Remediation Action Plan

Maitahi Subdivision
7 Ralphine Way, Nelson

CCKV MAITAI DEV CO LP

February 2025

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Quality Assurance

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1.0 INTRODUCTION

Envirolink Ltd has been commissioned by CCKV MAITAI DEV CO LP to prepare a remediation action plan (RAP) to support the earthworks that are required to remediate land impacted by former farming activities at 7 Ralphine Way, Nelson (the site). The proposed development includes standard residential lots, high-density residential properties, and reserve areas. A development plan is included in Appendix A.

The National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health[1] (NESCS) is applicable to sites where potentially contaminating activities (as defined in the Hazardous Activities and Industries List[2] (HAIL)) have been or are being carried out. The site has three areas which contain HAIL activities, including a wool shed and sheep treatment area, runout area (referred to as the 'southern paddock') and former homestead.

Previous investigations undertaken by Envirolink concluded that contaminants in soil at the site pose a potential risk to human health and the environment and that remediation would be required to facilitate the proposed development (refer Section 3.3). This RAP outlines the remedial measures necessary to render the site suitable for the proposed use.

The Kākā Hill Tributary and associated esplanade reserve is proposed to be realigned through the existing woolshed and former sheep spray. The reserve is approximately 60 m wide, with the riparian margin being approximately 40 m in width. The design includes a 3 m wide stream with banks, and a stormwater treatment wetland as shown below in Figure 1. The invert of the low flow channel is estimated to be 1.4 m below ground level. In addition to the esplanade reserves, there are two recreational reserves proposed in the north and west of the wider development.

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

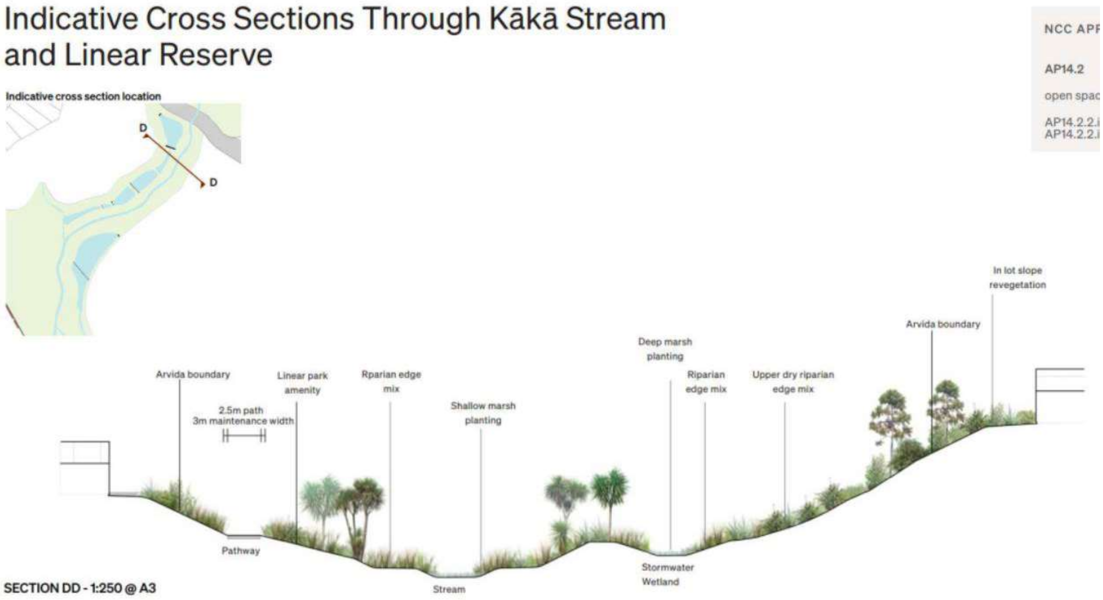

Figure 1: Indicative Cross Section Through Kākā Stream and Linear Reserve

The paddocks to the south (southern paddocks) of the esplanade reserve, and the former homestead are to be redeveloped by Arvida, which builds and operates aged residential care homes (Stage 1 of the development – high density residential).

This RAP is not intended to present a detailed depiction of site conditions but should be read in conjunction with previous Envirolink reporting.

- Envirolink, 2021 Detailed Site Investigation, Maitahi Subdivision, Ref: 211209.MaitahiDSI_v2.
- Envirolink, 2023, Addendum Contamination Assessment – Maitahi Subdivision – V4

The findings from previous reports are summarised in Section 3.3. This report focuses on the former sheep dip / spray and surrounding area.

2.0 OBJECTIVE AND SCOPE OF WORK

The objective of this remedial action plan is to:

- Review the conceptual site model (CSM) in the context of the latest site development plans;
- Document the remediation to be undertaken at the site;
- Document validation requirements for areas requiring remediation;
- Ensure potential on and off-site risks to human health and the environment associated with soil disturbance and redevelopment are adequately managed; and
- Provide sufficient information to determine resource consent requirements under the NESCS[3] to facilitate the remediation and proposed development.

The following scope was undertaken to achieve the above objectives:

- Summarisation of previous reporting and presentation of an up-to-date CSM;
- Consideration of site control procedures and health and safety protection measures;
- Consideration of remediation requirements to render the site suitable for the proposed usage;
- Consideration of soil management and disposal requirements;
- Production of this RAP summarising the above and consistent with the requirements of CLMG No. 1[4].

[3] Resource Management (National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health) Regulations 2011.
[4] 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

Property Address:	7 Ralphine Way, Maitai Valley
Locality:	Nelson 7010
Owner:	CCKV MAITAI DEV CO LP
Legal description (original property):	Part Section 11 Brook Street and Maitai DIST
Property Area:	Approx. 43.7 hectares
Map Reference (NZTM):	Latitude: -41.268176 Longitude: 173.310475

Ralphine Way is the primary access to the property currently listed as 7 Ralphine Way. At the end of the Way (170 m off Maitai Valley Rd), the property opens out to what is Kākā Valley. It 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 was previously used as a cattle and sheep farm.

The location and layout of the site are shown in Figures 2 and 3. Proposed development plans are presented in Appendix A.

Figure 2 - Site Location

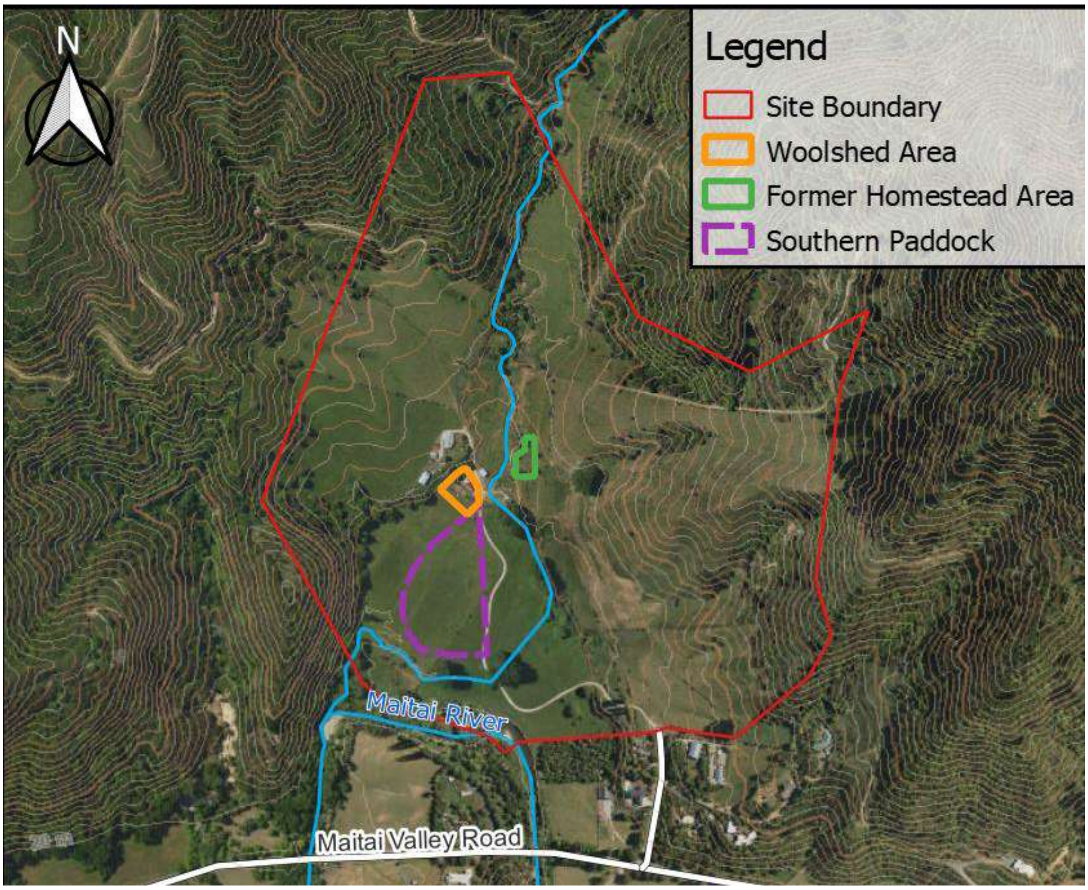

Figure 3 - Site Layout

3.2 Property Description and History

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

The higher parts of the property are currently used for grazing. The central part of the property contains the former woolshed, an implement shed and smaller auxiliary buildings. The existing farmhouse and additional farm related buildings are also located centrally but are located on a raised river terrace overlooking the woolshed. The flatter area to the south of the woolshed is grazing paddock. In more recent times the property mainly stocks cattle with some feral goats also present.

Kākā Stream runs north to south bisecting the property and cuts across the southernmost part before discharging into the Maitai River, which is immediately south. Several small overland flow paths, draining the lower paddocks toward the Maitai River, have also been noted.

An inspection of the area west of the woolshed revealed historical sheep treatment infrastructure including holding pads, chemical draining infrastructure and sump, and a standpipe which may have been used for water supply. A footbath was also observed towards the south of the woolshed. These features are shown on Figure 4.

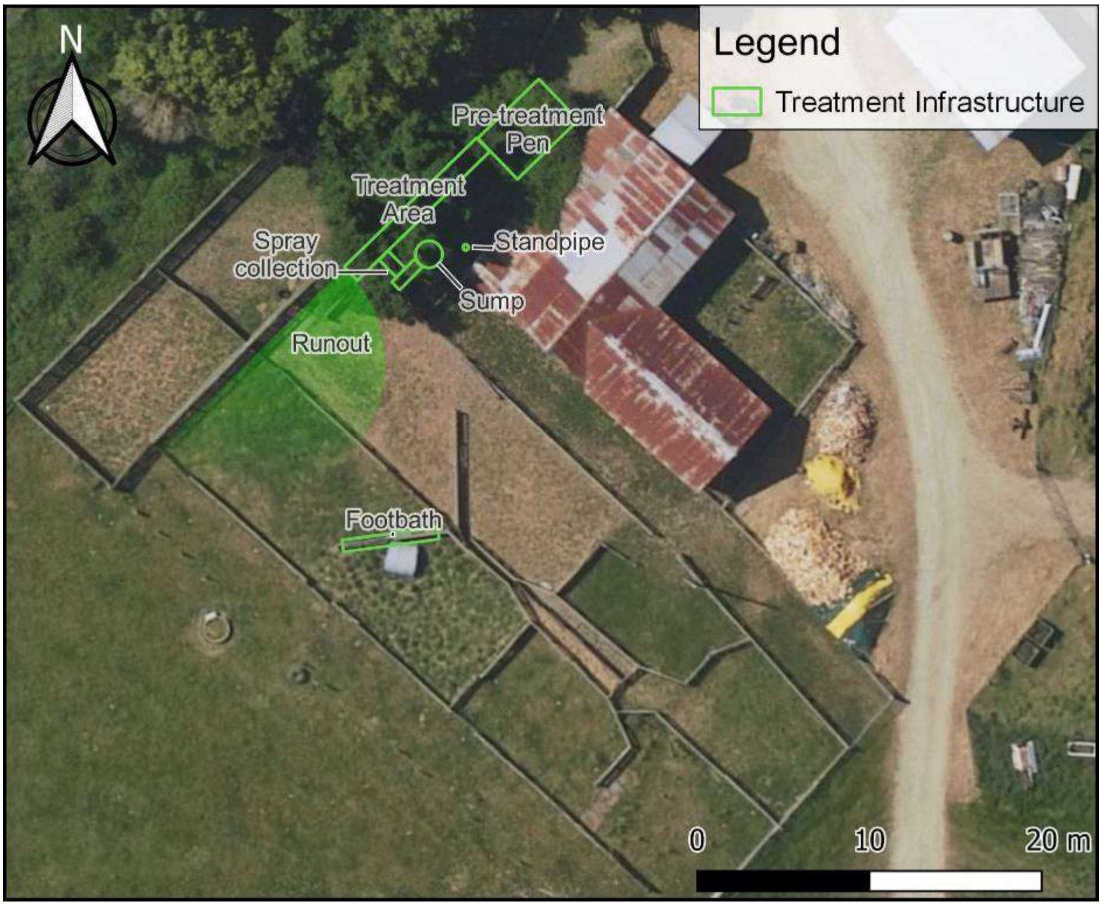

Figure 4 – Treatment Infrastructure Layout

Operations related to sheep dipping/spraying have been present since the earliest aerial photograph taken in the 1940s.

The former homestead was removed between 1980s and 2000, and a new dwelling was relocated to the current site, northwest of the woolshed.

3.3 Summary of Previous Findings and Reports

<u>Geology and Hydrogeology</u>

Ground conditions encountered on site are as presented in Table 1 below.

A layer of hardfill, has been placed across the sheep pens, presumably to improve drainage and prevent the surface material turning to mud during stock movements.

The natural ground conditions comprise layers of granular and cohesive river deposits. The cohesive deposits were inconsistent across the site but considered unlikely to act as a confining layer.

Within the boreholes, groundwater was encountered between 1.5 and 2.4 m below ground level (bgl) in the granular deposits. Groundwater contours, calculated from the groundwater bores that were installed as part of the earlier investigations, indicates that shallow water moves in a southerly/south-easterly direction. Nelson City Council (NCC) data[5] indicates that there are no water takes within 1,000 m of the site.

Table 1: Ground Conditions Encountered during Envirolink led investigations.

Unit		Typical Depth (mm bgl)	Typical Description	Notes
Topsoil		0-300	Dark brown organic sandy gravelly SILT	Encountered around treatment area and in paddocks
Fill/Hardfill		0-1,000	Orangish brown slightly silty SAND and GRAVEL with cobbles. Occasional anthropogenic material.	Likely imported river gravels. Encountered in sheep pens only.
River Deposits	Granular deposits	200-800	Orangish brown (slightly) silty SAND and GRAVEL with cobbles.	River deposit depth and composition likely to be variable across the woolshed and paddock areas. Cohesive deposits sometimes absent (e.g., TP05) or sometimes dominant (TP08).
	Cohesive deposits	800–1,100	Soft orangish brown sandy (slightly) gravelly CLAY/SILT	
	Granular deposits	1,100-1,900+	Orangish brown (slightly) silty SAND and/or GRAVEL with cobbles.	

Kākā Stream has been realigned from its original course which was through the woolshed area and along the base of the hill[6]. The stream is going to be realigned again, further south as part of the proposed esplanade reserve. The stream channel is being cut to intercept groundwater to improve the resilience of the stream against drought, thus the flow in the stream will increase.

<u>Former Homestead Area</u>

Sample location plans and tabular data are presented in the previous Envirolink reports. Those plans and results tables are included in Appendix C of this report.

In summary:

- Concentrations of heavy metals in shallow soils do not exceed relevant human health standards (NESCS[7] Soil Contaminant Standards (SCS)) for the proposed high density residential land use. Shallow soil in this area is considered suitable for re-use.

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[5] Obtained from NCC's Top of the South Maps GIS Platform: https://www.topofthesouthmaps.co.nz/
[6] Young, A. 2020. Historical and Archaeological Assessment for CCKV Maitai Dev Co LP and Bayview Nelson Limited. Dated 17 December 2020.
[7] MfE, 2012, National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health (NESCS).

- Concentrations of lead, zinc and arsenic reported are above NCC background concentrations and therefore if the soil is to be disposed of off-site, it will need to go to a facility authorised to accept it.

Woolshed, Sheep Dip and Runout Area

Various phases of investigation have been undertaken on both soil and groundwater in this part of the site. Sample location plans and tabular data are presented in the previous Envirolink reports. These plans and tables are included in Appendix C of this report.

