digestion of Extracted Samples*	Nitric acid digestion. APHA 3030 E (modified) 23rd ed. 2017.	-	38-42, 44-46
Total Arsenic	Nitric acid digestion, ICP-MS, screen level. APHA 3125 B 23rd ed. 2017.	0.021 g/m³	38-41

Sample Type: Aqueous			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
Total Cadmium	Nitric acid digestion, ICP-MS, screen level. APHA 3125 B 23rd ed. 2017.	0.0011 g/m^3	38, 40-41
Total Chromium	Nitric acid digestion, ICP-MS, screen level. APHA 3125 B 23rd ed. 2017.	0.011 g/m^3	40-42, 45-46
Total Copper	Nitric acid digestion, ICP-MS, screen level. APHA 3125 B 23rd ed. 2017.	0.011 g/m^3	45
Total Lead	Nitric acid digestion, ICP-MS, screen level. APHA 3125 B 23rd ed. 2017.	0.0021 g/m^3	38-41, 44
Total Nickel	Nitric acid digestion, ICP-MS, screen level. APHA 3125 B 23rd ed. 2017.	0.011 g/m^3	42, 45-46
Total Zinc	Nitric acid digestion, ICP-MS, screen level. APHA 3125 B 23rd ed. 2017.	0.021 g/m^3	38-41, 44-46
Organochlorine Pesticides Screening in Water, By Liq/Liq	Liquid / liquid extraction, GC-ECD analysis. In-house based on US EPA 8081.	0.00010 - 0.0008 g/m^3	39-43

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

Testing was completed between 12-Oct-2021 and 01-Dec-2021. For completion dates of individual analyses please contact the laboratory.

Samples are held at the laboratory after reporting for a length of time based on the stability of the samples and analytes being tested (considering any preservation used), and the storage space available. Once the storage period is completed, the samples are discarded unless otherwise agreed with the customer. Extended storage times may incur additional charges.

Kim Harrison MSc
Client Services Manager - Environmental

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Certificate of Analysis

Client:	Envirolink Limited	**Lab No:**	2757273 SPv1
Contact:	Marty O'Cain C/- Envirolink Limited 20 Stafford Drive Ruby Bay Mapua 7005	**Date Received:**	05-Nov-2021
		Date Reported:	12-Nov-2021
		Quote No:	114280
		Order No:	
		Client Reference:	J000300 - Kaka Valley
		Submitted By:	David Duncan

Sample Type: Soil

		Sample Name:	KVP 1/1 03-Nov-2021	KVP 1/2 03-Nov-2021	KVP 1/3 03-Nov-2021	KVP 1/4 03-Nov-2021	KVP 1/5 03-Nov-2021
		Lab Number:	2757273.1	2757273.2	2757273.3	2757273.4	2757273.5
Heavy Metals, Screen Level							
Total Recoverable Arsenic	mg/kg dry wt		6	25	5	9	7
Total Recoverable Cadmium	mg/kg dry wt		0.22	0.19	0.20	0.23	0.15
Total Recoverable Chromium	mg/kg dry wt		79	112	87	76	96
Total Recoverable Copper	mg/kg dry wt		46	62	44	48	51
Total Recoverable Lead	mg/kg dry wt		59	21	47	60	19.5
Total Recoverable Nickel	mg/kg dry wt		81	66	94	49	57
Total Recoverable Zinc	mg/kg dry wt		149	125	121	148	95

		Sample Name:	KVP 1/6 03-Nov-2021	KVP 1/7 03-Nov-2021	KVP 1/8 03-Nov-2021	KVP 1/9 03-Nov-2021	KVP 1/10 03-Nov-2021
		Lab Number:	2757273.6	2757273.7	2757273.8	2757273.9	2757273.10
Heavy Metals, Screen Level							
Total Recoverable Arsenic	mg/kg dry wt		12	5	6	3	4
Total Recoverable Cadmium	mg/kg dry wt		< 0.2	0.21	0.17	0.18	0.15
Total Recoverable Chromium	mg/kg dry wt		126	140	116	135	138
Total Recoverable Copper	mg/kg dry wt		58	57	59	55	47
Total Recoverable Lead	mg/kg dry wt		13.3	6.4	5.3	5.6	5.8
Total Recoverable Nickel	mg/kg dry wt		55	62	56	62	68
Total Recoverable Zinc	mg/kg dry wt		88	68	68	77	65

		Sample Name:	KVP 1- Dup 03-Nov-2021
		Lab Number:	2757273.13
Heavy Metals, Screen Level			
Total Recoverable Arsenic	mg/kg dry wt		11
Total Recoverable Cadmium	mg/kg dry wt		0.16
Total Recoverable Chromium	mg/kg dry wt		121
Total Recoverable Copper	mg/kg dry wt		59
Total Recoverable Lead	mg/kg dry wt		12.3
Total Recoverable Nickel	mg/kg dry wt		56
Total Recoverable Zinc	mg/kg dry wt		84

Sample Type: Aqueous

		Sample Name:	KVS 1 03-Nov-2021	KVT 2 03-Nov-2021
		Lab Number:	2757273.11	2757273.12

Sample Type: Aqueous						
Sample Name:		KVS 1 03-Nov-2021	KVT 2 03-Nov-2021			
Lab Number:		2757273.11	2757273.12			
Heavy metals, totals, screen As,Cd,Cr,Cu,Ni,Pb,Zn						
Total Arsenic	g/m³	< 0.021	2.4	-	-	-
Total Cadmium	g/m³	0.0025	0.181	-	-	-
Total Chromium	g/m³	< 0.011	0.34	-	-	-
Total Copper	g/m³	< 0.011	0.76	-	-	-
Total Lead	g/m³	0.0068	9.9	-	-	-
Total Nickel	g/m³	< 0.011	0.31	-	-	-
Total Zinc	g/m³	0.164	540	-	-	-
Organochlorine Pesticides Screening in Water, By Liq/Liq						
Aldrin	g/m³	< 0.0004	0.029	-	-	-
alpha-BHC	g/m³	< 0.0004	< 0.0004	-	-	-
beta-BHC	g/m³	< 0.0004	< 0.0004	-	-	-
delta-BHC	g/m³	< 0.0004	< 0.0004	-	-	-
gamma-BHC (Lindane)	g/m³	< 0.0004	< 0.0004	-	-	-
cis-Chlordane	g/m³	< 0.0004	< 0.0004	-	-	-
trans-Chlordane	g/m³	< 0.0004	< 0.0004	-	-	-
2,4'-DDD	g/m³	< 0.0004	< 0.0004	-	-	-
4,4'-DDD	g/m³	< 0.0004	< 0.0004	-	-	-
2,4'-DDE	g/m³	< 0.0004	< 0.0004	-	-	-
4,4'-DDE	g/m³	< 0.0004	< 0.0004	-	-	-
2,4'-DDT	g/m³	< 0.0004	< 0.0004	-	-	-
4,4'-DDT	g/m³	< 0.0004	< 0.0004	-	-	-
Dieldrin	g/m³	< 0.0004	0.0036	-	-	-
Endosulfan I	g/m³	< 0.0004	< 0.0004	-	-	-
Endosulfan II	g/m³	< 0.0004	< 0.0004	-	-	-
Endosulfan sulphate	g/m³	< 0.0004	< 0.0004	-	-	-
Endrin	g/m³	< 0.0004	< 0.0004	-	-	-
Endrin aldehyde	g/m³	< 0.0004	< 0.0004	-	-	-
Endrin ketone	g/m³	< 0.0004	< 0.0004	-	-	-
Heptachlor	g/m³	< 0.0004	< 0.0004	-	-	-
Heptachlor epoxide	g/m³	< 0.0004	< 0.0004	-	-	-
Hexachlorobenzene	g/m³	< 0.0008	< 0.0008	-	-	-
Methoxychlor	g/m³	< 0.0004	< 0.0004	-	-	-

Summary of Methods

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively simple matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis. A detection limit range indicates the lowest and highest detection limits in the associated suite of analytes. A full listing of compounds and detection limits are available from the laboratory upon request.
Unless otherwise indicated, analyses were performed at Hill Laboratories, 28 Duke Street, Frankton, Hamilton 3204.

Sample Type: Soil			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
Environmental Solids Sample Drying*	Air dried at 35°C Used for sample preparation. May contain a residual moisture content of 2-5%.	-	1-10, 13
Heavy Metals, Screen Level	Dried sample, < 2mm fraction. Nitric/Hydrochloric acid digestion US EPA 200.2. Complies with NES Regulations. ICP-MS screen level, interference removal by Kinetic Energy Discrimination if required.	0.10 - 4 mg/kg dry wt	1-10, 13

Sample Type: Aqueous			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
Heavy metals, totals, screen As,Cd,Cr,Cu,Ni,Pb,Zn	Nitric acid digestion, ICP-MS, screen level. APHA 3125 B 23rd ed. 2017.	0.0011 - 0.021 g/m³	11-12
Organochlorine Pesticides Screening in Water, By Liq/Liq	Liquid / liquid extraction, GC-ECD analysis. In-house based on US EPA 8081.	0.00010 - 0.0008 g/m³	11-12
Total Digestion	Nitric acid digestion. APHA 3030 E (modified) 23rd ed. 2017.	-	11-12

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

Testing was completed between 10-Nov-2021 and 12-Nov-2021. For completion dates of individual analyses please contact the laboratory.

Samples are held at the laboratory after reporting for a length of time based on the stability of the samples and analytes being tested (considering any preservation used), and the storage space available. Once the storage period is completed, the samples are discarded unless otherwise agreed with the customer. Extended storage times may incur additional charges.

This certificate of analysis must not be reproduced, except in full, without the written consent of the signatory.

Carole Rodgers-Carroll BA, NZCS
Client Services Manager - Environmental

Hill Laboratories
TRIED, TESTED AND TRUSTED

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Hamilton 3240 New Zealand

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Certificate of Analysis

Client:	Envirolink Limited	**Lab No:**	2757363	SPv2
Contact:	Marty O'Cain	**Date Received:**	05-Nov-2021	
	C/- Envirolink Limited	**Date Reported:**	30-Nov-2021	**(Amended)**
	20 Stafford Drive	**Quote No:**	114280	
	Ruby Bay	**Order No:**		
	Mapua 7005	**Client Reference:**	J000300 - Kaka Valley	
		Submitted By:	David Duncan	

Sample Type: Soil

Sample Name:		KV29-2 03-Nov-2021	KV29-3 03-Nov-2021	KV30-1 03-Nov-2021	KV30-2 03-Nov-2021	KV31-2 03-Nov-2021
Lab Number:		2757363.2	2757363.3	2757363.5	2757363.6	2757363.9
Individual Tests						
Dry Matter	g/100g as rcvd	77	89	87	87	83
TCLP Weight of Sample Taken	g	50	-	-	-	-
TCLP Initial Sample pH	pH Units	6.8	-	-	-	-
TCLP Acid Adjusted Sample pH	pH Units	1.6	-	-	-	-
TCLP Extractant Type*		NaOH/Acetic acid at pH 4.93 +/- 0.05	-	-	-	-
TCLP Extraction Fluid pH	pH Units	4.9	-	-	-	-
TCLP Post Extraction Sample pH	pH Units	5.0	-	-	-	-
Heavy Metals, Screen Level						
Total Recoverable Arsenic	mg/kg dry wt	810	141	-	71	430
Total Recoverable Cadmium	mg/kg dry wt	1.12	0.20	-	0.19	0.28
Total Recoverable Chromium	mg/kg dry wt	128	96	-	120	130
Total Recoverable Copper	mg/kg dry wt	97	67	-	107	130
Total Recoverable Lead	mg/kg dry wt	460	7.6	-	54	134
Total Recoverable Nickel	mg/kg dry wt	73	47	-	78	82
Total Recoverable Zinc	mg/kg dry wt	400	210	-	194	193
Organochlorine Pesticides Screening in Soil						
Aldrin	mg/kg dry wt	0.20	0.016	< 0.012	< 0.012	< 0.012
alpha-BHC	mg/kg dry wt	< 0.013	< 0.012	< 0.012	< 0.012	< 0.012
beta-BHC	mg/kg dry wt	0.077	< 0.012	< 0.012	< 0.012	< 0.012
delta-BHC	mg/kg dry wt	< 0.013	< 0.012	< 0.012	< 0.012	< 0.012
gamma-BHC (Lindane)	mg/kg dry wt	< 0.013	< 0.012	< 0.012	< 0.012	< 0.012
cis-Chlordane	mg/kg dry wt	< 0.013	< 0.012	< 0.012	< 0.012	< 0.012
trans-Chlordane	mg/kg dry wt	< 0.013	< 0.012	< 0.012	< 0.012	< 0.012
2,4'-DDD	mg/kg dry wt	< 0.013	< 0.012	< 0.012	< 0.012	< 0.012
4,4'-DDD	mg/kg dry wt	0.030	< 0.012	< 0.012	< 0.012	< 0.012
2,4'-DDE	mg/kg dry wt	< 0.013	< 0.012	< 0.012	< 0.012	< 0.012
4,4'-DDE	mg/kg dry wt	0.026	< 0.012	< 0.012	< 0.012	< 0.012
2,4'-DDT	mg/kg dry wt	< 0.013	< 0.012	< 0.012	< 0.012	< 0.012
4,4'-DDT	mg/kg dry wt	0.063	< 0.012	< 0.012	< 0.012	< 0.012
Total DDT Isomers	mg/kg dry wt	0.12	< 0.07	< 0.07	< 0.07	< 0.08
Dieldrin	mg/kg dry wt	22	3.1	1.48	0.099	4.7
Endosulfan I	mg/kg dry wt	< 0.013	< 0.012	< 0.012	< 0.012	< 0.012
Endosulfan II	mg/kg dry wt	< 0.013	< 0.012	< 0.012	< 0.012	< 0.012
Endosulfan sulphate	mg/kg dry wt	< 0.013	< 0.012	< 0.012	< 0.012	< 0.012
Endrin	mg/kg dry wt	0.22	0.035	< 0.012	< 0.012	0.025
Endrin aldehyde	mg/kg dry wt	< 0.013	< 0.012	< 0.012	< 0.012	< 0.012
Endrin ketone	mg/kg dry wt	0.137	< 0.012	< 0.012	< 0.012	< 0.012

Sample Type: Soil						
Sample Name:		KV29-2 03-Nov-2021	KV29-3 03-Nov-2021	KV30-1 03-Nov-2021	KV30-2 03-Nov-2021	KV31-2 03-Nov-2021
Lab Number:		2757363.2	2757363.3	2757363.5	2757363.6	2757363.9
Organochlorine Pesticides Screening in Soil						
Heptachlor	mg/kg dry wt	< 0.013	< 0.012	< 0.012	< 0.012	< 0.012
Heptachlor epoxide	mg/kg dry wt	< 0.013	< 0.012	< 0.012	< 0.012	< 0.012
Hexachlorobenzene	mg/kg dry wt	< 0.013	< 0.012	< 0.012	< 0.012	< 0.012
Methoxychlor	mg/kg dry wt	< 0.013	< 0.012	< 0.012	< 0.012	< 0.012