Proposed Esplanade Reserve: Concentrations of arsenic and dieldrin exceeding human health standards (NES recreational SCS) have been reported to depths up to 1.5 m below ground level (m bgl) within the immediate vicinity of the sheep dip and 0.7 m in the location of the surrounding infrastructure. Figure 5 presents the arsenic results in and around this area. Dieldrin has been detected in soil 25 m downgradient of the treatment infrastructure at its furthest point; soil sample KV42 (0-75mm depth) reported 1.32 mg/kg. The extent of the dieldrin contamination has been inferred but not fully defined.

In some areas, arsenic appears to have migrated through a shallow 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 the surface.

Proposed High Density Residential Area (Southern Paddocks): Concentrations of arsenic are reported below the applicable NES CS standard. Elevated concentrations of copper, chromium and nickel (as compared to background values) are interpreted to be geogenic associated with the ultramafic rock formations in the area. Mafic and ultramafic rocks typically contain naturally elevated concentrations of common anthropogenic contaminants including chromium, copper, nickel. Landcare Research[8] highlights the issue of elevated chromium and nickel in mafic soils of the Nelson-Tasman region, explains that a separate set of background values are required for those soils, and explains that insufficient data was available at the time to construct such a background.

Shallow groundwater encountered in the immediate vicinity of the sheep dip has reported concentrations of heavy metals and dieldrin that exceed applicable ecological standards[9] Shallow water was typically encountered from 1.4 m bgl.

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8 Landcare Research, June 2015, Background concentrations of trace elements and options for managing soil quality in the Tasman and Nelson Districts, a report to Tasman District Council

9 Australian and New Zealand Guidelines (ANZG) for Fresh and Marine Water Quality. In freshwater the 95% protection level has been used for heavy metals, and 99% for DDT and drins has been used to allow for bioaccumulation.

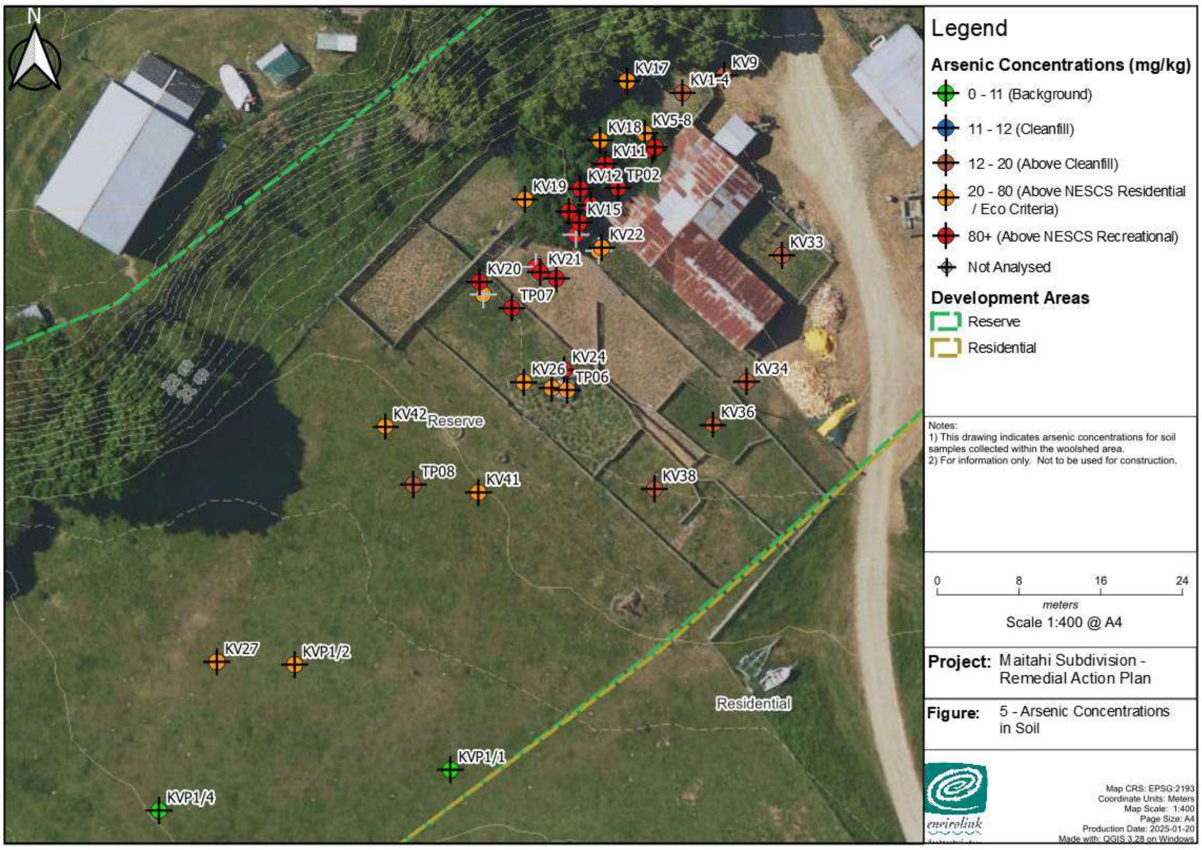

Figure 5 – Summary of Arsenic Results within the proposed Esplanade Reserve

Ecological Recommendations for Contamination Management (Maitahi Village)

Robertson Environmental undertook an ecological assessment and provided recommendations for suitable ecological remedial criteria to inform the remediation objectives for the proposed esplanade reserve. The criteria have been provided in support of *'safeguarding ecological integrity of the proposed ecological corridor'*. This report is included as Appendix B.

It is recommended that the ANZG 2018 DGV (freshwater 95%[9] and sediment[10]) be applied as ecological remediation criteria, as these are considered most applicable to the desired aquatic environmental outcomes.

A 'DGV-GV high' range has been recommended in order *to balance ecological recovery goals and practical constraints and will be used to inform risk-based decision making and remediation planning*.

The Robertson report recommends that the remedial drivers should be arsenic and OCP, and that other potential contaminants of concern will be captured as part of the proposed remediation. Specific remediation for nickel, chromium and copper is stated to '*not be warranted as their concentrations are generally consistent with local natural background*

[10] Australian and New Zealand Guidelines (ANZG) for Fresh and Marine Water Quality. A range of default guideline values have been recommended for the toxicants (DGV-GV-high). The values that have been set for the remediation are 20-70 mg/kg arsenic and 0.0028-0.007 mg/kg dieldrin.

concentrations and therefore they are not expected to pose a significant ecological or human health risk in the sampled areas.'

Based on the ecological criteria recommended, the following observations were noted in the report:

- 39 of 47 samples reported elevated arsenic in soil around the former treatment infrastructure, down to a depth of 1.6 m. All samples tested for dieldrin (27) reported elevated concentrations up to a depth of 1.6 m.
- Within the runout area only 2 samples (of 22) (soil samples KV27 and KVP1/2) reported elevated arsenic in soil. The 20 samples collected within the southern paddock did not report elevated arsenic in soil. This suggests the boundary for arsenic impact can be delineated based on existing results. Dieldrin was not tested for in the runout area.
- Elevated arsenic was not reported in groundwater analysed. Elevated concentrations of dieldrin have been reported. The report indicates that impacted groundwater is unlikely to present a risk to the environment once a reasonable mixing zone is accounted for. An initial estimate in to the available in-stream dilution, suggests there is low dilution potential. Further assessment of groundwater is recommended.

The report recommends additional investigation to define the contaminant boundaries.

4.0 CONCEPTUAL SITE MODEL

A conceptual site model (CSM) has been developed from an assessment of the sources associated with the contaminants of concern, potential exposure pathways, and feasible receptors. A risk is present if a complete pathway is present between the source of contamination and the receptors. Separate CSMs have been prepared for the former homestead area, the former sheep dip/spray and surrounding area and the southeastern paddocks (Tables 2 – 4).

Future site users are the primary on-site receptors from a human health perspective. Within the esplanade reserve the re-aligned stream and stormwater wetlands are the primary environmental receptors.

The woolshed and runout area are intended for ecological reserve usage. The southern paddocks and the former homestead will be used for high density residential purposes. Should the development plan change, the potential risks should be reassessed.

Table 2 - Conceptual Site Model - Linkage Assessment – Homestead Area – High Density Residential

<table>
<tr><th>Source (HAIL Category)</th><th>Associated Contaminants</th><th>Pathway</th><th>Receptor</th><th>Risk Assessment</th></tr>
<tr><td rowspan="2">Former Homestead</td><td rowspan="2">Heavy metals</td><td>Ingestion
Dermal Contact
Inhalation (dust)</td><td>Future site users</td><td>Minimal risk posed
Contaminants of concern do not exceed SCS for high density residential use.</td></tr>
<tr><td>Leaching of contaminants into water if soil disposed of improperly</td><td>Environmental receptors</td><td>Potential risk posed
Contaminant concentrations of lead and zinc exceed cleanfill limits.
Soil removed from site would require management to minimise risk.</td></tr>
</table>

Table 3 – Conceptual Site Model – Linkage Assessment – Sheep Treatment Area / Run-out – Eco Reserve

Source (HAIL Category)	Primary Contaminants of concern	Pathway	Receptor	Linkage Active?
Sheep Treatment – A8	Arsenic Dieldrin	Inhalation Ingestion Dermal Contact	Future site users	Potential risk posed Concentrations of arsenic and dieldrin widely exceed human health standards for recreational usage.
		Leaching of contaminants into water if soil disposed of improperly	Surface water	Potential risk posed. Ecological guidelines for soil are widely exceeded. Soil remediation is required to manage the risk.
		Dissolution and migration of soluble contaminants from in-situ soil	Surface water	Potential risk posed. Yes, shallow groundwater results indicate ecological guidelines are exceeded. Such guidelines are likely to be met once the soil source is removed and dilution during migration and within the stream is accounted for. Where dewatering is required, water will need to be treated prior to disposal.

<u>Note:</u> As detailed in the DSI, 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 4 - Conceptual Site Model - Linkage Assessment – Southeastern paddock- High Density Residential

Source (HAIL Category)	Primary Contaminants of concern	Pathway	Receptor	Linkage Active?
Sheep Treatment Runout Area / Possible Horticulture	Heavy metals	Inhalation Ingestion Dermal Contact	Future site users	Minimal risk posed Contaminants of concern do not exceed SCS for high density residential use.
		Leaching of contaminants into water	Surface water	Minimal risk posed. concentrations of heavy metals generally do not exceed background values (elevated concentrations are geogenic)
		Dissolution and migration of soluble contaminants from in-situ soil	Surface water	Minimal risk posed. concentrations of heavy metals generally do not exceed background values (elevated concentrations are geogenic)

5.0 REMEDIATION OPTIONS APRAISAL

The primary purpose of this report is to set out the proposed remediation and management methodology to ensure the site will be suitable for its proposed land use and will pose no unacceptable risk to human health or the environment, either on-site or off.

Remediation is required in the area of the woolshed and run out area being the proposed stream alignment and esplanade reserve. The other development areas (southern paddocks and homestead area) meet the applicable standards and therefore soil remediation is not proposed. Dependent on the development plans and proposed earthworks requirements, soil management may be required in these areas.

5.1 Remediation Options

The soil remediation options that have been considered include excavation and off-site disposal, in-situ management and encapsulation, and soil sorting. These options, including the advantages and disadvantages associated with cost, feasibility, extent of contamination, effectiveness, longevity etc., are presented in Table D.1 in Appendix D.

5.2 Soil Disposal and Treatment Options

<u>Off-site Disposal</u>

Soil with concentrations of dieldrin over 50 mg/kg exceed the HSNO Act Basel Convention threshold guidelines (low persistent organic pollutants (POPs) content threshold)[11]. According to the guidelines, waste containing organic pesticides at levels higher than these thresholds must be disposed of in a way that ensures the pesticide is '*destroyed, irreversibly transformed or isolated from the environment'*. Envirolink have commissioned some trials with Environmental Decontamination (NZ) Limited at Auckland University and with Enviro NZ Ltd to determine if there are options for facilitated dieldrin degradation. The trials are underway, however, the results and, if successful, the physical destruction of the material is unlikely to be confirmed prior to the commencement of the development. A temporary solution is proposed in Section 6.2 below.

York Valley Landfill (YVL) will accept soil with TCLP leachate concentrations of dieldrin of 0.004 mg/L[12], and 5 mg/L for arsenic. Of the six soil samples that have been analysed for TCLP, four exceed this value for dieldrin (soil samples KV11, 12, 14 and 29-2). None of the samples analysed exceeded TCLP values for arsenic, thus arsenic contaminated soil should be accepted.

Eves Valley Landfill will accept soil with 0.1 mg/kg dieldrin, and 140 mg/kg arsenic.

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[11] EPA (2023) Proposal to introduce Hazardous Substances (Storage and Disposal of Persistent Organic Pollutants) Notice 2023.
[12] 100x the drinking water standard (Water Services (Drinking Water Standards for New Zealand) Regulations 2022

On-site Disposal

An area has been identified approximately 1 km northeast of the woolshed for placement of excess soil from the development (from herein referred to as the 'upstream excess soil area'). This area is approximately 40 m from Kākā Hill tributary at its closest point.

It is proposed that an encapsulation cell will be formed in this area to enable the retention of significantly contaminated soils on site. The approximate location is presented in Figure 6 below. The encapsulation cell will be designed to provide environmental protection (liner and appropriate cap). The exact location of the cell will be confirmed once the quantity of soil requiring encapsulation has been determined and a full engineering design has been approved. Following encapsulation this area will be landscaped and / or regenerated with native vegetation. This area is not proposed for any future development and will be legally protected through a formal land covenant or similar.

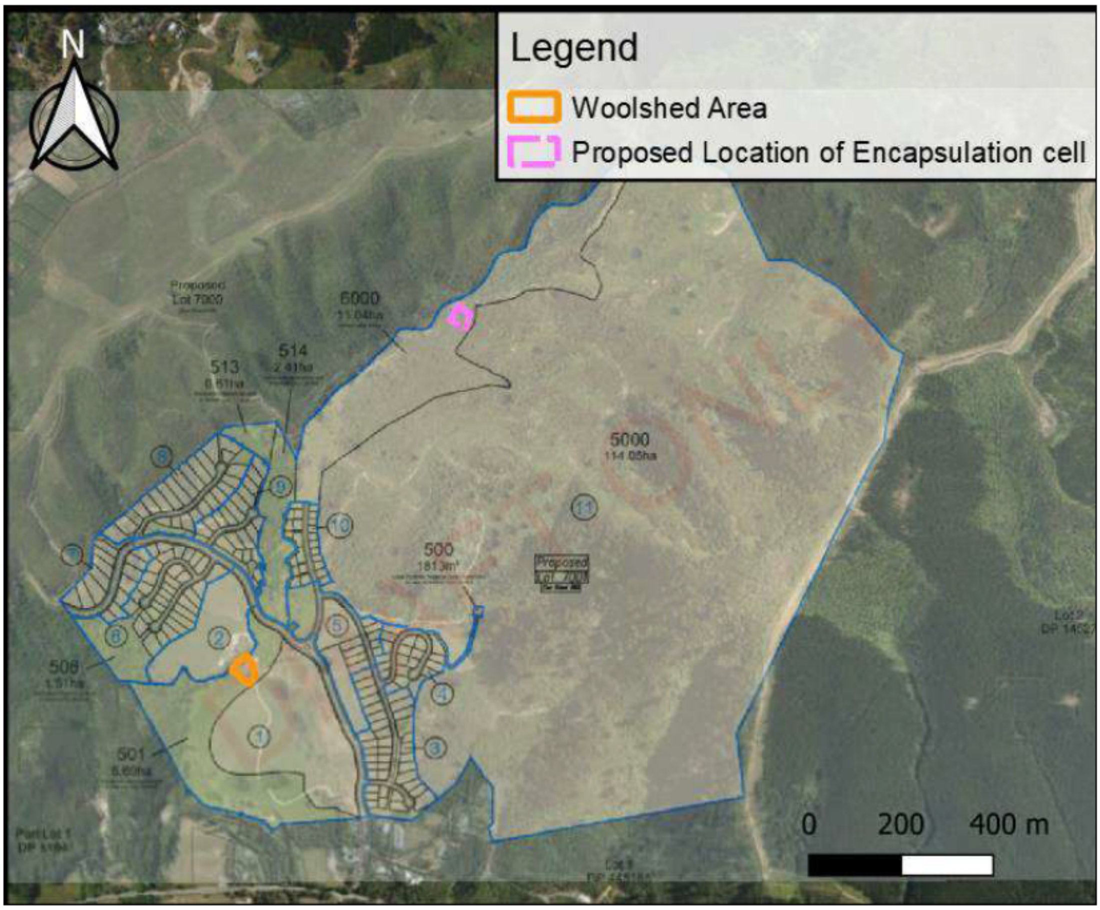

Figure 6 – Indicative / Approximate Location of Encapsulation Cell

Based on a review of the options and discussions with the developer, the preferred remedial methodology is a combination of the following:

1. Source removal, isolation and treatment for soil located in the area immediately around the treatment sump (dieldrin concentrations of 50 mg/kg or more) in accordance with EPA (2023)Error! Bookmark not defined..
2. Off-site disposal to landfill.
3. On-site encapsulation where appropriate.