Sample Name:		KV32-2 03-Nov-2021	KV33 03-Nov-2021	KV34 03-Nov-2021	KV36 03-Nov-2021	KV38 03-Nov-2021
Lab Number:		2757363.11	2757363.12	2757363.13	2757363.15	2757363.17
Individual Tests						
Dry Matter	g/100g as rcvd	88	-	-	-	-
Heavy Metals, Screen Level						
Total Recoverable Arsenic	mg/kg dry wt	63	16	18	16	19
Total Recoverable Cadmium	mg/kg dry wt	0.20	0.50	0.43	0.19	0.20
Total Recoverable Chromium	mg/kg dry wt	120	95	123	125	154
Total Recoverable Copper	mg/kg dry wt	190	54	60	65	77
Total Recoverable Lead	mg/kg dry wt	69	67	40	26	33
Total Recoverable Nickel	mg/kg dry wt	163	42	146	98	177
Total Recoverable Zinc	mg/kg dry wt	124	198	230	136	200
Organochlorine Pesticides Screening in Soil						
Aldrin	mg/kg dry wt	< 0.012	-	-	-	-
alpha-BHC	mg/kg dry wt	< 0.012	-	-	-	-
beta-BHC	mg/kg dry wt	< 0.012	-	-	-	-
delta-BHC	mg/kg dry wt	< 0.012	-	-	-	-
gamma-BHC (Lindane)	mg/kg dry wt	< 0.012	-	-	-	-
cis-Chlordane	mg/kg dry wt	< 0.012	-	-	-	-
trans-Chlordane	mg/kg dry wt	< 0.012	-	-	-	-
2,4'-DDD	mg/kg dry wt	< 0.012	-	-	-	-
4,4'-DDD	mg/kg dry wt	< 0.012	-	-	-	-
2,4'-DDE	mg/kg dry wt	< 0.012	-	-	-	-
4,4'-DDE	mg/kg dry wt	< 0.012	-	-	-	-
2,4'-DDT	mg/kg dry wt	< 0.012	-	-	-	-
4,4'-DDT	mg/kg dry wt	< 0.012	-	-	-	-
Total DDT Isomers	mg/kg dry wt	< 0.07	-	-	-	-
Dieldrin	mg/kg dry wt	0.59	-	-	-	-
Endosulfan I	mg/kg dry wt	< 0.012	-	-	-	-
Endosulfan II	mg/kg dry wt	< 0.012	-	-	-	-
Endosulfan sulphate	mg/kg dry wt	< 0.012	-	-	-	-
Endrin	mg/kg dry wt	< 0.012	-	-	-	-
Endrin aldehyde	mg/kg dry wt	< 0.012	-	-	-	-
Endrin ketone	mg/kg dry wt	< 0.012	-	-	-	-
Heptachlor	mg/kg dry wt	< 0.012	-	-	-	-
Heptachlor epoxide	mg/kg dry wt	< 0.012	-	-	-	-
Hexachlorobenzene	mg/kg dry wt	< 0.012	-	-	-	-
Methoxychlor	mg/kg dry wt	< 0.012	-	-	-	-

Sample Name:		KV41 03-Nov-2021	KV42 03-Nov-2021	KVP 2/1 03-Nov-2021	KVP 2/2 03-Nov-2021	KVP 2/3 03-Nov-2021
Lab Number:		2757363.20	2757363.21	2757363.22	2757363.23	2757363.24
Individual Tests						
Dry Matter	g/100g as rcvd	-	80	-	-	-
Heavy Metals, Screen Level						
Total Recoverable Arsenic	mg/kg dry wt	32	59	5	5	6
Total Recoverable Cadmium	mg/kg dry wt	0.23	0.37	0.17	0.15	0.16
Total Recoverable Chromium	mg/kg dry wt	130	121	132	117	144
Total Recoverable Copper	mg/kg dry wt	69	120	58	47	61
Total Recoverable Lead	mg/kg dry wt	46	32	6.9	10.7	9.0
Total Recoverable Nickel	mg/kg dry wt	61	164	56	56	63

Sample Type: Soil						
Sample Name:		KV41 03-Nov-2021	KV42 03-Nov-2021	KVP 2/1 03-Nov-2021	KVP 2/2 03-Nov-2021	KVP 2/3 03-Nov-2021
Lab Number:		2757363.20	2757363.21	2757363.22	2757363.23	2757363.24
Heavy Metals, Screen Level						
Total Recoverable Zinc	mg/kg dry wt	149	200	63	64	72
Organochlorine Pesticides Screening in Soil						
Aldrin	mg/kg dry wt	-	< 0.013	-	-	-
alpha-BHC	mg/kg dry wt	-	< 0.013	-	-	-
beta-BHC	mg/kg dry wt	-	< 0.013	-	-	-
delta-BHC	mg/kg dry wt	-	< 0.013	-	-	-
gamma-BHC (Lindane)	mg/kg dry wt	-	< 0.013	-	-	-
cis-Chlordane	mg/kg dry wt	-	< 0.013	-	-	-
trans-Chlordane	mg/kg dry wt	-	< 0.013	-	-	-
2,4'-DDD	mg/kg dry wt	-	< 0.013	-	-	-
4,4'-DDD	mg/kg dry wt	-	< 0.013	-	-	-
2,4'-DDE	mg/kg dry wt	-	< 0.013	-	-	-
4,4'-DDE	mg/kg dry wt	-	< 0.013	-	-	-
2,4'-DDT	mg/kg dry wt	-	< 0.013	-	-	-
4,4'-DDT	mg/kg dry wt	-	< 0.013	-	-	-
Total DDT Isomers	mg/kg dry wt	-	< 0.08	-	-	-
Dieldrin	mg/kg dry wt	-	1.32	-	-	-
Endosulfan I	mg/kg dry wt	-	< 0.013	-	-	-
Endosulfan II	mg/kg dry wt	-	< 0.013	-	-	-
Endosulfan sulphate	mg/kg dry wt	-	< 0.013	-	-	-
Endrin	mg/kg dry wt	-	< 0.013	-	-	-
Endrin aldehyde	mg/kg dry wt	-	< 0.013	-	-	-
Endrin ketone	mg/kg dry wt	-	< 0.013	-	-	-
Heptachlor	mg/kg dry wt	-	< 0.013	-	-	-
Heptachlor epoxide	mg/kg dry wt	-	< 0.013	-	-	-
Hexachlorobenzene	mg/kg dry wt	-	< 0.013	-	-	-
Methoxychlor	mg/kg dry wt	-	< 0.013	-	-	-

Sample Name:		KVP 2/4 03-Nov-2021	KVP 2/5 03-Nov-2021	KVP 2/6 03-Nov-2021	KVP 2/7 03-Nov-2021	KVP 2/8 03-Nov-2021
Lab Number:		2757363.25	2757363.26	2757363.27	2757363.28	2757363.29
Heavy Metals, Screen Level						
Total Recoverable Arsenic	mg/kg dry wt	5	5	5	4	5
Total Recoverable Cadmium	mg/kg dry wt	0.19	0.15	0.15	0.14	0.17
Total Recoverable Chromium	mg/kg dry wt	140	143	161	148	181
Total Recoverable Copper	mg/kg dry wt	54	51	57	57	64
Total Recoverable Lead	mg/kg dry wt	7.6	7.9	12.5	7.4	10.6
Total Recoverable Nickel	mg/kg dry wt	73	66	97	69	128
Total Recoverable Zinc	mg/kg dry wt	70	67	75	61	76