5.3 Remedial Targets.

For the purpose of soil and water remediation, arsenic and dieldrin are the representative and driving contaminants of concern (COC or key indicators)[13].

Addressing contamination from these COC will address contamination from other pesticides and heavy metals that may also be present in lower concentrations. Tables 5 - 7 below highlight the remedial criteria chosen for areas of the proposed development.

In the location of the proposed riparian corridor (the esplanade reserve including the Kākā Hill tributary realignment and the proposed stormwater wetland being 40 m wide), ecological criteria will drive the remediation as recommended in the Robertson Environmental Ecological Report (see section 3.3.2). The criteria will need to be met to the full depth of the proposed invert of the stream (1.4m bgl). Here remediation will be driven by risk to the environment.

Once beyond the riparian corridor, the remedial criteria will be driven by risk to human health. Remedial criteria will be soil contaminant standards (SCS) listed in Tables B2 and B3 (soil contaminant standards for health for inorganic and organic substances) of the NESCS. High-density residential, and recreational exposure scenarios are relevant to the proposed development in these areas.

Within the esplanade reserve but beyond the riparian corridor the recreational exposure scenario is most relevant. Here the shallowest 0.5 m of soil will be remediated as it is this depth that is most likely to be disturbed during possible future earthworks activities (e.g., infrastructure installation). The recreational SCS are considered conservative in this situation given they were calculated for sports fields where the risk of soil contact and ingestions is much higher than native bush reserve areas.

Table 5 - Soil Remedial Criteria (mg/kg) for various parts of the site.

COC	Ecological Criteria (Esplanade Reserve - Riparian Corridor)[14]	Residential High-Density Standards – NES CS[15]Error! Bookmark not defined.	Recreational Reserves Standards – NES CS
Arsenic	20 - 70	20	80[15]
Dieldrin	0.0028 - 0.007	45	50*

measured as mg/kg
* reduced to 50mg/kg due to Low POP content threshold (EPA, 2023)

[13] Aldrin has an estimated half-life of 0.3 years, sunlight and bacteria convert aldrin to dieldrin fairly quicky. (Source: MfE, 2006, Identifying, Investigating and Managing Risks Associated with Former Sheep-dip Sites).
[14] ANZG 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. (Sediment Default Guideline Values). A range of default guideline values have been recommended for the toxicants (DGV-GV-high).
[15] Resource Management (National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health) Regulations 2011.

There are three proposed routes for unsuitable soil disposal as detailed in Section 5.2.

The encapsulation cell will be designed to provide complete environmental protection (liner, appropriate cap etc.). It is proposed that the soil to be encapsulated meets the Wasteminz Class 3 waste acceptance criteria (WAC)[16] for arsenic as detailed in Table 6. Class 3 WAC are not considered to be necessary for dieldrin due to its physical and chemical properties (it binds to soil and is insoluble in water) and given that the cell will be designed to create an effective long term physical barrier between the fill and the surrounding environment. The proposed encapsulation cell WAC for dieldrin is the Low POP content threshold (EPA, 2023) being < 50 mg/kg.

Any soil with arsenic concentrations above the Class 3 WAC will need to be disposed of to landfill.

Table 6 – Soil Disposal Criteria

Contaminant	Off-site disposal destruction requirement - Low POP Content Threshold (mg/kg)	York Valley Landfill WAC (Soil TCLP) (mg/l)	On-site Encapsulation Cell Class 3 WAC (mg/kg)
Arsenic	-	5*	140[16] (mg/kg)
Dieldrin	> 50	0.004	< 50

* All soil tested to date meets the criteria for arsenic and is therefore suitable for disposal to landfill. Dieldrin is the limiting contaminant.

Flow charts are presented in Appendix E to visualise the contaminated soil disposal routes based on the concentrations that have been detected to date. These may be modified based on the results of further assessment during the remediation process.

Groundwater criteria have not been set at this stage, as a methodology for groundwater remediation has not yet been defined. If it is deemed to be necessary, following further investigation, a remedial methodology and criteria will be provided to the regulator.

[16] Waste Management Institute New Zealand, 2022. Technical Guidelines for Disposal to Land Class 3 WAC for arsenic.

6.0 REMEDIATION ACTION PLAN

6.1 Roles and Responsibility

The resource consent holder will be responsible for distributing this plan to the lead contractor and ensuring compliance with the plan.

The detailed planning, procedures and works sequence undertaken during the remediation process will be developed by the main contractor, who will also be responsible for the appropriate execution of the works plan and procedures. The contractor shall regularly liaise with the SQEP to ensure that work is being carried out in accordance with the RAP, organise the site visits and discuss any contaminated land issues that may arise during the excavation works.

The SQEP shall visit the site to monitor the remedial works, to confirm the requirements of this report are being implemented, and to review disposal documentation where required. The contractor will inform the SQEP when specific 'milestones' in the remediation are being undertaken or constructed. The SQEP shall undertake appropriate soil screening and testing in full compliance with Ministry for the Environment (MfE) guidelines. A site validation report and long-term management plan will be written on completion of the remediation.

6.2 Proposed Activity

The following action plan has been formulated based on the proposed development plan and the investigation works undertaken to date. The procedures and methodologies may change based on additional investigation or any modifications to the proposed development. This RAP will be updated as required and issued to the appropriate jurisdiction for approval.

The various stages of the remediation will need to be considered when scheduling the proposed earthworks.

Work to be undertaken includes:

- Removal of existing structures (stockyards and shearing shed);
- Soil dieldrin source removal and isolation;
- Additional soil and groundwater investigation[17] to delineate the remaining impacted soil and accurately define the volumes of soil requiring remediation and management;
- Excavation / construction of encapsulation cell area to create capacity to place the contaminated material;
- Excavation and disposal of contaminated soil from within the proposed esplanade reserve (recommended to be undertaken in stages);
- Where material is un-suitable for re-use in the wider development (e.g. recreational reserves) contaminated soil will either be:
    - Disposed of to a facility authorised to accept it; or
    - Placed within a suitably located, on-site engineered, encapsulation cell.
- Dewatering and treatment;

[17] Once the soil source around the treatment infrastructure is removed,

- Reinstate the encapsulation area as per final engineering design plans, using soil that meets background concentrations set for the Maitai / Kaka Valley area;
- Site validation and reporting, including a site validation report and an ongoing site management plan.

Please note that if further investigations or validation results show that material is at or below the local background concentrations set for the Maitai / Kaka Valley area, then no further constraints are required for the reuse of that material.

6.3 Remediation Procedure

1. Source Removal

Dieldrin is reported at greatest concentrations around the treatment infrastructure (in an area of the proposed stormwater wetland). Concentrations exceeding 40 – 50 mg/kg[18] have been reported in a number of locations (soil samples KV11,12,14,15,16, TP02) to a maximum depth of 0.5 m bgl (soil sample KV29-2 reported 20+ mg/kg dieldrin at 300 - 375 mm). Dieldrin preferentially binds to the organic content in soil, therefore is most elevated in topsoil.

Following removal of the infrastructure, the heavily impacted soil will be excavated and placed within large bags (Hazbags) that can store up to 1 tonne of material. The bags, once filled, will be locked into shipping containers. Rules and controls for hazardous substances will need to be followed when working with this material. A task specific health and safety plan will be completed prior to these works. The container(s) will be identified as containing hazardous substances and positioned in a location that will be recorded with and approved by the local regulator.

The material will remain in the shipping containers until the results of the facilitated dieldrin degradation trials, discussed in Section 5.2, are available and treatment options are known and costs considered.

Based on investigation data collected to date it is estimated that the volume of soil requiring this treatment will be approximately 30 m^3 - 40 m^3 (60 m^2 area over 0.5 m depth). This area is highlighted red on Figure 7 below.

The proposed remediation procedure is to:

- Pump out any residual liquid in the sump and place it in an IBC for testing to determine disposal or storage requirements;
- Remove sump and associated infrastructure;
- Mark out the proposed remedial extent;
- Strip the topsoil layer (silt) from the remedial area until the underlying material is identified (sand and gravel) at a depth of around 0.5 m;
- Place soil directly into bags for temporary storage in shipping containers;
- An XRF should be used as an additional tool to guide the soil remedial extents and depths in real time (generally elevated concentrations of arsenic indicate higher concentrations of dieldrin);

- Validate the stripped surface and edges of the source footprint to ensure remaining soil meets the applicable low POP content threshold for dieldrin (< 50mg/kg). If further exceedances are reported additional dig out, bagging and isolation will be required.

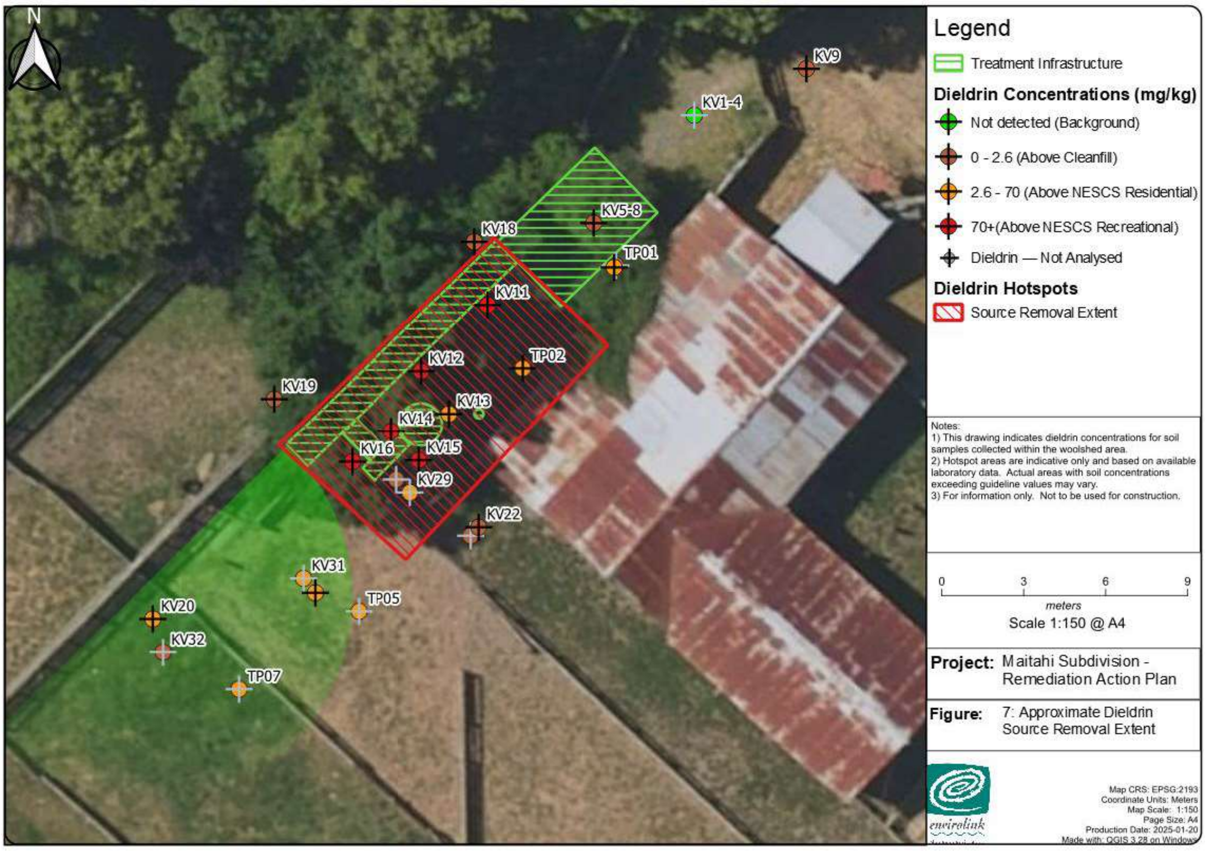

Figure 7 – Approximate Dieldrin Source Removal Extent (red hash)

2. Additional Investigation

Additional investigation is recommended to determine the extent and depth of the dieldrin impact southwest of the source area, and to undertake additional TCLP analysis to confirm landfill disposal options following source removal. The sampling and analysis plan will be confirmed by a SQEP. A draft plan is included in Appendix F. Ultra trace analytical methods should be used for detecting the dieldrin.

Please note that any additional investigation / validation sample requirements for dieldrin will have to be carried out by an accredited laboratory. Time will be required to collect the validation samples and have them analysed. This time delay will need to be factored into the contractors schedule.

It is also recommended that an additional round of groundwater sampling is undertaken using low flow methods to inform groundwater remedial requirements. Ultra trace analytical methods should be used for dieldrin. It is however considered likely that soil source removal and further soil remediation will be sufficient to address the risk to shallow groundwater as a pathway to surface water courses. This will take time, and the benefits of natural attenuation may not be immediately evident.

3. Soil Removal and Disposal

Soil with elevated concentrations of contaminants (above the proposed ecological criteria) will be excavated and removed from the proposed esplanade reserve. Given the proposed watercourse invert level, the maximum remedial depth will be 1.5 m.

Stage A

Following the removal of the source material, the ensuing remedial objective is to excavate the next most impacted soil; soil that exceeds both the ecological criteria and human health recreational criteria (see Table 6). Soil will be disposed off-site at an authorised landfill or encapsulated on site within the containment cell.

Based on the data collected, soil from within the blue and red highlight areas shown on Figure 8 does not meet the recreational criteria (for arsenic and / or dieldrin). The estimated volume of soil is approximately 480 m^3 (red highlight area 60 m^2 x 0.5 - 1.5 m[19] bgl and blue highlight 280 m^2 x 1.5 m is 420 m^3).

It is estimated that approximately 50% of this soil will have arsenic concentrations in excess of the chosen WAC (>140 mg/kg arsenic) for the encapsulation cell and will require off-site disposal.

The proposed remedial procedure is:

- Mark out the estimated extent of the contamination (blue highlight area);
- Strip the topsoil layer (silt) from the remedial area until the underlying material is identified (sand and gravel);
- Excavate the sand and gravel to the agreed depth (~1.5 m);
- Use an XRF to guide remedial extent and identify any soils not suitable for placement in the encapsulation cell (i.e. concentrations of arsenic >140 mg/kg);
- Place soil with concentrations greater than 140 mg/kg directly into trucks or temporarily stockpile for off-site disposal; soil with concentrations less than 140 mg/kg is suitable for placement into the encapsulation cell;
- The stripped surface and edges of the excavation should be sampled and analysed in the laboratory to confirm residual soil contaminant concentrations meets recreational criteria. Where remedial criteria is not met, additional excavation will be required to a maximum depth of 1.5 m (proposed invert level of the stream).

At the time of writing the report, acceptance of soil with elevated dieldrin concentrations has not been confirmed with the local landfill. However, following source removal (i.e. Step 1) the remaining soil may be suitable for disposal to landfill. Toxicity characteristic leachate procedure (TCLP) analysis undertaken on soil sample KV20 and KV21 (beyond the 'source', see Table 7 below) reported dieldrin concentrations with leachate (soil concentrations of 1-10 mg/kg of dieldrin) that complies with the York Valley Landfill acceptance criteria. Additional testing would be required to confirm this. Previous leachate analysis for arsenic has indicated that arsenic concentrations reported will be suitable for disposal at York Valley Landfill.

[19] Surficial 0.5 m already removed as part of source removal

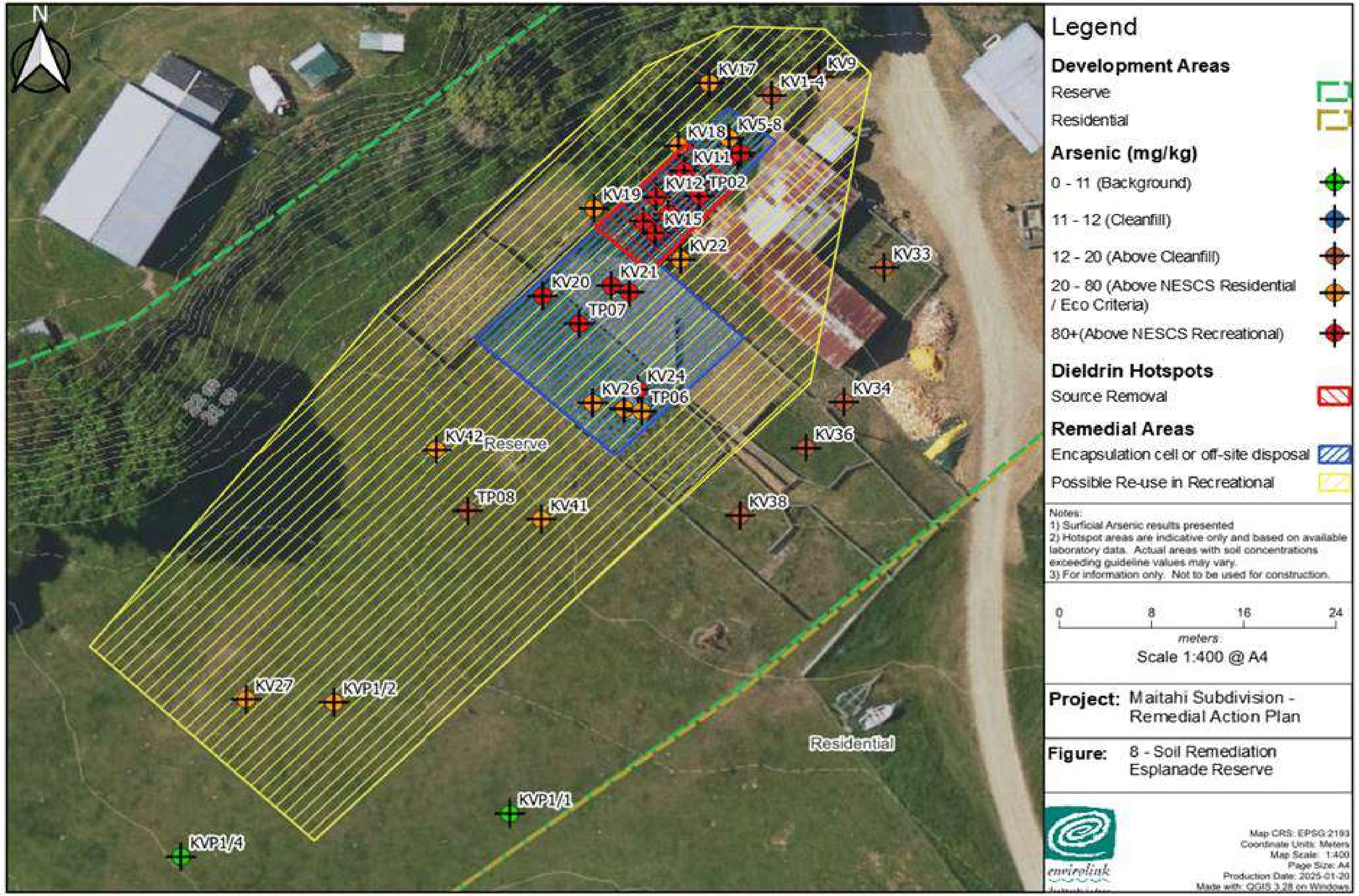

Figure 8 – Soil Remediation Esplanade Reserve

Table 7: TCLP – Summary of Arsenic and Dieldrin Results Based on Previous Investigations

Sample ID	Depth (mm)	Arsenic		Dieldrin	
		Soil (mg/kg)	TCLP (g/m³)	Soil (mg/kg)	TCLP (g/m³)
TP01	200	1,190	0.28	-	-
TP02	200	360	2.8	-	-
KV10	75	108	0.046	-	-
KV11	75	450	0.26	78	0.037
KV12	75	580	0.47	240	0.059
KV14	75	420	0.163	620	0.099
KV20	75			4	0.00156
KV21	75			9.5	0.0023
KV29-2	300-375			22	0.02
YVL Acceptance		100	5	0.1	0.004

<u>Stage B</u>

The next stage is to excavate the remaining impacted soil within the esplanade reserve that exceeds applicable ecological criteria, as shown by the yellow highlighted area on Figure 8.

Based on data collected, the impacted soil is estimated to cover around 2,000 m^2 in area. Investigation has not progressed beyond surficial soil, so the depth of impact is undefined. An average depth of 500 mm across this area is considered conservative. Given this, the estimated volume of soil remediation is ~1,000 m^3. This volume will be refined based on the additional investigation.

The remediation procedure will be as below:

- Mark out the estimated extent of the contamination (yellow highlight).
- Use an XRF to guide remedial extent and identify any soils that exceed the applicable ecological criteria (applicable to arsenic only) within the proposed wider esplanade area.
- Strip the topsoil layer (silt) from the delineated area until the underlying material is identified (sand and gravel).
- Excavate the sand and gravel to the agreed depth (~0.5 m).
- Where geotechnically suitable excavated soil can be re-used in proposed recreational reserves. If there is insufficient capacity within the recreational reserves then the soil could be placed in the upstream excess soil location in the north of the property.
- Any soil movement or relocation will be documented by a SQEP and contractor for inclusion in the SVR.
- The stripped surface and edges of the excavation should be sampled and analysed to confirm residual soil contaminants meets the ecological criteria. Where remedial

criteria are not met, additional excavation will be required to a maximum depth of 1.5 m (proposed invert level of the stream).

4. Dewatering and Water Treatment[20]

Where there is natural groundwater ingress into excavations that will hinder the earthworks, the water should be pumped out for treatment. A combination of coagulation/flocculation and filtration through a reactive media (activated carbon) is likely to be the most effective treatment method. However, discussions will be had with engineers/specialists to confirm the most appropriate method. Standard, on-site dewatering systems can be established at the appropriate time.

6.4 Encapsulation Cell

The proposed location for the encapsulation cell is approximately 1 km northwest of the woolshed site as shown on Figure 6. Given the volumes discussed for Stage 2A in Section 6.3, it is estimated approximately 300 - 500 m^3 of soil may require encapsulation. This volume may change based on the findings of the additional investigation.

The following items should be considered by an engineer when undertaking cell design and determining final placement.

- The cell will be created by excavating to a maximum depth of 500 mm above the highest known groundwater level, and at least 25 m from all watercourses, overland streams and any other environmental receptor;
- Given the naturally granular ground conditions it is recommended that an engineered soil liner is used. This is likely to be a minimum 300 mm of clean clay placed at the base and sides of the cell. Dieldrin will adsorb to the clay reducing its bioavailability;
- After the contaminated soil is placed in the cell, it will be track rolled for compaction. A filter or bidim cloth will then be placed over the contaminated material;
- A heavy-duty plastic liner (HDPE) will then be placed on top of the contaminated material. A minimum 1,000 micron HDPE or similar product will be used;
- There will be at least 300 mm overlap of plastic where joins are required laterally along the containment cell;
- Once the plastic liner has been placed in position, a minimum of 300 mm of compacted clay will be placed on top, followed by a minimum of 200 mm of topsoil. This material can be sourced from elsewhere on site if it is tested and complies with appropriate standards or has been sourced from a reputable supplier;
- 200 mm above the plastic liner a layer of orange plastic mesh (safety mesh) will be placed on the surface. The mesh will act as a warning to future managers of the bund that are inadvertently or deliberately excavating through the capping layer. It will identify that they should cease any further excavation;
- If the area is to be planted consideration must be given to the depths of roots required for proposed vegetation. Ideally shallow root plants e.g. tussocks will be planted.

[20] Please note that the any proposed water treatment is for the remediation and construction of the esplanade reserve only; it is not required for all earthworks associated with the wider development

Please note that the construction of the encapsulation cell described above is conceptual only. It is subject to review by a chartered engineer and may require significant alteration or amendment based on ground conditions, topography, hydrogeology and drainage constraints.

7.0 VALIDATION TESTING

7.1 Excavated Surface Validation

Following the excavation or stripping of any contaminated material and prior to reinstating the remediated area, validation samples will be required to show that soil contaminant concentrations meet the remedial criteria. Validation samples should be collected by SQEP and analysed for the key indicator contaminants being arsenic and dieldrin.

The results will also be compared to the background concentrations and cleanfill criteria for the Nelson Tasman region.

The validation samples should be collected by a SQEP and analysed at an accredited laboratory. An XRF can be used during remedial observation to help guide the remedial extent and enable screening of the soil for arsenic concentrations in real time.

7.2 Imported Material

The development/remediation may require importing soil or other material (such as engineering aggregate) that is suitable for use. Where fill is imported to the site from known sources that have been certified 'clean' (i.e., is either virgin quarried clean product or certified as meeting suitable criteria from a recognised supplier or recycling facility), analytical testing will not be required. Fill imported from other sources may require an assessment of the land use history by a SQEP and potentially, analytical testing. The source and location of any imported material should be recorded by the lead contractor and available on request.

The developer and / or the contractor may be required to provide a signed declaration confirming that the material used to reinstate the reserve area has come from a location described above. If a declaration is requested but not forthcoming at the completion of the works, then validation samples may be required from the impacted area.

7.3 Reporting

A site validation report (SVR) will be prepared and submitted to Nelson City Council on completion of the subdivision stage. The report will provide a record of the volumes of material that have been removed and disposed / relocated based on the remediation strategy proposed in the RAP. The SVR will identify any areas where residual contamination remains and any necessary ongoing management requirements.

An ongoing site management plan will be prepared for any contaminated material retained on site, including that within the encapsulation cell. The site management plan will identify the location of the encapsulation cell, the concentrations of the contaminants, the depth to the contaminants from the finished level and appropriate instructions / restriction if, in the future, the material is to be disturbed.

8.0 SITE MANAGEMENT

The appointed engineer / contractor shall prepare an Earthworks Management Plan that includes but is not limited to the following. This information is restricted to the remedial area (e.g. woolshed, sheep spray and runout), unless otherwise stated.

8.1 Off-site Removal

Material that does not meet the encapsulation cell WAC may require off-site disposal to a facility authorised to accept such material.

All appropriate disposal protocols, procedures and fees will be applicable to any material that is removed off site. All documentation relating to the removal of material from the site will be collated by the appointed contractor and provided to the Council and / or supervising engineers on request. Such information will include the volumes that have been removed, weigh bridge receipts and the corresponding acceptance documentation by the facility authorised to accept it. Prior to leaving the site the truck must be adequately covered to prevent loose material, including dust, from exiting the truck during transport.

If off-site disposal does occur, this information will be included in the final validation report.

Appropriate forms and documentation will need to be provided to the facility accepting the waste prior to delivery. This may include laboratory reports showing the analytical results of the soil samples and / or any leachate analysis.

8.2 On-site Soil Management

Contaminated soil should be loaded directly onto trucks for disposal / relocation. If contaminated soil from around the sheep dip / spray area is to be stockpiled for longer than 48 hours, then it shall be:

- Track-rolled and compacted to reduce erosion;
- Be no higher than 2.5 m;
- The stockpiled sides angled so that they can be track-rolled;
- The outside of the stockpile will be bunded or protected by silt fences;
- Dust suppression procedures shall be implemented if weather conditions are such that airborne dust becomes visible from the stockpile.

8.3 Unidentifiable Material

While unlikely, upon discovery of any unusual looking or odorous waste that has not already been identified, work shall stop immediately. If by discovery there is perceived to be an immediate risk to the workers in the vicinity, then the area shall be evacuated immediately. If contact with the waste has occurred, by either dermal contact or inhalation, then medical attention should be sought.

Whether or not the discovered material poses an immediate risk to human health, the area must be cordoned off with high visibility tape. The contractor's environmental consultant and the Council's contaminated sites / hazardous substances representative are to be contacted.

Any intact drums or tanks that are uncovered shall be dealt with in a similar manner as described above. There should be no attempt made to remove the containers. The container(s) will not be removed until it is certain that it is empty, or the contents have been identified and deemed safe for removal by a suitably qualified person.

8.4 Erosion Control

Included in the earthworks management plan will be measures to control erosion and sediment movement. The plan will include standard erosion and sediment control measures that are implemented for a construction project of this nature. An erosion and sediment control plan for the entire development is being prepared by others. A number of these measures will be sufficient to manage the contaminated sediment and minimise the risk to on-site workers, adjacent residents and the environment. However, for the purpose of this remediation action plan the following erosion and sediment control measures should be included in the final ESCP:

- Prevent clean water from entering the contaminated site while it is under excavation by establishing perimeter controls and diversion drains;
- Stockpiles to be track-rolled and bunded or protected with silt fences;
- The use of mist sprinklers or similar to reduce wind erosion of stockpiles and exposed surfaces (ensure material does not become saturated and cause inundation or entrainment);
- Sediment control measures need to be installed to prevent entrained sediment entering any nearby stormwater pipes;
- Ensure contaminated sediment is not transported off site by trucks and other utility vehicles;
- Ensure all trucks are covered if contaminated material is transported off site;
- Ensuring work schedules stabilise or contain exposed surfaces as soon as is practicable;
- Ensuring erosion and sediment control measures are sufficient and in place during non-work periods i.e., evenings, weekends and public holidays.

8.5 Health and Safety

All contractors and/or outside organisations working on the site will be expected to provide on request, a health and safety plan prepared specifically for the type of work and associated machinery they will be involved with.

The main contractor bears the responsibility of providing the most appropriate induction to any worker/visitor. All workers involved in the remediation works or working around the remediation area shall be inducted in regard to the risks to human health related to the contaminants present on site. An induction roster will be maintained by the main contractor. All site workers must be familiar with the typical contamination indicators that may be encountered and the requirements under the accidental discovery protocol.

Although the risk to construction workers is low due to the short term exposure time, it is still considered prudent to prevent site workers from being unnecessarily exposed to potential hazardous substances at the site. A few simple protocols can be implemented. Such protocols should be included in the contractor's health and safety plan:

- No food to be consumed within 10 m of areas under excavation;
- There shall be no smoking within 10 m of areas under excavation;
- All visitors must report to the site manager and are to be made aware of the on-site hazards associated with this site;
- Personal protective equipment (PPE) will include hard hat, safety boots, long sleeve cotton overalls, high visibility vest, and gloves. These items shall always be worn by staff working on the excavations until the affected areas are excavated and the site shown to be 'clean' by analytical soil sample results or suitably capped with clean material. These items are not required within an enclosed operating area (excavator or truck cab);
- Good quality disposable dust masks should be available to all staff during earthworks operations[21]. All staff will be required to wear dust masks if wind conditions are causing dust to become visually air borne. Dampening down the material or covering it may be used to prevent dust becoming excessively airborne;
- Site workers should ensure that they wash their hands thoroughly after working with the material and prior to eating, smoking or touching their face;
- Signs will be erected at all entrances to the site clearly stating that it is a hazardous site and public access is prohibited. The sign will include the appropriate contact numbers for site management;
- If any unusual looking or odorous waste, including intact drums or tanks, are discovered during the excavations then work should stop immediately. If by discovery there is perceived to be an immediate risk to workers, then the area shall be evacuated immediately. The area should then be cordoned off and the appropriate authorities informed.
- In all emergency situations the first concern must be to save life and prevent injury
- Onsite emergencies shall be handled as follows:
    - Make area safe
    - Advise emergency services
    - Supervise area until emergency services arrive
    - Advise regulatory authorities

Note: Wearing PPE can put workers at risk of developing heat stress. If heat stress is likely to be a problem, regular monitoring of staff will be necessary. Training workers to recognise the effects of heat stress should be part of the ongoing evaluation review process.

8.6 Groundwater

Monitoring of the groundwater will be undertaken on a limited basis after the source material has been removed as part of the further investigation recommendations. The findings will define the groundwater remediation methodology and approach. Once soil source removal and further soil remediation has occurred, it is considered likely that residual arsenic / OCPs will naturally attenuate over time.

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[21] Further detailed information is available on this subject in the NZS/AS 1715:2009; Selection, use and maintenance of respiratory protection devices or A Guide to Respiratory Protection (1999)

8.7 Wider Site Management

Topsoil from the southern paddock and former homestead (the proposed high-density residential areas – refer Figure 2) exceeds NCC recgonised background values. Marginally elevated concentrations of copper, nickel and chromium are associated with ultramafic rock formations (i.e. naturally elevated) and not considered to pose a risk to receptors.