Sample Name:		KVP 2/9 03-Nov-2021	KVP 2/10 03-Nov-2021	KVP 2- Dup 03-Nov-2021		
Lab Number:		2757363.30	2757363.31	2757363.32		
Heavy Metals, Screen Level						
Total Recoverable Arsenic	mg/kg dry wt	5	5	5	-	-
Total Recoverable Cadmium	mg/kg dry wt	0.13	0.19	0.15	-	-
Total Recoverable Chromium	mg/kg dry wt	151	200	139	-	-
Total Recoverable Copper	mg/kg dry wt	57	57	52	-	-
Total Recoverable Lead	mg/kg dry wt	5.5	7.3	7.5	-	-
Total Recoverable Nickel	mg/kg dry wt	87	172	69	-	-
Total Recoverable Zinc	mg/kg dry wt	61	77	66	-	-

Sample Type: Aqueous						
Sample Name:		KV29-2 [TCLP extract[				
Lab Number:		2757363.33				

Sample Type: Aqueous						
Sample Name:		KV29-2 [TCLP extract[				
Lab Number:		2757363.33				
Individual Tests						
Total Arsenic	g/m³	0.57	-	-	-	-
Total Chromium	g/m³	< 0.011	-	-	-	-
Total Lead	g/m³	0.0116	-	-	-	-
Total Zinc	g/m³	0.85	-	-	-	-
Organochlorine Pesticides Screening in Water, By Liq/Liq						
Aldrin	g/m³	< 0.00010	-	-	-	-
alpha-BHC	g/m³	< 0.0002	-	-	-	-
beta-BHC	g/m³	< 0.0002	-	-	-	-
delta-BHC	g/m³	< 0.0002	-	-	-	-
gamma-BHC (Lindane)	g/m³	< 0.0002	-	-	-	-
cis-Chlordane	g/m³	< 0.00010	-	-	-	-
trans-Chlordane	g/m³	< 0.00010	-	-	-	-
2,4'-DDD	g/m³	< 0.0002	-	-	-	-
4,4'-DDD	g/m³	< 0.0002	-	-	-	-
2,4'-DDE	g/m³	< 0.0002	-	-	-	-
4,4'-DDE	g/m³	< 0.0002	-	-	-	-
2,4'-DDT	g/m³	< 0.0002	-	-	-	-
4,4'-DDT	g/m³	< 0.0002	-	-	-	-
Dieldrin	g/m³	0.020	-	-	-	-
Endosulfan I	g/m³	< 0.0002	-	-	-	-
Endosulfan II	g/m³	< 0.0002	-	-	-	-
Endosulfan sulphate	g/m³	< 0.0002	-	-	-	-
Endrin	g/m³	0.00021	-	-	-	-
Endrin aldehyde	g/m³	< 0.00010	-	-	-	-
Endrin ketone	g/m³	0.0004	-	-	-	-
Heptachlor	g/m³	< 0.00010	-	-	-	-
Heptachlor epoxide	g/m³	< 0.00010	-	-	-	-
Hexachlorobenzene	g/m³	< 0.0008	-	-	-	-
Methoxychlor	g/m³	< 0.00010	-	-	-	-

Analyst's Comments

Amended Report: This certificate of analysis replaces report '2757363-SPv1' issued on 10-Nov-2021 at 11:13 am.
Reason for amendment: At the client's request, a TCLP has been added.

Summary of Methods

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively simple matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis. A detection limit range indicates the lowest and highest detection limits in the associated suite of analytes. A full listing of compounds and detection limits are available from the laboratory upon request.
Unless otherwise indicated, analyses were performed at Hill Laboratories, 28 Duke Street, Frankton, Hamilton 3204.

Sample Type: Soil			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
Individual Tests			
Environmental Solids Sample Drying*	Air dried at 35°C Used for sample preparation. May contain a residual moisture content of 2-5%.	-	2-3, 6, 9, 11-13, 15, 17, 20-32
Dry Matter (Env)	Dried at 103°C for 4-22hr (removes 3-5% more water than air dry) , gravimetry. (Free water removed before analysis, non-soil objects such as sticks, leaves, grass and stones also removed). US EPA 3550.	0.10 g/100g as rcvd	2-3, 5-6, 9, 11, 21
Heavy Metals, Screen Level	Dried sample, < 2mm fraction. Nitric/Hydrochloric acid digestion US EPA 200.2. Complies with NES Regulations. ICP-MS screen level, interference removal by Kinetic Energy Discrimination if required.	0.10 - 4 mg/kg dry wt	2-3, 6, 9, 11-13, 15, 17, 20-32
Organochlorine Pesticides Screening in Soil	Sonication extraction, GC-ECD analysis. Tested on as received sample. In-house based on US EPA 8081.	0.010 - 0.06 mg/kg dry wt	2-3, 5-6, 9, 11, 21
TCLP Profile*	Extraction at 30 +/- 2 rpm for 18 +/- 2 hours, (Ratio 1g sample : 20g extraction fluid). US EPA 1311.	-	2
TCLP Profile			
TCLP Weight of Sample Taken	Gravimetric. US EPA 1311.	0.1 g	2

Sample Type: Soil			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
TCLP Initial Sample pH	pH meter. US EPA 1311.	0.1 pH Units	2
TCLP Acid Adjusted Sample pH	pH meter. US EPA 1311.	0.1 pH Units	2
TCLP Extractant Type*	US EPA 1311.	-	2
TCLP Extraction Fluid pH	pH meter. US EPA 1311.	0.1 pH Units	2
TCLP Post Extraction Sample pH	pH meter. US EPA 1311.	0.1 pH Units	2

Sample Type: Aqueous			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
Individual Tests			
Total Digestion of Extracted Samples*	Nitric acid digestion. APHA 3030 E (modified) 23rd ed. 2017.	-	33
Total Arsenic	Nitric acid digestion, ICP-MS, screen level. APHA 3125 B 23rd ed. 2017.	0.021 g/m^3	33
Total Chromium	Nitric acid digestion, ICP-MS, screen level. APHA 3125 B 23rd ed. 2017.	0.011 g/m^3	33
Total Lead	Nitric acid digestion, ICP-MS, screen level. APHA 3125 B 23rd ed. 2017.	0.0021 g/m^3	33
Total Zinc	Nitric acid digestion, ICP-MS, screen level. APHA 3125 B 23rd ed. 2017.	0.021 g/m^3	33
Organochlorine Pesticides Screening in Water, By Liq/Liq	Liquid / liquid extraction, GC-ECD analysis. In-house based on US EPA 8081.	0.00010 - 0.0008 g/m^3	33

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

Testing was completed between 08-Nov-2021 and 30-Nov-2021. For completion dates of individual analyses please contact the laboratory.

Samples are held at the laboratory after reporting for a length of time based on the stability of the samples and analytes being tested (considering any preservation used), and the storage space available. Once the storage period is completed, the samples are discarded unless otherwise agreed with the customer. Extended storage times may incur additional charges.