Topsoil with elevated concentrations of zinc and lead was identified around the homestead and will require management if disturbed . If this topsoil is excess to site requirements it will need to be disposed of to an authorised facility or in the ‘upstream excess soil area’ in the north of the property.

Standard earthworks management procedures will be in place during works in these areas.

The contractor will inform the SQEP when earthworks are proposed. The SQEP will provide advice on soil disposal as required. The SQEP and contractor shall keep a record of soil excavation volumes, soil movement and disposal in the location of the former homestead. This information will be reported in the site validation report (SVR).

Excess soil should not be placed near any watercourses (i.e. not within 25 m). Excess soil should be stabilised as soon as possible.

9.0 CONCLUSIONS AND RECOMMENDATIONS

Three former HAIL areas were identified on the property. The former woolshed, sheep spray area, and run out zone have reported significantly elevated concentrations of arsenic and OCPs. This area is proposed to be used as an esplanade reserve, including stormwater wetland and stream. The two other HAIL areas, the southern paddock and the former homestead, are suitable for the proposed high density residential use.

Remediation of the former woolshed and sheep spray area will be completed in stages, as detailed below. The key indicator contaminants are arsenic and dieldrin, as such these contaminants of concern will drive the remedial methodology. All stages of the proposed works will be monitored by a SQEP.

- Soil dieldrin source removal and isolation;
- Additional soil and groundwater investigation to:
    - Delineate impact to more accurately define the volumes of soil requiring remediation and management;
    - Determine a methodology for groundwater remediation if deemed necessary.
- Excavation and disposal of contaminated soil from within the proposed esplanade reserve;
- Dewatering and treatment where encountered;
- Where unsuitable for re-use in the wider development (e.g. recreational reserves), contaminated soil will either be:
    - Disposed of at a facility authorised to accept it, or;
    - Placed within a suitably located, on-site, engineered, encapsulation cell;
- Site validation and reporting, including a site validation report and long-term management plan.

Soil from the southern paddock and former homestead is suitable for the proposed use and therefore remediation is not required. Slightly elevated (above background) concentrations of nickel, copper and chromium are a result of the local geology and are not considered to pose a risk to receptors. Slightly elevated (above NCC cleanfill) concentrations of zinc and lead in shallow soil around the homestead were reported. This soil will need to be managed in accordance with Section 8.6.

The RAP will be updated following further investigation, development layout changes, modifications to site conditions etc. Given the nature of this project the remediation and management will need to adapt to the design as it progresses. Amendments to the RAP will be in consultation with the local authority prior to implementation.

The following are recommendations of this RAP and could be included as conditions of consent.

- Works will be undertaken in accordance with this remediation action plan. Where an update to the RAP is required, the updated report will be issued to Council prior to completion of the next stage of remedial works;
- At the completion of the works a site validation report (SVR) will be provided to Council, which will include:
    - Confirmation the works were completed in accordance with the RAP.

- Location and dimensions of excavations completed.
    - Testing of soils undertaken during the activity.
    - Volume and location of disposed excess soil.
    - Records of any unexpected discoveries of contamination.
    - Confirmation of soil disposal location via waste tickets / receipts.
    - Final design, volume and location of the encapsulation cell.
- Where contaminated soils are to be retained on the property, an ongoing site management plan (OMP) will be produced. The OMP will include:
    - The type, quantity and location of residual soil contamination on the site.
    - Any ongoing monitoring requirements following the development.
    - Detail management measures should the site be subject to further developments.
- All excavation works will be monitored by a SQEP and testing undertaken to determine soil contaminant concentrations to determine appropriate disposal locations and provide information to the SVR and OMP.

CCKV Maitai Dev Co LP also requests a condition of consent that allows for modifications / amendments to this RAP to be made or recommended that may be outside the current scope. Changes to remediation methodologies and construction requirements can change over the course of a development and therefore the applicant requests flexibility within the resource consent to align with such changes.

10.0 LIMITATIONS

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.

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.

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. It is also for this reason that further investigation has been recommended during the undertaking of the remediation to ensure that the soil contaminants are better delineated as the remediation is progressing.

Appendix A
Proposed Subdivision Plan

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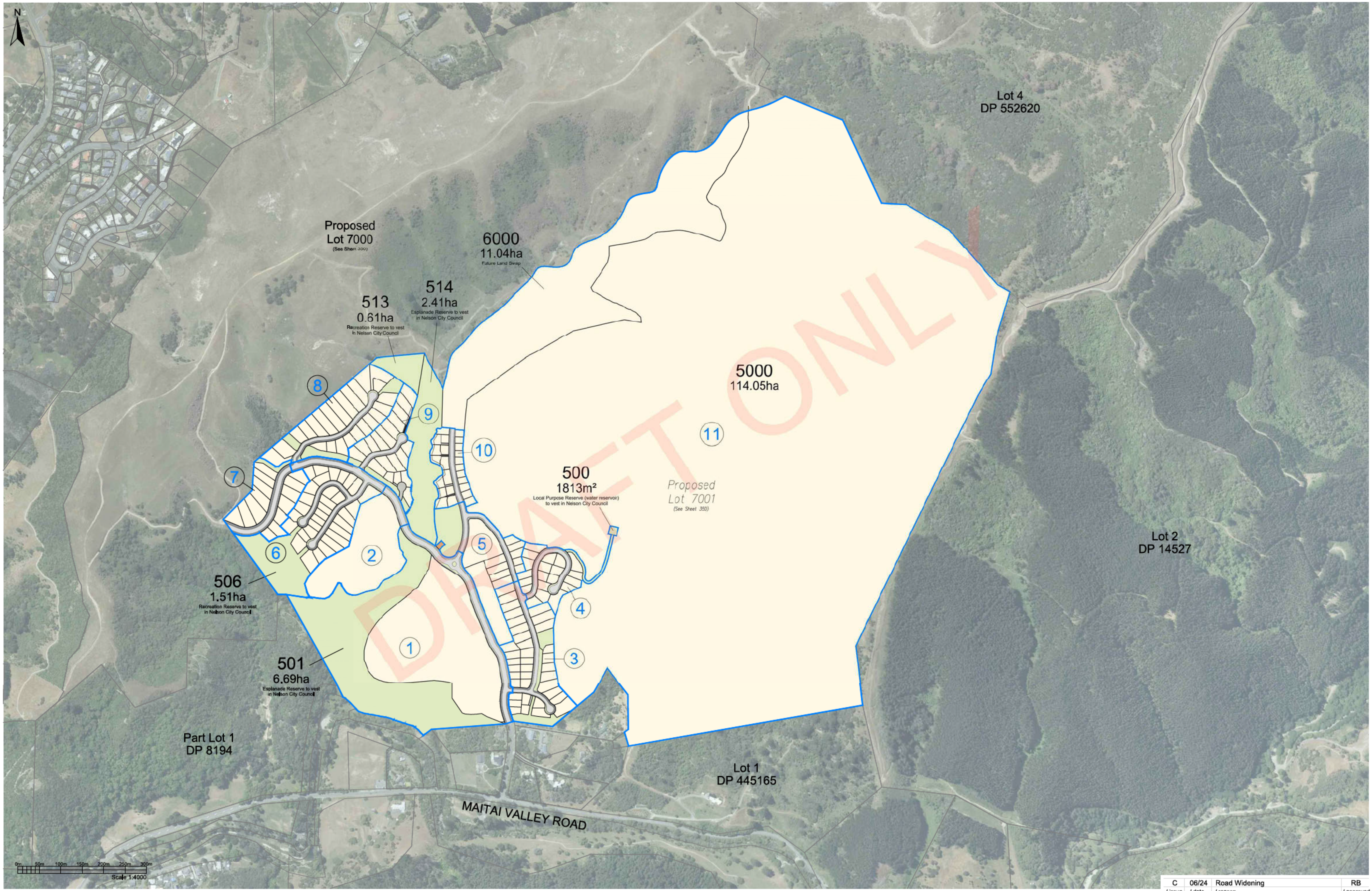
contractor to locate all existing services & verify all dimensions before commencing work



C	06/24	Road Widening	RB
/ issue	/ date	/ reason	/ approved

CAD ref: 37470 - Scheme Plan (Issue C).dwg

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ENGINEERS / SURVEYORS / PLANNERS

Davis Ogilvie & Partners Limited
Level 1, 24 Moorhouse Avenue, Addington, Christchurch 8140
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Maitahi Village Deleopment

Overall Plan, Stages 1-11

Maitahi Village, Nelson

/ design	/ drawn	/ QA check	/ dwg
RB/BL	BL	BVB	351
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Appendix B
Robertson Environmental Ecological Report

Memo

robertson environmental

ECOLOGICAL ASSESSMENT & REPORTING SERVICES

To:	Mark Lile; Landmark Lile Ltd	Project:	Maitahi Village Development
From:	Ben Robertson; Robertson Enviro Ltd	Date:	23 January 2025
cc:	Neil Donaldson; CCKV (Maitahi Project Manager)		
Subject:	Maitahi Village - Ecological Recommendations for Contamination Management		

Ecological Recommendations for Contamination Management — Lower Kākā Hill Tributary Realignment, Maitahi Village (Stage 1) Development

1 Purpose and Scope

As part of the Maitahi Village development, Robertson Environmental Limited (REL) has been engaged by CCKV Maitai Dev Co LP (Maitahi) to undertake a detailed review of information related to the proposed remediation of a HAIL (Hazardous Activities and Industries List) site present on-site. This review is intended to inform the preparation of a Remedial Action Plan (RAP), which will be developed by a Suitably Qualified and Experienced Practitioner (SQEP) as a proposed consent condition.

Our focus is on the works related to the realignment of the lower Kākā Hill Tributary and the adjacent esplanade reserve area (referred to herein as 'the proposed ecological corridor'), with the aim of providing guidance and recommendations to manage associated ecological impacts. The key objectives of this memorandum are to:

- Identify suitable ecological guidelines for the proposed ecological corridor.
- Review existing sampling data to evaluate contamination levels within the proposed ecological corridor in relation to these ecological guidelines.
- Determine any information gaps, including further sampling requirements to delineate the contamination boundary for the proposed ecological corridor.

- **Ben Robertson** (Principal Consultant, Director) BSc (Hons), PhD, CEnvP
- **Barry Robertson** (Technical Advisor, Director) BSc, Dip Sci, PhD
- **Jodie Robertson** (Senior Consultant) BSc, PG Dip, MSc
- **Julian Goulding** (Technical Officer) BComm, Master 3000 Gross Tonnes

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Below we outline the project background, key findings, and recommended inputs to aid in developing a comprehensive RAP.

2 Documents Reviewed

The following documents have been provided by the Client and reviewed:

- Detailed Site Investigation (DSI) Maitahi Subdivision. Envirolink Report for CCKV Maitai Dev. Co LP. Dec 2021.
- Addendum Contamination Assessment - Maitai Subdivision Version 4. Envirolink letter to CCKV Maitai Dev. Co LP. 23 June 2023.
- Excel Spreadsheet of 11 August 2023 groundwater sampling results from Envirolink.
- Synthetic Precipitation Leachate Procedure (SPLP) results for soil samples, from Envirolink 19 Sept 2023.
- Contaminated Land Volume Estimate, Maitahi Subdivision. Envirolink report June 2023.
- Draft Concept Landscape Masterplan. Rough Milne Mitchell Landscape Architects (RMM), April 2024.

3 Project Overview

The indicative footprint and drawings (Appendix X of the main AEE Report prepared by Landmark Lile) have been prepared for assessment purposes and are indicative only. The final design of the Project will be confirmed at detailed design stage.

A draft concept landscape masterplan, prepared by RMM, is provided in **Attachment A**. The proposed layout for the lower Kākā Hill Tributary realignment and esplanade reserve, along with the indicative HAIL site area, is shown in Figure 1. This design includes a meandering 3-metre-wide stream with banks and treatment wetlands, positioned within the broader esplanade reserve area on either side.

4 Background

4.1 Site

The DSI and associated information (collectively referred to herein as 'the DSI Report') provides background information on the site. It indicates that the site has been used as a farm for many years, stocking sheep and cattle and possibly growing hops in the 1800s. 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 likely layout is shown in Figure 1 (see inset). Given the above, and the long history of the farm operation, it is likely that sheep have been treated with arsenic and organochlorine (OCP)-based solutions. Additionally, zinc and copper are commonly used to control foot rot and are included as contaminants of concern.

The site appears on Nelson City Council's (NCC) HAIL[1] register as a result of the histori-

[1] Ministry for the Environment (MfE), 2011. Hazardous Activities and Industries List.

cal undertaking of livestock treatment. The National Environmental Standard (NESCS) for Assessing and Managing Contaminants in Soil to Protect Human Health[2] requires a detailed 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 regulatory authority (NCC) 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 indicates whether the site is fit for the proposed purpose or if additional information is required. The DSI Report assesses potentially contaminative historical usage of the property in the context of the NESCS and is intended to support a resource consent application. The DSI Report identifies the site as a confirmed HAIL site, with sheep dip/spray activities, in Category A8 and with associated contaminants being arsenic, copper, zinc and organochlorine pesticides.

The DSI Report details the methods and results from extensive soil and groundwater sampling in the old sheep dip area and nearby locations. It also provides soil and water guideline values for assessing their risk, as well as for remediation purposes.

Using the findings from the DSI Report, in the following sections outline key contaminants of interest, relevant ecological guidlines, and highlights relevant data from prior sampling results.

4.2 Key Contaminants[3]

A general summary of the characteristics of the contaminants identified in the DSI Report is presented below.

Organochlorine pesticides (OCPs)

The ecological risks and fate of organochlorine pesticides like dieldrin, DDT, aldrin, and endrin, historically used in former sheep dips, are significant due to their persistence, bioaccumulation, and toxicity.

- **Persistence in soil and sediment -** These pesticides are highly resistant to natural degradation, allowing them to remain in soil and sediment for decades. This persistence leads to long-term contamination in and around former sheep dip sites.
- **Bioaccumulation and biomagnification -** Organochlorines readily accumulate in the fatty tissues of organisms. They biomagnify up the food chain, meaning predators and higher trophic level species experience increasingly concentrated levels of these toxins, which can impact entire ecosystems.

2 Resource Management (National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health) Regulations 2011.

3 McBride, M. B. (1994). Environmental Chemistry of Soils. Oxford University Press; Humphries, M. S., & Douglas, G. B. (2001). Environmental impact of sheep-dip pesticides on aquatic ecosystems in New Zealand. New Zealand Journal of Marine and Freshwater Research, 35(1), 29-41; Gaw, S. K., Close, M. E., & Flintoft, M. J. (2008). Contamination of New Zealand's soil environment by persistent organic pollutants. New Zealand Journal of Agricultural Research, 51(4), 331-342; ANZECC & ARMCANZ. (2000). Australian and New Zealand Guidelines for Fresh and Marine Water Quality; Davies, P. E., & Cook, L. S. J. (2006). Sheep dip chemicals and their environmental fate: A review. Journal of Environmental Quality, 35(1), 23-30.

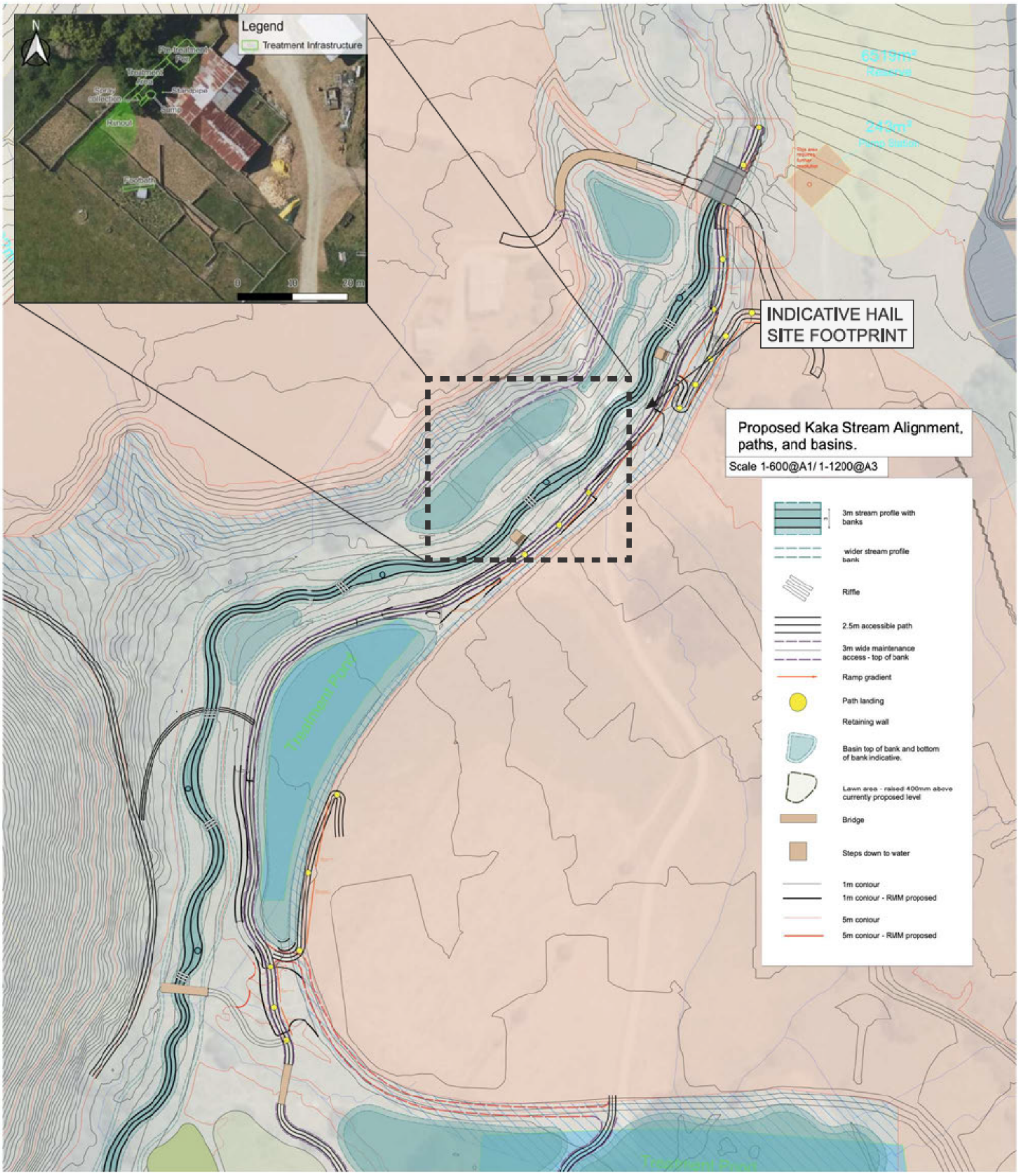


Figure 1. Indicative footprint of the contaminated (HAIL) site in relation to the proposed esplanade reserve and alignment of the lower Kākā Hill Tributary. The inset shows the Sheep Treatment Infrastructure, as shown in Figure 3 of the Envirolink DSI Report. Concept landscape drawings provided by RMM.

- **Ecotoxicity -** These chemicals are highly toxic to aquatic life, impacting fish, invertebrates, and amphibians by impairing reproduction, growth, and survival. For birds and mammals, bioaccumulation poses severe risks, especially for top predators, leading to eggshell thinning in birds, neurological effects, and even mortality.

- **Toxic breakdown products -** While some organochlorines degrade slowly, they can form equally harmful breakdown products (e.g., DDE from DDT), which maintain the toxicity and persistence of the original compound.

- **Leaching and runoff -** Over time, these pesticides can leach into groundwater or be transported via runoff to nearby waterbodies, spreading contamination and increasing exposure risk for wildlife and humans.

Due to their ecological risks and environmental persistence, these pesticides have been banned or heavily restricted. However, their legacy continues to affect soil, water, and wildlife around contaminated sites like former sheep dips, necessitating ongoing monitoring and remediation efforts.

Arsenic

Arsenic, historically used in old sheep dips, poses considerable ecological risks due to its toxicity, persistence, and potential for leaching into groundwater.

- **Persistence and toxicity in soil -** Arsenic is a persistent contaminant that does not break down over time, remaining in soils around old sheep dips for decades. Its high toxicity can harm plants, soil organisms, and animals, reducing biodiversity and disrupting ecological functions in contaminated areas.

- **Leaching to groundwater -** Arsenic can leach from soil into groundwater, especially in acidic or sandy soils. This leaching risks contaminating local water supplies and impacting aquatic ecosystems, where arsenic toxicity can affect fish, invertebrates, and other organisms.

- **Bioaccumulation and food chain impact -** Arsenic can accumulate in plants and animals, leading to chronic exposure for species higher up the food chain, including predators. While it does not biomagnify as strongly as organochlorines, it can still pose health risks to animals and humans consuming contaminated water or food.

- **Toxic effects -** In aquatic environments, arsenic is highly toxic to fish and other aquatic organisms, affecting reproduction, growth, and survival. On land, it can inhibit plant growth, reduce microbial activity, and harm insects, birds, and mammals exposed to contaminated soils.

- **Long-term ecological impact -** Given its persistence and toxicity, arsenic contamination around old sheep dips require careful management and, where possible, remediation to prevent ongoing ecological harm. It is particularly concerning for ecosystems with sensitive or endangered species that may be more vulnerable to its toxic effects.

Arsenic's ecological risks and long-lasting presence make it a priority for monitoring and risk assessment at former sheep dip sites, where contamination may still impact local soils, water, and wildlife.

Heavy Metals

Heavy metals historically used in sheep dips in New Zealand, such as copper, zinc, and sometimes lead, pose significant ecological risks due to their persistence, toxicity, and potential for bioaccumulation.

- **Persistence in soil and sediment -** Heavy metals do not degrade over time, allowing them to remain in soils and sediments indefinitely. This persistence can lead to long-term contamination around old sheep dip sites.

- **Bioaccumulation and toxicity to organisms -** Metals like copper and lead can accumulate in plants and animals, leading to toxic effects on organisms across the food chain. Chronic exposure can impair reproduction, growth, and survival, especially in sensitive species such as invertebrates and amphibians.

- **Mobility and leaching risks -** While many metals bind tightly to soil particles, under certain soil conditions (e.g., acidic or waterlogged soils), they can leach into groundwater, posing risks to nearby aquatic systems. Runoff during heavy rainfall can also transport metals to streams and rivers.

- **Impact on soil health and biodiversity -** Heavy metals can disrupt soil microbial communities, reduce soil fertility, and impair plant health. They can also cause toxicity in soil-dwelling organisms like earthworms, affecting overall soil biodiversity and ecosystem function.

- **Long-term environmental and health implications -** Due to their toxicity and inability to degrade, heavy metals around old sheep dip sites require monitoring and may necessitate remediation to prevent ongoing ecological harm. Risks persist for wildlife, livestock, and potentially humans exposed to contaminated soil or water.

Also of relevance in this study is the fact that elevated levels of some heavy metals, in particular nickel, chromium, and copper, are frequently observed in Nelson's soils due to both natural and anthropogenic sources. The region's unique geology contributes to these elevated metal concentrations, as certain soil types, like ultramafic soils, naturally contain higher levels of these metals. Cavanagh (2015)[4] indicates background levels for these heavy metals in the Nelson/Tasman area[5], but noting that no data was available for soils in the Maitai Valley.

Other Contaminants in Sheep Dip/Spray Activities

Other contaminants are possibly present as a result of historical sheep dip/spray activities, but these are considered as of lesser ecological risk than OCPs. These other contaminants include the following.

- **Organophosphate pesticides -** These started to become commonly used in sheep dips

[4] 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.

[5] For min-max (median) in mg/kg: Chromium 4-95 (41) except in some high zones where it was 88-187 (110.5); Nickel 2-56 (23) except in some high zones where it was 88-280 (123); Copper 3-42 (24).

in New Zealand during the 1960s and 1970s. This shift occurred as organochlorine pesticides were gradually phased out due to concerns about their persistence in the environment and toxicity to wildlife. Organophosphates, such as diazinon and chlorpyrifos, were introduced as alternatives because they break down more quickly in the environment. However, they still posed toxicity risks to both animals and humans, leading to tighter regulations and, eventually, the decline in their use over subsequent decades.

- **Synthetic Pyrethroids -** Synthetic pyrethroids, used in some old sheep dips as alternatives to organochlorines and organophosphates, present ecological risks due to their moderate persistence in soils and high toxicity to aquatic life. These chemicals can persist for weeks to months, binding strongly to soil and sediment particles, which restricts their mobility but leads to localised accumulation. Pyrethroids are particularly hazardous to fish and aquatic invertebrates at low concentrations, and runoff or leaching from contaminated soils can disrupt aquatic ecosystems. While they have low bioaccumulation potential, they can still cause sublethal effects on behaviour, reproduction, and survival in aquatic and soil-dwelling organisms. Heavy rainfall can transport pyrethroid-bound soil particles into nearby water bodies, heightening exposure risks, and they may also harm beneficial soil organisms, affecting soil health and ecological functions.

- **Carbamates -** Carbamates used in old sheep dips present ecological risks primarily due to their toxicity to non-target organisms, though they are less persistent than other pesticides like organochlorines and organophosphates. In soil, carbamates typically break down within days to weeks, reducing long-term contamination risks. However, they can still leach into groundwater or run off into nearby water bodies, posing immediate toxicity risks to aquatic organisms, especially fish and invertebrates. Carbamates also impact beneficial soil organisms, such as insects and microbes, which can disrupt soil health and ecosystem functions. While they do not significantly bioaccumulate, their acute toxicity and potential for leaching make carbamates a concern for local ecosystems around sheep dip sites where they are used.

5 Relevant Standards and Guidelines

The DSI Report assesses soil and groundwater contamination against specific ecological and environmental standards.

5.1 Soil Triggers

The DSI Report applies ecological-soil guideline values (Eco-SGV) to assess soil contaminant concentrations due to the potential contact between contaminated soil and surface water. These values are based on guidelines by Cavanaugh (2016, 2019)[6] for residential/recreational usage on typical soils with aged contamination. For contaminants like nickel, dieldrin, and lindane—where Eco-SGVs are unavailable—the ANZECC (2013) sediment quality guidelines (SQG) are used.

Eco-SGVs are designed to protect terrestrial ecosystems, including soil microbes, inverte-

[6] Cavanaugh, J, 2016. User Guide: Background soil concentrations and soil guideline values for the protection of ecological receptors (Eco-SGVs) Consultation Draft; Cavanaugh, J, 2019. Updating the Ecological Soil Guideline Values (Eco-SGVs).

brates, plants, wildlife, and livestock. However, these values are not directly applicable to aquatic sediments or stream bank margins, where sediments can easily enter the freshwater receiving environment. For aquatic environments (both stream water and sediments), the most applicable standards are from the Nelson Resource Management Plan (NRMP) - Appendix 28 (2006), which rely on toxicant standards from the ANZECC (2000) guidelines. The most recent update to these standards is found in the ANZG (2018) sediment guidelines (see Table 1 below).

Table 1 Recommended aquatic ecological guidelines (sediment) for contaminants sampled at the site[a].

Guideline	Arsenic	Cd	Cr	Cu	Pb	Ni	Zn	Tot DDT	Dieldrin	Aldrin	Endrin
ANZG 2018 DGV (sediment) (mg/kg)	20	1.5	80	65	50	21	200	0.0012	0.0028	N/A	0.0027
ANZG 2018 GV High (sediment) (mg/kg)	70	10	370	270	220	52	410	0.005	0.007	N/A	0.06
ANZECC 2000 ISQG Low (mg/kg)										0.001	

[a] It is important to note that applying these guidelines in a remedial context should take into account the elevated levels of certain heavy metals—particularly nickel, chromium, and copper—which are commonly found in Nelson's soils as a result of both natural processes and anthropogenic activities.

The DGV-GV High range is intended to provide a framework for assessing contaminant levels and their potential ecological impacts. Sediment concentrations below the Default Guideline Value (DGV) generally indicate negligible risk and are unlikely to require remediation, whereas concentrations exceeding the Guideline Value High (GV High) are associated with significant ecological risks and necessitate immediate management or remediation. The intermediate range between DGV and GV High highlights increasing levels of risk, supporting prioritisation of sites based on severity and the need for intervention. This framework accounts for variability in sediment types, contaminant bioavailability, and site-specific ecological sensitivities, enabling the development of tailored and effective remediation strategies. Furthermore, in some scenarios, achieving concentrations within this intermediate range may be appropriate to balance ecological recovery goals and practical constraints, particularly when remediation to background levels is not feasible or sustainable. It is recommended that this range be used to inform risk-based decision-making and remediation planning for the present site.

5.2 Groundwater Triggers

The DSI Report applies the ANZECC (2000 and 2013) guidelines at 95% protection limits to assess groundwater risks. The current recommended standards, however, are from the ANZG (2018) guidelines, which update the previous ANZECC (2000) values (see Table 2 for relevant contaminants). Notable changes include revised limits for arsenic (now 24 µg/L from 13 µg/L) and DDT (now 0.006 µg/L from 0.01 µg/L). Furthermore, the DSI Report currently uses detection limits for OCPs that are set too high; these should be adjusted to 'ultra trace' levels, below the ANZG (2018) guidelines.

Table 2 Recommended aquatic ecological guidelines (freshwater) for contaminants sampled at site.

Guideline	Arsenic	Cd	Cr	Cu	Pb	Ni	Zn	Tot DDT	Dieldrin	Aldrin	Endrin	Lindane
ANZG (2018) (freshwater) (µg/L)	24	0.2	1	1.4	3.4	11	8	0.006	0.01 (low reliability)	0.001(low reliability)	0.01	0.2
Protection Level	95%	95%	95%	95%	95%	95%	95%	To account for the bioaccumulating nature of this toxicant, it is recommended that the 99% species protection level DGV is used for slightly to moderately disturbed systems.				95%

5.3 Application to Project Area

Section 6 Risk-Based Assessment of this memo applies these aquatic ecological trigger limits to evaluate soil and groundwater contamination (as measured in the DSI Report) across the proposed ecological corridor. Given the proximity of this area to the stream (and treatment wetland) and the presence of steep slopes, careful management of soil and groundwater quality is essential. These conditions increase the likelihood of sediment transport into the stream, necessitating that the entire esplanade reserve area (including soils and groundwater) comply with aquatic ecological guidelines to prevent contamination of the aquatic receiving environment.

6 Risk-Based Assessment

The DSI Report has taken a practical 'risked-based' approach to the contamination of the HAIL site by focusing on the most toxic, high-risk contaminants as the main indicators of the extent of soil and groundwater contamination at the site, but also sampling for lower risk contaminants. This strategy, prioritises the assessment of contaminants that pose greatest environmental hazards, with the understanding that secondary, lower-risk contaminants will be addressed indirectly through the remediation actions of removing the soil and groundwater containing high risk contaminants at concentrations above acceptable guideline limits.

Based on the guideline values, and the measured concentrations at the site, the focus was directed on the most toxic contaminants, that were consistently present at elevated concentrations compared with the appropriate guideline value, that is the OCP, deildrin, and the metalloid, arsenic.

Using dieldrin as a primary indicator of aquatic ecological risk in a remediation project around a former sheep dip site is defensible for several reasons:

- **Toxicity profile -** Dieldrin is recognised for its high toxicity to aquatic organisms, including fish and invertebrates. Research has shown that even low concentrations can lead to significant ecological impacts, making it a critical marker for assessing overall risk to aquatic ecosystems.
- **Bioaccumulation potential -** Dieldrin has a higher tendency to bioaccumulate in aquatic food webs compared to its counterparts, aldrin and endrin. This characteristic means that its presence in sediments can indicate potential long-term ecological effects on fish and other organisms, thereby serving as an effective sentinel for aquatic health.
- **Existing regulatory framework** - Sediment quality guidelines such as those from ANZG (2018), provide specific DGVs for dieldrin.
- **Linkage to other compounds -** While used as a main indicator, its analysis can indirectly reflect the presence and risks associated with aldrin and endrin due to their chemical similarities and potential co-occurrence in historical agricultural practices. Therefore, monitoring dieldrin can provide insights into the broader contamination profile without the need for extensive assessment of each individual compound.
- **Historical context -** The historical use of sheep dips and its established ecological risks in the literature make it a relevant choice for current remediation projects. Evidence from previous studies supports the correlation between dieldrin presence in sediment and detrimental effects on aquatic life, reinforcing its utility as an indicator.