Kim Harrison MSc
Client Services Manager - Environmental

Appendix E
ProUCL Worksheets

1				UCL Statistics for Uncensored Full Data Sets							
2											
3			User Selected Options								
4			Date/Time of Computation	ProUCL 5.11/12/2021 3:45:16 pm							
5			From File	Kaka Valley KVP ProUCL Input.xls							
6			Full Precision	OFF							
7			Confidence Coefficient	95%							
8			Number of Bootstrap Operations	2000							
9											
10											
11	Arsenic										
12											
13					General Statistics						
14				Total Number of Observations	20			Number of Distinct Observations	7		
15								Number of Missing Observations	0		
16				Minimum	3			Mean	5.6		
17				Maximum	12			Median	5		
18				SD	1.93			Std. Error of Mean	0.432		
19				Coefficient of Variation	0.345			Skewness	2.246		
20											
21					Normal GOF Test						
22				Shapiro Wilk Test Statistic	0.721			Shapiro Wilk GOF Test			
23				5% Shapiro Wilk Critical Value	0.905			Data Not Normal at 5% Significance Level			
24				Lilliefors Test Statistic	0.322			Lilliefors GOF Test			
25				5% Lilliefors Critical Value	0.192			Data Not Normal at 5% Significance Level			
26					Data Not Normal at 5% Significance Level						
27											
28					Assuming Normal Distribution						
29				95% Normal UCL				95% UCLs (Adjusted for Skewness)			
30				95% Student's-t UCL	6.346			95% Adjusted-CLT UCL (Chen-1995)	6.542		
31								95% Modified-t UCL (Johnson-1978)	6.382		
32											
33					Gamma GOF Test						
34				A-D Test Statistic	1.846			Anderson-Darling Gamma GOF Test			
35				5% A-D Critical Value	0.742			Data Not Gamma Distributed at 5% Significance Level			
36				K-S Test Statistic	0.31			Kolmogorov-Smirnov Gamma GOF Test			
37				5% K-S Critical Value	0.194			Data Not Gamma Distributed at 5% Significance Level			
38					Data Not Gamma Distributed at 5% Significance Level						
39											
40					Gamma Statistics						
41				k hat (MLE)	11.57			k star (bias corrected MLE)	9.865		
42				Theta hat (MLE)	0.484			Theta star (bias corrected MLE)	0.568		
43				nu hat (MLE)	462.7			nu star (bias corrected)	394.6		
44				MLE Mean (bias corrected)	5.6			MLE Sd (bias corrected)	1.783		
45								Approximate Chi Square Value (0.05)	349.6		
46				Adjusted Level of Significance	0.038			Adjusted Chi Square Value	346.2		
47											
48					Assuming Gamma Distribution						
49				95% Approximate Gamma UCL (use when n>=50))	6.322			95% Adjusted Gamma UCL (use when n<50)	6.383		
50											
51					Lognormal GOF Test						
52				Shapiro Wilk Test Statistic	0.837			Shapiro Wilk Lognormal GOF Test			
53				5% Shapiro Wilk Critical Value	0.905			Data Not Lognormal at 5% Significance Level			
54				Lilliefors Test Statistic	0.295			Lilliefors Lognormal GOF Test			
55				5% Lilliefors Critical Value	0.192			Data Not Lognormal at 5% Significance Level			
56					Data Not Lognormal at 5% Significance Level						
57											

58					Lognormal Statistics						
59				Minimum of Logged Data	1.099				Mean of logged Data	1.679	
60				Maximum of Logged Data	2.485				SD of logged Data	0.289	
61											
62					Assuming Lognormal Distribution						
63				95% H-UCL	6.316				90% Chebyshev (MVUE) UCL	6.672	
64				95% Chebyshev (MVUE) UCL	7.169				97.5% Chebyshev (MVUE) UCL	7.857	
65				99% Chebyshev (MVUE) UCL	9.211						
66											
67					Nonparametric Distribution Free UCL Statistics						
68					Data do not follow a Discernible Distribution (0.05)						
69											
70					Nonparametric Distribution Free UCLs						
71				95% CLT UCL	6.31				95% Jackknife UCL	6.346	
72				95% Standard Bootstrap UCL	6.302				95% Bootstrap-t UCL	6.996	
73				95% Hall's Bootstrap UCL	10.29				95% Percentile Bootstrap UCL	6.35	
74				95% BCA Bootstrap UCL	6.5						
75				90% Chebyshev(Mean, Sd) UCL	6.895				95% Chebyshev(Mean, Sd) UCL	7.481	
76				97.5% Chebyshev(Mean, Sd) UCL	8.296				99% Chebyshev(Mean, Sd) UCL	9.895	
77											
78					Suggested UCL to Use						
79				95% Student's-t UCL	6.346				or 95% Modified-t UCL	6.382	
80											
81	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.										
82	Recommendations are based upon data size, data distribution, and skewness.										
83	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).										
84	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.										
85											
86											
87	Chromium										
88											
89					General Statistics						
90				Total Number of Observations	20				Number of Distinct Observations	18	
91									Number of Missing Observations	0	
92				Minimum	76				Mean	132.9	
93				Maximum	200				Median	139	
94				SD	31.58				Std. Error of Mean	7.061	
95				Coefficient of Variation	0.238				Skewness	-0.0841	
96											
97					Normal GOF Test						
98				Shapiro Wilk Test Statistic	0.952				Shapiro Wilk GOF Test		
99				5% Shapiro Wilk Critical Value	0.905				Data appear Normal at 5% Significance Level		
100				Lilliefors Test Statistic	0.139				Lilliefors GOF Test		
101				5% Lilliefors Critical Value	0.192				Data appear Normal at 5% Significance Level		
102					Data appear Normal at 5% Significance Level						
103											
104					Assuming Normal Distribution						
105				95% Normal UCL					95% UCLs (Adjusted for Skewness)		
106				95% Student's-t UCL	145.1				95% Adjusted-CLT UCL (Chen-1995)	144.4	
107									95% Modified-t UCL (Johnson-1978)	145.1	
108											
109					Gamma GOF Test						
110				A-D Test Statistic	0.668				Anderson-Darling Gamma GOF Test		
111				5% A-D Critical Value	0.741				Detected data appear Gamma Distributed at 5% Significance Level		
112				K-S Test Statistic	0.171				Kolmogorov-Smirnov Gamma GOF Test		
113				5% K-S Critical Value	0.194				Detected data appear Gamma Distributed at 5% Significance Level		
114					Detected data appear Gamma Distributed at 5% Significance Level						

115											
116					Gamma Statistics						
117				k hat (MLE)	17.16			k star (bias corrected MLE)	14.62		
118				Theta hat (MLE)	7.743			Theta star (bias corrected MLE)	9.088		
119				nu hat (MLE)	686.6			nu star (bias corrected)	584.9		
120				MLE Mean (bias corrected)	132.9			MLE Sd (bias corrected)	34.75		
121								Approximate Chi Square Value (0.05)	529.8		
122				Adjusted Level of Significance	0.038			Adjusted Chi Square Value	525.7		
123											
124					Assuming Gamma Distribution						
125				95% Approximate Gamma UCL (use when n>=50))	146.7			95% Adjusted Gamma UCL (use when n<50)	147.9		
126											
127					Lognormal GOF Test						
128				Shapiro Wilk Test Statistic	0.919			Shapiro Wilk Lognormal GOF Test			
129				5% Shapiro Wilk Critical Value	0.905			Data appear Lognormal at 5% Significance Level			
130				Lilliefors Test Statistic	0.185			Lilliefors Lognormal GOF Test			
131				5% Lilliefors Critical Value	0.192			Data appear Lognormal at 5% Significance Level			
132					Data appear Lognormal at 5% Significance Level						
133											
134					Lognormal Statistics						
135				Minimum of Logged Data	4.331			Mean of logged Data	4.86		
136				Maximum of Logged Data	5.298			SD of logged Data	0.256		
137											
138					Assuming Lognormal Distribution						
139				95% H-UCL	148.4			90% Chebyshev (MVUE) UCL	156.2		
140				95% Chebyshev (MVUE) UCL	166.7			97.5% Chebyshev (MVUE) UCL	181.2		
141				99% Chebyshev (MVUE) UCL	209.7						
142											
143					Nonparametric Distribution Free UCL Statistics						
144					Data appear to follow a Discernible Distribution at 5% Significance Level						
145											
146					Nonparametric Distribution Free UCLs						
147				95% CLT UCL	144.5			95% Jackknife UCL	145.1		
148				95% Standard Bootstrap UCL	144.2			95% Bootstrap-t UCL	145		
149				95% Hall's Bootstrap UCL	145.3			95% Percentile Bootstrap UCL	144.2		
150				95% BCA Bootstrap UCL	144.2						
151				90% Chebyshev(Mean, Sd) UCL	154.1			95% Chebyshev(Mean, Sd) UCL	163.7		
152				97.5% Chebyshev(Mean, Sd) UCL	177			99% Chebyshev(Mean, Sd) UCL	203.2		
153											
154					Suggested UCL to Use						
155				95% Student's-t UCL	145.1						
156											
157					Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.						
158					Recommendations are based upon data size, data distribution, and skewness.						
159					These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).						
160					However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.						
161											
162					Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be						
163					reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.						
164											
165											
166	Copper										
167											
168					General Statistics						
169				Total Number of Observations	20			Number of Distinct Observations	12		
170								Number of Missing Observations	0		
171				Minimum	44			Mean	54.1		

172				Maximum	64			Median	56		
173				SD	5.467			Std. Error of Mean	1.222		
174				Coefficient of Variation	0.101			Skewness	-0.324		
175											
176					Normal GOF Test						
177				Shapiro Wilk Test Statistic	0.941			Shapiro Wilk GOF Test			
178				5% Shapiro Wilk Critical Value	0.905			Data appear Normal at 5% Significance Level			
179				Lilliefors Test Statistic	0.202			Lilliefors GOF Test			
180				5% Lilliefors Critical Value	0.192			Data Not Normal at 5% Significance Level			
181					Data appear Approximate Normal at 5% Significance Level						
182											
183					Assuming Normal Distribution						
184				95% Normal UCL				95% UCLs (Adjusted for Skewness)			
185				95% Student's-t UCL	56.21			95% Adjusted-CLT UCL (Chen-1995)	56.02		
186								95% Modified-t UCL (Johnson-1978)	56.2		
187											
188					Gamma GOF Test						
189				A-D Test Statistic	0.693			Anderson-Darling Gamma GOF Test			
190				5% A-D Critical Value	0.74			Detected data appear Gamma Distributed at 5% Significance Level			
191				K-S Test Statistic	0.212			Kolmogorov-Smirnov Gamma GOF Test			
192				5% K-S Critical Value	0.193			Data Not Gamma Distributed at 5% Significance Level			
193					Detected data follow Appr. Gamma Distribution at 5% Significance Level						
194											
195					Gamma Statistics						
196				k hat (MLE)	100.2			k star (bias corrected MLE)	85.2		
197				Theta hat (MLE)	0.54			Theta star (bias corrected MLE)	0.635		
198				nu hat (MLE)	4008			nu star (bias corrected)	3408		
199				MLE Mean (bias corrected)	54.1			MLE Sd (bias corrected)	5.861		
200								Approximate Chi Square Value (0.05)	3273		
201				Adjusted Level of Significance	0.038			Adjusted Chi Square Value	3263		
202											
203					Assuming Gamma Distribution						
204				95% Approximate Gamma UCL (use when n>=50))	56.33			95% Adjusted Gamma UCL (use when n<50)	56.5		
205											
206					Lognormal GOF Test						
207				Shapiro Wilk Test Statistic	0.931			Shapiro Wilk Lognormal GOF Test			
208				5% Shapiro Wilk Critical Value	0.905			Data appear Lognormal at 5% Significance Level			
209				Lilliefors Test Statistic	0.21			Lilliefors Lognormal GOF Test			
210				5% Lilliefors Critical Value	0.192			Data Not Lognormal at 5% Significance Level			
211					Data appear Approximate Lognormal at 5% Significance Level						
212											
213					Lognormal Statistics						
214				Minimum of Logged Data	3.784			Mean of logged Data	3.986		
215				Maximum of Logged Data	4.159			SD of logged Data	0.103		
216											
217					Assuming Lognormal Distribution						
218				95% H-UCL	56.39			90% Chebyshev (MVUE) UCL	57.86		
219				95% Chebyshev (MVUE) UCL	59.57			97.5% Chebyshev (MVUE) UCL	61.93		
220				99% Chebyshev (MVUE) UCL	66.57						
221											
222					Nonparametric Distribution Free UCL Statistics						
223					Data appear to follow a Discernible Distribution at 5% Significance Level						
224											
225					Nonparametric Distribution Free UCLs						
226				95% CLT UCL	56.11			95% Jackknife UCL	56.21		
227				95% Standard Bootstrap UCL	56.06			95% Bootstrap-t UCL	56.03		
228				95% Hall's Bootstrap UCL	55.99			95% Percentile Bootstrap UCL	56.05		

229				95% BCA Bootstrap UCL	55.95							
230				90% Chebyshev(Mean, Sd) UCL	57.77				95% Chebyshev(Mean, Sd) UCL	59.43		
231				97.5% Chebyshev(Mean, Sd) UCL	61.73				99% Chebyshev(Mean, Sd) UCL	66.26		
232												
233					Suggested UCL to Use							
234				95% Student's-t UCL	56.21							
235												
236					When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test							
237					When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL							
238												
239					Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.							
240					Recommendations are based upon data size, data distribution, and skewness.							
241					These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).							
242					However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.							
243												
244					Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be							
245					reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.							
246												
247												
248	Lead											
249												
250					General Statistics							
251				Total Number of Observations	20				Number of Distinct Observations	20		
252									Number of Missing Observations	0		
253				Minimum	5.3				Mean	15.68		
254				Maximum	60				Median	7.75		
255				SD	17.58				Std. Error of Mean	3.932		
256				Coefficient of Variation	1.121				Skewness	2.043		
257												
258					Normal GOF Test							
259				Shapiro Wilk Test Statistic	0.597				Shapiro Wilk GOF Test			
260				5% Shapiro Wilk Critical Value	0.905				Data Not Normal at 5% Significance Level			
261				Lilliefors Test Statistic	0.354				Lilliefors GOF Test			
262				5% Lilliefors Critical Value	0.192				Data Not Normal at 5% Significance Level			
263					Data Not Normal at 5% Significance Level							
264												
265					Assuming Normal Distribution							
266				95% Normal UCL					95% UCLs (Adjusted for Skewness)			
267				95% Student's-t UCL	22.48				95% Adjusted-CLT UCL (Chen-1995)	24.07		
268									95% Modified-t UCL (Johnson-1978)	22.78		
269												
270					Gamma GOF Test							
271				A-D Test Statistic	2.398				Anderson-Darling Gamma GOF Test			
272				5% A-D Critical Value	0.758				Data Not Gamma Distributed at 5% Significance Level			
273				K-S Test Statistic	0.266				Kolmogorov-Smirnov Gamma GOF Test			
274				5% K-S Critical Value	0.197				Data Not Gamma Distributed at 5% Significance Level			
275					Data Not Gamma Distributed at 5% Significance Level							
276												
277					Gamma Statistics							
278				k hat (MLE)	1.487				k star (bias corrected MLE)	1.298		
279				Theta hat (MLE)	10.54				Theta star (bias corrected MLE)	12.08		
280				nu hat (MLE)	59.5				nu star (bias corrected)	51.91		
281				MLE Mean (bias corrected)	15.68				MLE Sd (bias corrected)	13.76		
282									Approximate Chi Square Value (0.05)	36.36		
283				Adjusted Level of Significance	0.038				Adjusted Chi Square Value	35.33		
284												
285					Assuming Gamma Distribution							