Arsenic is also commonly present at the site at concentrations exceeding guidelines. Dieldrin and arsenic have different chemical properties that influence their leaching potential from soils, and generally, dieldrin is considered to be less mobile and more persistent in soil compared to arsenic. Dieldrin is a hydrophobic compound that tends to strongly adsorb to soil particles, which limits its mobility in the environment. This strong binding reduces the likelihood of dieldrin leaching into groundwater or surface water. Studies have shown that dieldrin can persist in soil for extended periods, with limited movement unless significant erosion or soil disturbance occurs. Arsenic, on the other hand, can be more mobile in certain soil conditions, particularly in acidic environments where it may dissolve and leach into groundwater more readily. Arsenic's solubility can increase with changes in pH and the presence of organic matter, leading to a higher potential for leaching, especially in contaminated sites. The leaching behaviour of both contaminants can be influenced by environmental factors such as soil type, moisture content, and temperature. In sandy soils, for instance, both dieldrin and arsenic may exhibit increased leaching potential compared to clayey soils that bind contaminants more tightly. Given the more mobile nature of arsenic, the risk analysis has been undertaken to also include arsenic.

7 DSI Contaminant Results

Tables 3, 4, and 5 compare contaminant levels in soil and groundwater samples from the DSI Report with the recommended ecological guidelines provided in Tables 1 and 2. The soil and groundwater results for the key indicators—arsenic and dieldrin—are summarised below. For spatial reference, GIS-based maps of arsenic and dieldrin concentrations are overlaid with the concept landscape plan and shown in Figures 2, 3, 4, and 5.

7.1 Soil Contamination

Arsenic

Arsenic sampling was conducted near the former sheep dip area (Figure 2A) and within the paddock southeast of this location (Figure 2B). The results are summarised below:

- In the vicinity of the former sheep dip, 33 sampling sites were examined, with 39 of the 47 analysed samples exceeding the sediment guideline value of 20 mg/kg (NRMP 2006 and ANZG 2018). None of these samples exceeded the guideline by more than 100-fold. At several locations, samples were collected from depths greater than 0-75 mm, revealing arsenic levels above guidelines down to a depth of 1.6 metres.
- Within the southeastern paddock, 22 sites were sampled, and only 2 samples exceeded the 20 mg/kg guideline. These samples were closest to the former sheep dip area, and none exceeded the guideline by more than 10-fold. No deeper subsurface samples (below 0-75 mm) were collected in this area.

Arsenic contamination of soils was observed in close proximity to the former sheep dip and adjacent area. The absence of arsenic exceedances in southern and eastern paddock samples suggests that the contamination boundary for arsenic can likely be delineated to the north, south, and east. However, additional data may be needed to confirm the western boundary.

Other Heavy Metals

Concentrations of nickel, chromium, and copper for the majority of samples (Table 4) exceeded the recommended aquatic guidelines for sediment but were within background levels for the Nelson/Tasman region as noted above in Section 4 Key Contaminants. This indicates that while these metals were detected, their presence is consistent with natural background levels, and they are not expected to pose significant ecological or human health risks in the sampled areas.

Deildrin

Dieldrin sampling was conducted near the former sheep dip area (see Figure 3), with results summarised as follows:

- All soil samples analysed for dieldrin exceeded the sediment guideline value (ANZG, 2018, DGV of 0.0028 mg/kg), making it impossible to identify a clear dieldrin contamination boundary where guideline values are met.
- Among these, 12 of the 27 samples exceeded the guideline by more than 1000-fold.
- In several instances, samples were collected from depths greater than 0-75 mm, with dieldrin contamination observed as deep as 1.6 metres.
- The analytical detection limit for dieldrin was 0.011 mg/kg, which is higher than the guideline value of 0.0028 mg/kg, limiting the precision of results. Similarly, DDT had a detection limit of 0.07 mg/kg, exceeding its guideline value of 0.0012 mg/kg, with aldrin and endrin facing similar limitations.

Extensive dieldrin contamination was observed in the former sheep dip area and adjacent locations. However, the limited sampling scope prevented precise delineation of the contaminated area's boundary. Further sampling is recommended to define this boundary accurately, using ‘ultra trace’ methods with detection limits below guideline values for dieldrin (and DDT, aldrin, and endrin).

Table 3 DSI soils sample results for the former sheep dip area compared with DGV triggers in Table 1 as follows: No colour, Below Trigger; Green = Exceeds 0-10x; Yellow = Exceeds 10-100x; Orange = Exceeds 100-1000x; Red = Exceeds >1000x. Units for all data mg/kg.

Sampling location[a]	Depth (mm)	Arsenic	Cd	Cr	Cu	Pb	Ni	Zn	Tot DDT	Dieldrin	Aldrin	Endrin
KV1-4 Comp	0-75	20	0.42	88	58	31	89	340	<0.08	-	-	-
KV1-4-SS Comp	200-275	8	0.25	158	42	22	410	193	<0.07	-	-	-
KV5-8 Comp	0-75	32	0.4	111	44	34	155	250	<0.11	-	-	-
KV9	0-75	17	0.19	77	55	20	63	188	<0.08	0.024	<0.013	<0.013
KV10	0-75	108	10.4	89	81	200	73	5500	<0.15	3.2	<0.03	<0.03
KV11	0-75	450	9.8	98	96	390	90	610	0.27	78	0.077	0.63
KV12	0-75	580	16.3	104	124	152	82	480	4.2	240	0.62	2.9
KV13	0-75	270	3.6	107	72	179	53	900	0.34	36	0.02	0.34
KV14	0-75	420	15.6	109	67	176	89	750	1.19	620	9.9	3.9
KV15	0-75	158	11.5	85	96	200	65	1440	3.5	153	0.69	0.59
KV29-2	300-375	810	1.12	128	97	460	73	400	0.12	-	-	-
KV29-3	600-700	141	0.2	96	67	7.6	47	210	<0.07	-	-	-
KV16	0-75	-	-	-	-	-	-	-	5.3	400	1.5	5.8
KV17	0-75	31	0.42	142	51	37	210	550	-	-	-	-
KV18	0-75	35	0.34	87	49	22	147	300	<0.09	0.153	<0.015	<0.015
KV19	0-75	31	0.3	124	43	19	195	190	<0.08	0.074	<0.013	<0.013
KV20	0-75	89	0.49	127	97	31	240	260	<0.09	4	<0.015	0.016
KV32-2	350-425	63	0.2	120	190	69	163	124	<0.07	-	-	-
KV21	0-75	90	0.52	113	88	50	185	230	<0.10	9.5	<0.016	0.036
KV31-2	300-375	430	0.28	130	130	134	82	193	<0.08	-	-	-
KV22	0-75	53	1.1	119	119	137	128	680	-	-	-	-
KV30-1	0-75	-	-	-	-	-	-	-	<0.07	-	-	-
KV30-2	300-375	71	0.19	120	107	54	78	194	<0.07	-	-	-
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	-	<0.013	<0.013	<0.013
KV33	0-75	16	0.5	95	54	67	42	198	-	<0.011	<0.011	<0.011
KV34	0-75	18	0.43	123	60	40	146	230	-	0.13	<0.018	<0.018
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	-	-	-
KV TP01 0.2m		1190	<0.10	67	80	20	35	92	<0.07	0.051	<0.012	<0.012
KV TP01 0.5m		1020	0.31	111	74	59	60	280	<0.08	0.153	<0.014	<0.014
KV TP01 0.8m		40	-	-	-	-	-	-	-	-	-	-
KV TP02 0.2m		360	6.9	125	76	250	93	1050	0.16	41	0.044	0.27
KV TP02 0.5m		470	0.46	159	121	1750	115	430	<0.10	0.22	<0.016	<0.016
KV TP02 1.0m		128	0.27	130	52	15	49	63	-	-	-	-
KV TP02 1.5m		240	0.45	132	59	32	55	111	-	-	-	-
KV TP04 0.8m		112	0.15	150	54	37	60	86	<0.08	0.27	<0.013	<0.013
KV TP04 1.6m		110	0.29	122	54	4.9	52	147	<0.08	0.37	<0.012	<0.012
KV TP05 0.5m		133	0.17	113	71	24	79	140	<0.07	2.8	<0.012	0.022
KV TP05 0.9m		55	-	-	-	-	-	-	<0.07	0.35	<0.012	<0.012
TP06 0.5m		30	0.21	151	90	31	200	410	<0.07	0.191	<0.012	<0.012
TP07 0.5m		172	0.32	128	740	72	153	210	<0.08	5.7	<0.013	<0.013
TP07 1.2m		57	-	-	50	-	-	-	<0.08	0.98	<0.012	<0.012
TP08 0.3m		18	-	-	-	-	-	-	-	-	-	-
Sediment Guidelines												
		Arsenic	**Cd**	**Cr**	**Cu**	**Pb**	**Ni**	**Zn**	**Tot DDT**	**Dieldrin**	**Aldrin**	**Endrin**
ANZG 2018 DGV		**20**	**1.5**	**80**	**65**	**50**	**21**	**200**	**0.0012**	**0.0028**	none	**0.0027**
ANZECC 2000 ISQG Low											**0.001**	

NMRP (2006) ISQG Low	20	1.5	80	65	50	21	200	0.0016	0.00002	none	0.00002
NRMP 2006 ISQG Hi	70	10	370	270	220	52	410	0.046	0.008	none	0.008
ANZG GV High	70	10	370	270	220	52	410	0.005	0.007	none	0.06
NESCS-Recreational	80	400	2700	>10000	880	1200	30000	400			
Background Soil Concentrations (Cavanagh 2015)											
	Arsenic	**Cd**	**Cr**	**Cu**	**Pb**	**Ni**	**Zn**	**Tot DDT**	**Dieldrin**	**Aldrin**	**Endrin**
Nelson / Tasman Region			4-187	3-42		2-280					

[a] As shown in Figures 2A, 2B and 3.

Table 4 DSI soils sample results for paddock area immediately south of the former sheep dip area compared with DGV triggers in Table 1 as follows: No colour, Below Trigger; Green = Exceeds 0-10x; Yellow = Exceeds 10-100x; Orange = Exceeds 100-1000x; Red = Exceeds >1000x. Units for all data mg/kg.

Sampling location[a]	Depth (mm)	Arsenic	Cadmium	Chromium	Copper	Lead	Nickel	Zinc
KV27	0-75	30	0.29	70	55	84	53	176
KVP ½	0-75	25	0.19	112	62	21	66	125
KVP 1/1	0-75	6	0.22	79	46	59	81	149
KVP ⅓	0-75	5	0.2	87	44	47	94	121
KVP ¼	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 ⅛	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 ⅔	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
Sediment Guidelines								
		Arsenic	**Cadmium**	**Chromium**	**Copper**	**Lead**	**Nickel**	**Zinc**
ANZG (2018) DGV		**20**	**1.5**	**80**	**65**	**50**	**21**	**200**
NMRP (2006) ISQG Low		20	1.5	80	65	50	21	200
NRMP 2006 ISQG Hi		70	10	370	270	220	52	410
ANZG GV High		70	10	370	270	220	52	410
NESCS-Recreational		80	400	2700	>10000	880	1200	30000
Background Soil Concentrations (Cavanagh 2015)								
		Arsenic	**Cadmium**	**Chromium**	**Copper**	**Lead**	**Nickel**	**Zinc**
Nelson / Tasman Region				4-187	3-42		2-280	

[a] As shown in Figures 2A, 2B and 3.

7.2 Groundwater Contamination

Groundwater sampling was conducted on two occasions on 19 April 2023 and 11 August 2023. The results are presented in Table 5A,B.

Arsenic

Arsenic sampling was undertaken at 5 sites, all located in the immediate vicinity of the former sheep dip area (Figure 4). None of the groundwater samples analysed for arsenic exceeded the water quality guideline value (ANZG, 2018, 24 ug/l).

In terms of spatial coverage, sampling effort to date appears to be sufficient to delineate the likely boundary of the groundwater 'contaminated area' for arsenic and the full extent of contamination within that boundary.

Deildrin (and other OCPs)

Dieldrin sampling was conducted at the same five sites as arsenic, all located near the former sheep dip area (Figure 5). The results are summarised as follows:

- During the first sampling event, all groundwater samples exceeded the water quality guideline for dieldrin (ANZG, 2018, 0.01 µg/L). One of the five samples exceeded the guideline by over 100-fold, and three others exceeded it by more than 10-fold. On the second sampling event, contamination levels were lower, with only three sites exceeding the guideline, none by more than 100-fold.
- Aldrin, a related organochlorine pesticide (OCP), was detected at one site at elevated concentrations (over 100 times the guideline value) during the first event, though levels decreased significantly on the second event.
- Detection limits for DDT were not low enough to provide precise values, only confirming concentrations were below 10 times the guideline. Aldrin faced similar detection issues.

Groundwater contamination was identified at the limited number of sites sampled. Depending on the dilution potential in the stream, additional sampling may be needed to refine the contamination boundary for OCPs and assess the extent within this area. If required, further sampling should include dieldrin, DDT, aldrin, and endrin, utilising ultra-trace methods with detection limits below guideline values to improve accuracy.

The applicable groundwater guidelines are the ANZG (2018) values for 95% protection (or 99% for DDT), with the low-reliability guideline for dieldrin as no alternative is currently available. These guidelines are expected to be met after considering dilution following groundwater mixing with the stream. The necessity for further sampling would depend on the calculated dilution potential in the receiving environment (further discussed below and in Section 8 Recommendations for Remedial Action Plan).

Available 'In-Stream' Dilution

Conservative, coarse estimates of the maximum groundwater contaminant concentrations required to meet instream ANZECC water quality guidelines after accounting for allowable dilution are presented below. The estimates are based on several assumptions as follows.

Groundwater Flow Estimates

Tonkin+Taylor (T+T) have provided preliminary estimates of groundwater flows from the contaminated area using an existing model. This model incorporates a previous version of the channel realignment and utilises soil permeability values from tests conducted further out in the floodplain, not immediately adjacent to the former sheep dip site. Consequently, T+T recommend treating these initial estimates as rough approximations.

If these preliminary flows suggest potential issues with meeting relevant guidelines, it would be prudent to develop a more refined model that accurately represents the specific conditions of the area in question.

These coarse groundwater flow estimates (best and conservative) are as follows:

Best estimate permeability parameters, based on limited testing			
Groundwater Flow	Drought day	Normal Day	Wet day
Top 2m (m3/s/m2)	0	1.00E-06	2.00E-06
Below 2m (m3/s/m2)	1.00E-06	3.00E-06	8.00E-06
Total (m3/s/m2)	0.000001	0.000004	0.00001

Conservative estimate permeability parameters, based on limited testing			
Groundwater Flow	Drought day	Normal Day	Wet day
Top 2m (m3/s/m2)	0	1.00E-05	1.00E-05
Below 2m (m3/s/m2)	6.00E-06	2.00E-05	1.00E-04
Total (m3/s/m2)	0.000006	0.00003	0.00011

Stream Flow Estimates

Relevant stream flows in the lower Kākā Hill Tributary were estimated using NZ River Maps (NIWA). The mean flow was estimated at 0.047 m^3/s and the 1 in 5 year low flow at 0.0032 m^3/s. The 1 in 5 year low flow was assumed as a realistic worst case scenario for dilution potential within the stream.

Upstream Contaminant Concentrations

Contaminant concentrations (i.e. organochlorine pesticides and arsenic) ‘upstream’ of the contaminated area were assumed to be 0 ug/l.

Extent of Contaminated Groundwater Front

The maximum physical dimensions of the predicted southeast flowing and potentially contaminated groundwater front entering the stream from the contaminated area was estimated to be 100 m long and 4 m deep. It is also assumed that the groundwater flow emanating from this 100 m x 4 m front enters the stream as a point discharge.

Reasonable Mixing Zone Requirements

The Nelson Regional Management Plan (NRMP), Vol 3, Appendices AP28.7.i states that:

‘...*The following apply for permitted, controlled and discretionary activities:*

For all discharges excluding stormwater, in determining the size of the zone of reasonable mixing, the following conditions will apply:

a. *the maximum size of the mixing zone, singularly or cumulatively in combination with other mixing zones, shall be the most restrictive combination of the following:*
    - *the mixing zone does not extend in a downstream direction from the discharge point(s) for a distance greater than 100 m plus the depth of water at the discharge point(s), or extend upstream for a distance of more than 30 m, or*
    - *the mixing zone does not utilise more than 25% of the flow, or*
    - *the mixing zone does not occupy more than 25% of the width of the water body.*

b. *all known, available and reasonable methods of prevention, control and treatment have been applied, and*
c. *water quality standards as set out in Appendix 28.5 are not exceeded outside of the boundary of the proposed mixing zone as a result of the discharge, and*
d. *the size of a mixing zone and the concentrations of pollutants present are minimised, and*
e. *there is no lethal toxicity to biota exposed to the diluted effluent within the mixing zone for periods less than or equal to 1 hour (i.e. they are unlikely to die if moving through the mixing zone)...'.*

The second option of the NRMP Reasonable Mixing Zone Requirements as above, which allows for mixing with 25% of the stream flow, is likely more restrictive than the first option, which permits mixing over 100 meters plus the depth of water. This is because the first option assumes mixing with the entire stream flow, leading to greater dilution of contaminants.