95% Approximate Gamma UCL (use when n>=50))					22.39		95% Adjusted Gamma UCL (use when n<50)				23.04
Lognormal GOF Test											
			Shapiro Wilk Test Statistic		0.785		Shapiro Wilk Lognormal GOF Test				
			5% Shapiro Wilk Critical Value		0.905		Data Not Lognormal at 5% Significance Level				
			Lilliefors Test Statistic		0.206		Lilliefors Lognormal GOF Test				
			5% Lilliefors Critical Value		0.192		Data Not Lognormal at 5% Significance Level				
Data Not Lognormal at 5% Significance Level											
Lognormal Statistics											
			Minimum of Logged Data		1.668				Mean of logged Data		2.38
			Maximum of Logged Data		4.094				SD of logged Data		0.778
Assuming Lognormal Distribution											
			95% H-UCL		22.17				90% Chebyshev (MVUE) UCL		22.43
			95% Chebyshev (MVUE) UCL		26.1				97.5% Chebyshev (MVUE) UCL		31.18
			99% Chebyshev (MVUE) UCL		41.17						
Nonparametric Distribution Free UCL Statistics											
Data do not follow a Discernible Distribution (0.05)											
Nonparametric Distribution Free UCLs											
			95% CLT UCL		22.15				95% Jackknife UCL		22.48
			95% Standard Bootstrap UCL		22.02				95% Bootstrap-t UCL		25.62
			95% Hall's Bootstrap UCL		21.42				95% Percentile Bootstrap UCL		22.54
			95% BCA Bootstrap UCL		23.51						
			90% Chebyshev(Mean, Sd) UCL		27.47				95% Chebyshev(Mean, Sd) UCL		32.82
			97.5% Chebyshev(Mean, Sd) UCL		40.23				99% Chebyshev(Mean, Sd) UCL		54.8
Suggested UCL to Use											
			95% Chebyshev (Mean, Sd) UCL		32.82						
Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
Recommendations are based upon data size, data distribution, and skewness.											
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
Nickel											
General Statistics											
			Total Number of Observations		20				Number of Distinct Observations		16
									Number of Missing Observations		0
				Minimum	49				Mean		76
				Maximum	172				Median		67
				SD	29.37				Std. Error of Mean		6.568
			Coefficient of Variation		0.387				Skewness		2.243
Normal GOF Test											
			Shapiro Wilk Test Statistic		0.744		Shapiro Wilk GOF Test				
			5% Shapiro Wilk Critical Value		0.905		Data Not Normal at 5% Significance Level				
			Lilliefors Test Statistic		0.244		Lilliefors GOF Test				
			5% Lilliefors Critical Value		0.192		Data Not Normal at 5% Significance Level				
Data Not Normal at 5% Significance Level											
Assuming Normal Distribution											
95% Normal UCL							95% UCLs (Adjusted for Skewness)				

343				95% Student's-t UCL	87.36			95% Adjusted-CLT UCL (Chen-1995)				90.32
344								95% Modified-t UCL (Johnson-1978)				87.91
345												
346					Gamma GOF Test							
347				A-D Test Statistic	1.178			Anderson-Darling Gamma GOF Test				
348				5% A-D Critical Value	0.742			Data Not Gamma Distributed at 5% Significance Level				
349				K-S Test Statistic	0.224			Kolmogorov-Smirnov Gamma GOF Test				
350				5% K-S Critical Value	0.194			Data Not Gamma Distributed at 5% Significance Level				
351					Data Not Gamma Distributed at 5% Significance Level							
352												
353					Gamma Statistics							
354				k hat (MLE)	9.658			k star (bias corrected MLE)	8.242			
355				Theta hat (MLE)	7.869			Theta star (bias corrected MLE)	9.221			
356				nu hat (MLE)	386.3			nu star (bias corrected)	329.7			
357				MLE Mean (bias corrected)	76			MLE Sd (bias corrected)	26.47			
358								Approximate Chi Square Value (0.05)	288.6			
359				Adjusted Level of Significance	0.038			Adjusted Chi Square Value	285.6			
360												
361					Assuming Gamma Distribution							
362				95% Approximate Gamma UCL (use when n>=50))	86.81			95% Adjusted Gamma UCL (use when n<50)	87.74			
363												
364					Lognormal GOF Test							
365				Shapiro Wilk Test Statistic	0.868			Shapiro Wilk Lognormal GOF Test				
366				5% Shapiro Wilk Critical Value	0.905			Data Not Lognormal at 5% Significance Level				
367				Lilliefors Test Statistic	0.206			Lilliefors Lognormal GOF Test				
368				5% Lilliefors Critical Value	0.192			Data Not Lognormal at 5% Significance Level				
369					Data Not Lognormal at 5% Significance Level							
370												
371					Lognormal Statistics							
372				Minimum of Logged Data	3.892			Mean of logged Data	4.278			
373				Maximum of Logged Data	5.147			SD of logged Data	0.311			
374												
375					Assuming Lognormal Distribution							
376				95% H-UCL	86.42			90% Chebyshev (MVUE) UCL	91.49			
377				95% Chebyshev (MVUE) UCL	98.73			97.5% Chebyshev (MVUE) UCL	108.8			
378				99% Chebyshev (MVUE) UCL	128.5							
379												
380					Nonparametric Distribution Free UCL Statistics							
381					Data do not follow a Discernible Distribution (0.05)							
382												
383					Nonparametric Distribution Free UCLs							
384				95% CLT UCL	86.8			95% Jackknife UCL	87.36			
385				95% Standard Bootstrap UCL	86.32			95% Bootstrap-t UCL	96.6			
386				95% Hall's Bootstrap UCL	136.7			95% Percentile Bootstrap UCL	87			
387				95% BCA Bootstrap UCL	90.65							
388				90% Chebyshev(Mean, Sd) UCL	95.7			95% Chebyshev(Mean, Sd) UCL	104.6			
389				97.5% Chebyshev(Mean, Sd) UCL	117			99% Chebyshev(Mean, Sd) UCL	141.4			
390												
391					Suggested UCL to Use							
392					95% Student's-t UCL	87.36			or 95% Modified-t UCL	87.91		
393												
394					Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.							
395					Recommendations are based upon data size, data distribution, and skewness.							
396					These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).							
397					However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.							
398												
399												

	A	B	C	D	E	F	G	H	I	J	K	L
400	Zinc											
401												
402						General Statistics						
403					Total Number of Observations	20			Number of Distinct Observations			16
404									Number of Missing Observations			0
405					Minimum	61			Mean			81.65
406					Maximum	149			Median			71
407					SD	26.77			Std. Error of Mean			5.986
408					Coefficient of Variation	0.328			Skewness			1.869
409												
410						Normal GOF Test						
411					Shapiro Wilk Test Statistic	0.705			Shapiro Wilk GOF Test			
412					5% Shapiro Wilk Critical Value	0.905			Data Not Normal at 5% Significance Level			
413					Lilliefors Test Statistic	0.319			Lilliefors GOF Test			
414					5% Lilliefors Critical Value	0.192			Data Not Normal at 5% Significance Level			
415						Data Not Normal at 5% Significance Level						
416												
417						Assuming Normal Distribution						
418					95% Normal UCL				95% UCLs (Adjusted for Skewness)			
419					95% Student's-t UCL	92			95% Adjusted-CLT UCL (Chen-1995)			94.17
420									95% Modified-t UCL (Johnson-1978)			92.42
421												
422						Gamma GOF Test						
423					A-D Test Statistic	1.946			Anderson-Darling Gamma GOF Test			
424					5% A-D Critical Value	0.742			Data Not Gamma Distributed at 5% Significance Level			
425					K-S Test Statistic	0.295			Kolmogorov-Smirnov Gamma GOF Test			
426					5% K-S Critical Value	0.194			Data Not Gamma Distributed at 5% Significance Level			
427						Data Not Gamma Distributed at 5% Significance Level						
428												
429						Gamma Statistics						
430					k hat (MLE)	12.69			k star (bias corrected MLE)			10.82
431					Theta hat (MLE)	6.434			Theta star (bias corrected MLE)			7.546
432					nu hat (MLE)	507.6			nu star (bias corrected)			432.8
433					MLE Mean (bias corrected)	81.65			MLE Sd (bias corrected)			24.82
434									Approximate Chi Square Value (0.05)			385.6
435					Adjusted Level of Significance	0.038			Adjusted Chi Square Value			382.1
436												
437						Assuming Gamma Distribution						
438					95% Approximate Gamma UCL (use when n>=50))	91.65			95% Adjusted Gamma UCL (use when n<50)			92.49
439												
440						Lognormal GOF Test						
441					Shapiro Wilk Test Statistic	0.782			Shapiro Wilk Lognormal GOF Test			
442					5% Shapiro Wilk Critical Value	0.905			Data Not Lognormal at 5% Significance Level			
443					Lilliefors Test Statistic	0.277			Lilliefors Lognormal GOF Test			
444					5% Lilliefors Critical Value	0.192			Data Not Lognormal at 5% Significance Level			
445						Data Not Lognormal at 5% Significance Level						
446												
447						Lognormal Statistics						
448					Minimum of Logged Data	4.111			Mean of logged Data			4.363
449					Maximum of Logged Data	5.004			SD of logged Data			0.273
450												
451						Assuming Lognormal Distribution						
452					95% H-UCL	91.32			90% Chebyshev (MVUE) UCL			96.32
453					95% Chebyshev (MVUE) UCL	103.1			97.5% Chebyshev (MVUE) UCL			112.6
454					99% Chebyshev (MVUE) UCL	131.2						
455												
456						Nonparametric Distribution Free UCL Statistics						

	A	B	C	D	E	F	G	H	I	J	K	L
457	Data do not follow a Discernible Distribution (0.05)											
458												
459	Nonparametric Distribution Free UCLs											
460				95% CLT UCL		91.5				95% Jackknife UCL		92
461				95% Standard Bootstrap UCL		91.27				95% Bootstrap-t UCL		97.75
462				95% Hall's Bootstrap UCL		95.03				95% Percentile Bootstrap UCL		92.05
463				95% BCA Bootstrap UCL		93.45						
464				90% Chebyshev(Mean, Sd) UCL		99.61				95% Chebyshev(Mean, Sd) UCL		107.7
465				97.5% Chebyshev(Mean, Sd) UCL		119				99% Chebyshev(Mean, Sd) UCL		141.2
466												
467	Suggested UCL to Use											
468				95% Student's-t UCL		92				or 95% Modified-t UCL		92.42
469												
470	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
471	Recommendations are based upon data size, data distribution, and skewness.											
472	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
473	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
474												

1				UCL Statistics for Data Sets with Non-Detects							
2											
3			User Selected Options								
4			Date/Time of Computation	ProUCL 5.11/12/2021 3:44:50 pm							
5			From File	Kaka Valley KVP ProUCL Input.xls							
6			Full Precision	OFF							
7			Confidence Coefficient	95%							
8			Number of Bootstrap Operations	2000							
9											
10											
11	Cadmium										
12											
13					General Statistics						
14				Total Number of Observations	19			Number of Distinct Observations	11		
15								Number of Missing Observations	1		
16				Minimum	0.13			Mean	0.171		
17				Maximum	0.23			Median	0.17		
18				SD	0.0295			Std. Error of Mean	0.00677		
19				Coefficient of Variation	0.173			Skewness	0.55		
20											
21					Normal GOF Test						
22				Shapiro Wilk Test Statistic	0.938			Shapiro Wilk GOF Test			
23				5% Shapiro Wilk Critical Value	0.901			Data appear Normal at 5% Significance Level			
24				Lilliefors Test Statistic	0.178			Lilliefors GOF Test			
25				5% Lilliefors Critical Value	0.197			Data appear Normal at 5% Significance Level			
26					Data appear Normal at 5% Significance Level						
27											
28					Assuming Normal Distribution						
29				95% Normal UCL				95% UCLs (Adjusted for Skewness)			
30				95% Student's-t UCL	0.182			95% Adjusted-CLT UCL (Chen-1995)	0.183		
31								95% Modified-t UCL (Johnson-1978)	0.182		
32											
33					Gamma GOF Test						
34				A-D Test Statistic	0.404			Anderson-Darling Gamma GOF Test			
35				5% A-D Critical Value	0.74			Detected data appear Gamma Distributed at 5% Significance Level			
36				K-S Test Statistic	0.18			Kolmogorov-Smirnov Gamma GOF Test			
37				5% K-S Critical Value	0.198			Detected data appear Gamma Distributed at 5% Significance Level			
38					Detected data appear Gamma Distributed at 5% Significance Level						
39											
40					Gamma Statistics						
41				k hat (MLE)	36.38			k star (bias corrected MLE)	30.67		
42				Theta hat (MLE)	0.00469			Theta star (bias corrected MLE)	0.00556		
43				nu hat (MLE)	1383			nu star (bias corrected)	1166		
44				MLE Mean (bias corrected)	0.171			MLE Sd (bias corrected)	0.0308		
45								Approximate Chi Square Value (0.05)	1087		
46				Adjusted Level of Significance	0.0369			Adjusted Chi Square Value	1081		
47											
48					Assuming Gamma Distribution						
49				95% Approximate Gamma UCL (use when n>=50))	0.183			95% Adjusted Gamma UCL (use when n<50)	0.184		
50											
51					Lognormal GOF Test						
52				Shapiro Wilk Test Statistic	0.953			Shapiro Wilk Lognormal GOF Test			
53				5% Shapiro Wilk Critical Value	0.901			Data appear Lognormal at 5% Significance Level			
54				Lilliefors Test Statistic	0.171			Lilliefors Lognormal GOF Test			
55				5% Lilliefors Critical Value	0.197			Data appear Lognormal at 5% Significance Level			
56					Data appear Lognormal at 5% Significance Level						
57											

58	Lognormal Statistics										
59			Minimum of Logged Data		-2.04				Mean of logged Data		-1.783
60			Maximum of Logged Data		-1.47				SD of logged Data		0.17
61											
62	Assuming Lognormal Distribution										
63			95% H-UCL		0.183				90% Chebyshev (MVUE) UCL		0.19
64			95% Chebyshev (MVUE) UCL		0.2				97.5% Chebyshev (MVUE) UCL		0.212
65			99% Chebyshev (MVUE) UCL		0.237						
66											
67	Nonparametric Distribution Free UCL Statistics										
68	Data appear to follow a Discernible Distribution at 5% Significance Level										
69											
70	Nonparametric Distribution Free UCLs										
71			95% CLT UCL		0.182				95% Jackknife UCL		0.182
72			95% Standard Bootstrap UCL		0.181				95% Bootstrap-t UCL		0.184
73			95% Hall's Bootstrap UCL		0.183				95% Percentile Bootstrap UCL		0.181
74			95% BCA Bootstrap UCL		0.181						
75			90% Chebyshev(Mean, Sd) UCL		0.191				95% Chebyshev(Mean, Sd) UCL		0.2
76			97.5% Chebyshev(Mean, Sd) UCL		0.213				99% Chebyshev(Mean, Sd) UCL		0.238
77											
78	Suggested UCL to Use										
79			95% Student's-t UCL		0.182						
80											
81	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.										
82	Recommendations are based upon data size, data distribution, and skewness.										
83	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).										
84	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.										
85											