Therefore, given the assumptions for the lower Kākā Hill Tributary, a mixing zone using of 25% of the flow is permissible before the receiving water standard must be met.

Based on these assumptions and mixing zone requirements, the '*maximum allowable concentration for groundwater contaminants under worst-case conditions*' (Gconc) can be calculated using the following mass balance equation:

Gconc = (DSconc × (Gfl + ASfl)) / Gfl

Where:

- **DSconc**: Target downstream concentration (μg/L)
- **Gfl**: Groundwater flow (0.0012 m^3/s)
- **ASfl**: Available stream flow for dilution (0.0008 m^3/s, i.e., 25% of 0.0032 m^3/s)

For example, for a target downstream guideline concentration of 100 μg/L:

Gconc = (100 × (0.0012 + 0.0008)) / 0.0012 = (100 × 0.002) / 0.0012 = 0.2 / 0.0012 = 166.67 μg/L.

This calculation indicates that, conservatively, the concentration of contaminants in the groundwater should not exceed 166.67 μg/L to ensure that the downstream concentration remains at or below the target of 100 μg/L. This means the groundwater contaminant concentration must not exceed 1.67 times the proposed ANZECC water quality guidelines, as shown in Table 5A.

For more precise and potentially less stringent groundwater contaminant limits, it would be appropriate to develop a targeted groundwater flow model. This model should incorporate a more accurate stream mixing component—specifically, the diffuse mixing of groundwater with 25% of the stream flow—and provide a detailed assessment of the dimensions of the contaminated groundwater front.

Table 5A DSI groundwater sample results (19 April 2023) for the former sheep dip area compared with recommended guideline triggers in Table 2 as follows: No colour, Below Trigger; Green = Exceeds 0-10x; Yellow = Exceeds 10-100x; Orange = Exceeds 100-1000x; Red = Exceeds >1000x.

Units for all data µg/L.

Sampling location[a]	Arsenic	Cd	Cr	Cu	Pb	Ni	Zn	Tot DDT	Dieldrin	Aldrin	Endrin	Lindane
KVBH01	<1	<0.05	0.7	2.2	<0.1	2	7.1	<0.2	<0.1	<0.1	<0.1	<0.2
KVBH02	2.2	<0.05	1.1	1.7	<0.1	1.3	10.2	<0.2	1.06	<0.1	<0.1	<0.2
KVBH03	<1	<0.05	0.6	2.9	<0.1	1.3	4	<0.2	0.2	0.15	<0.1	<0.2
KVBH04	4.6	<0.05	1.4	3.3	<0.1	2	6.3	<0.2	0.21	<0.1	<0.1	<0.2
KVBH04A	1.6	<0.05	1.3	10.5	<0.1	3.1	40	<0.2	0.1	<0.1	<0.1	<0.2
Water Quality Guidelines												
ANZG (2018)	**24**	**0.2**	**1**	**1.4**	**3.4**	**11**	**8**	**0.006**	**0.01**	**0.001**	**0.01**	**0.2**
Protection Level	95%	95%	95%	95%	95%	95%	95%	To account for the bioaccumulating nature of this toxicant, it is recommended that the 99% species protection level DGV is used for slightly to moderately disturbed systems.				95%

[a] As shown in Figures 4 and 5.

Table 5B DSI groundwater sample results (11 August 2023) for the former sheep dip area compared with recommended guideline triggers in Table 2 as follows: No colour, Below Trigger; Green = Exceeds 0-10x; Yellow = Exceeds 10-100x; Orange = Exceeds 100-1000x; Red = Exceeds >1000x. Units for all data µg/L.

Sampling location[a]	Arsenic	Cd	Cr	Cu	Pb	Ni	Zn	Tot DDT	Dieldrin	Aldrin	Endrin	Lindane
KVBH01	<1	<0.05	0.6	1.1	<0.1	8	4.2	<0.06	<0.008	<0.008	<0.008	<0.01
KVBH02	3	<0.05	0.7	1.2	<0.1	1	13.2	<0.06	0.27	0.02	<0.008	<0.01
KVBH03	<1	<0.05	0.6	2	<0.1	0.6	1.1	<0.06	0.03	<0.008	<0.008	<0.01
KVBH04	<1	<0.05	<0.5	2.8	<0.1	0.6	1.5	<0.06	0.166	0.008	<0.008	<0.01
KVBH04A	1.9	<0.05	0.7	7.5	<0.1	0.9	3	<0.06	<0.008	<0.008	<0.008	<0.01
Water Quality Guidelines												
ANZG (2018)	**24**	**0.2**	**1**	**1.4**	**3.4**	**11**	**8**	**0.006**	**0.01**	**0.001**	**0.01**	**0.2**
Protection Level	95%	95%	95%	95%	95%	95%	95%	To account for the bioaccumulating nature of this toxicant, it is recommended that the 99% species protection level DGV is used for slightly to moderately disturbed systems.				95%

[a] As shown in Figures 4 and 5.

8 Recommendations for Remedial Action Plan (RAP)

The proposed realignment of the lower Kākā Hill Tributary and the adjacent esplanade reserve intersects a former sheep dip site, leading to soil and groundwater contamination concerns. To effectively manage potential ecological impacts, the following steps are recommended for the development of a Remedial Action Plan (RAP) by a Suitably Qualified and Experienced Practitioner (SQEP):

- **Application of ANZG (2018) water and sediment quality guidelines**

  To protect soil and groundwater quality within the ecological corridor, apply the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG, 2018). Given the site's proximity to the stream and its steepened slopes, there's an increased risk of sediment transport into the waterway. Implement conservative soil and groundwater management practices to prevent contamination of the freshwater environment.

Specific remediation for nickel, chromium, and copper may not be warranted, as their levels are consistent with expected natural background concentrations.

- **Comprehensive delineation of contaminated areas**

  Soil Contamination: Existing data indicates significant contamination with organochlorine pesticides (OCPs) and arsenic. Conduct additional sampling, especially west of the current sampling footprint, to precisely define contamination boundaries.

  Groundwater Contamination: Contamination has been identified at limited sites. Further sampling is necessary to delineate the extent of OCP contamination, considering the stream's dilution potential. Employ ultra-trace analytical methods with detection limits below guideline values to ensure accurate assessments.

- **Further assessment of groundwater flow and dilution potential**

  An initial estimate suggests a low dilution potential (approximately 1.67 times the proposed ANZECC water quality guidelines). A detailed assessment of groundwater flow, including diffuse mixing with stream flow, may be required to more accurately evaluate dilution capacity and inform the need for further groundwater sampling (i.e. testing to confirm that residual concentrations meet the recommended guidelines).

- **Establishment of groundwater contaminant guideline triggers**

  Apply ANZG (2018) guideline values for 95% species protection (99% for DDT) and low-reliability guidelines for dieldrin due to limited data. Accurate accounting of groundwater flow and dilution as suggested above may demonstrate compliance with these guidelines.

- **Review of RAP**

  The RAP should be reviewed by the Project Ecologist to ensure alignment with best practices and consistency with the Project objectives, particularly the achievement of *Net Gain* outcomes for local ecology.

- **Adaptive management**

  These recommendations are based on preliminary designs and may require adjustments as the Project advances. Modifications in alignment, site conditions, or new findings during further investigations should prompt updates to the RAP to align with the Project's ecological objectives and ensure net ecological gains.

By following these steps, it is anticipated that the RAP will effectively address contamination issues, safeguarding the ecological integrity of the proposed ecological corridor (realigned stream and the esplanade reserve).

9 Applicability

Robertson Environmental's professional opinions are based on its professional judgement, experience, and training. These opinions are also based upon data derived from the existing information and analysis described in this document. Robertson Environmental Limited has relied upon information provided by the Client to inform parts of this document, some of which has not been fully verified by Robertson Environmental Limited.

This letter has been prepared for the exclusive use of CCKV Maitai Dev Co LP (Maitahi), with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose without our prior review and agreement.

If you have any further queries or wish to discuss any aspect of the above, please do not hesitate to contact Ben Robertson via phone ([redacted]) or email ([redacted]).

Robertson Environmental Limited

Report Prepared by:

Dr Ben Robertson

Principal Consultant Ecologist, Director

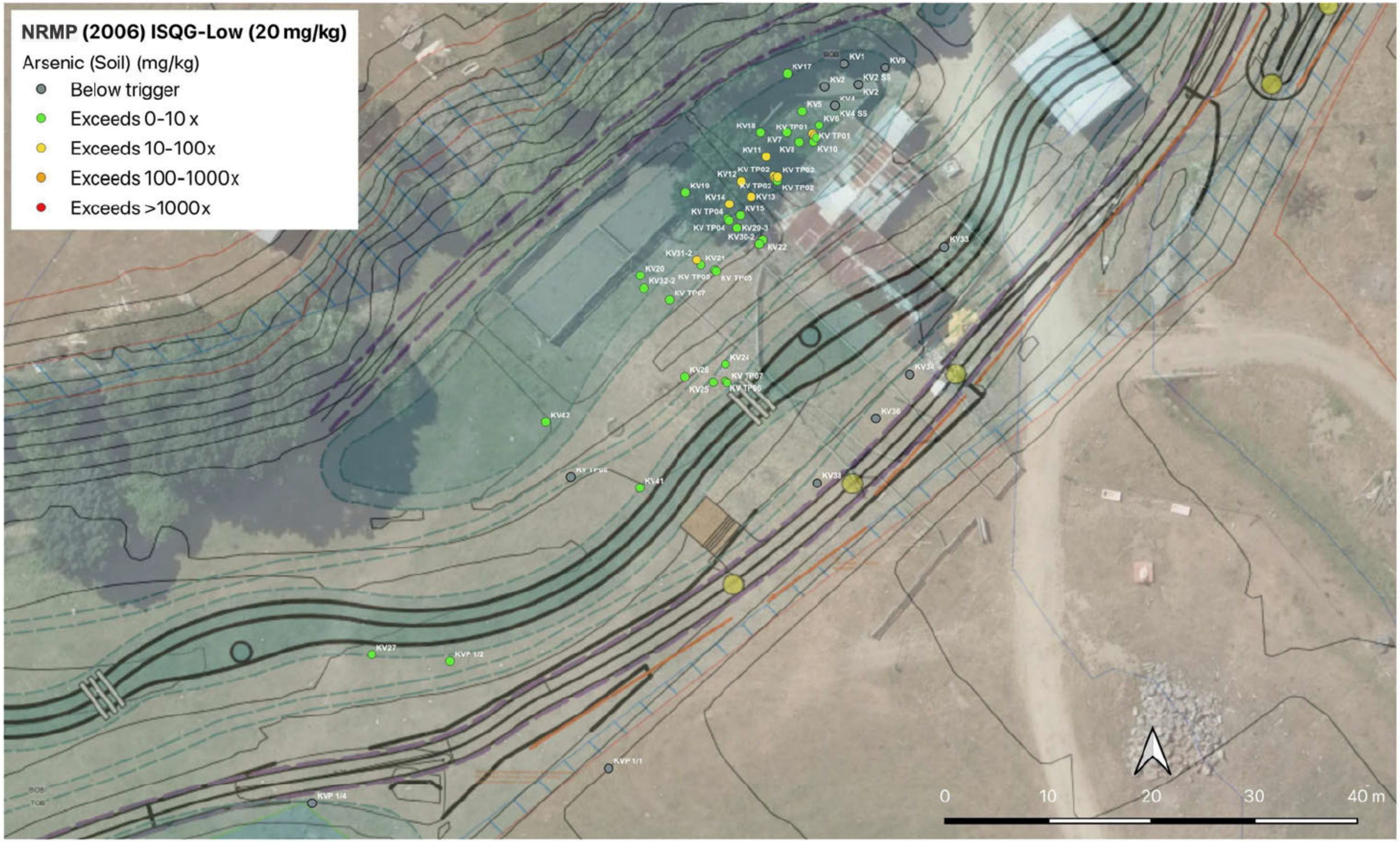


Figure 2A Arsenic concentrations in <u>soils</u> at sampling sites in vicinity of the former sheep dip area and proposed stream realignment and esplanade reserve. Refer to Figure 1 for an overlay of relevant features within the landscape plan.

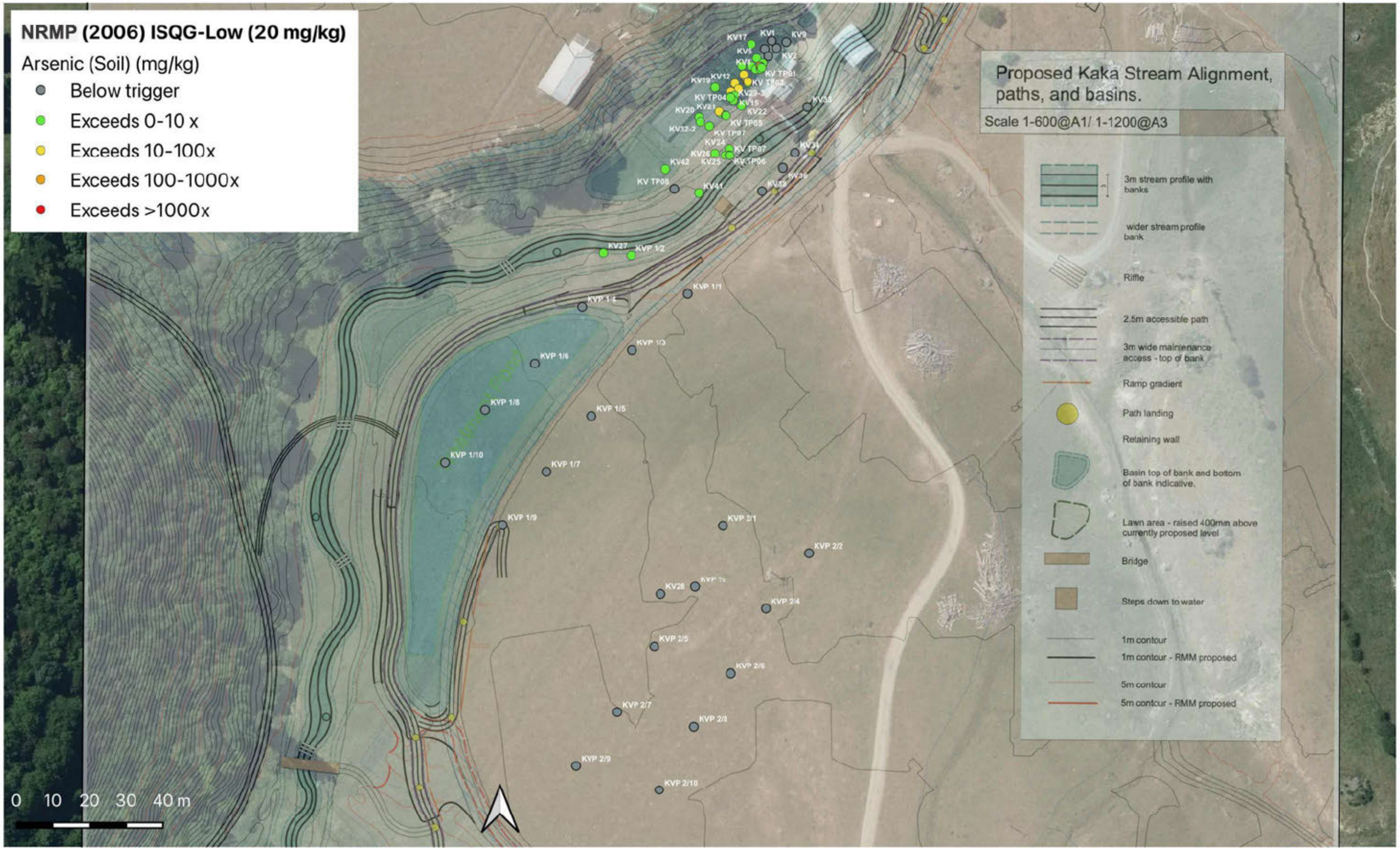


Figure 2B Overview of arsenic concentrations in soils at sampling sites in vicinity of the former sheep dip area and proposed stream realignment and esplanade reserve and the southeastern paddock. Refer to Figure 1 for an overlay of relevant features within the landscape plan.

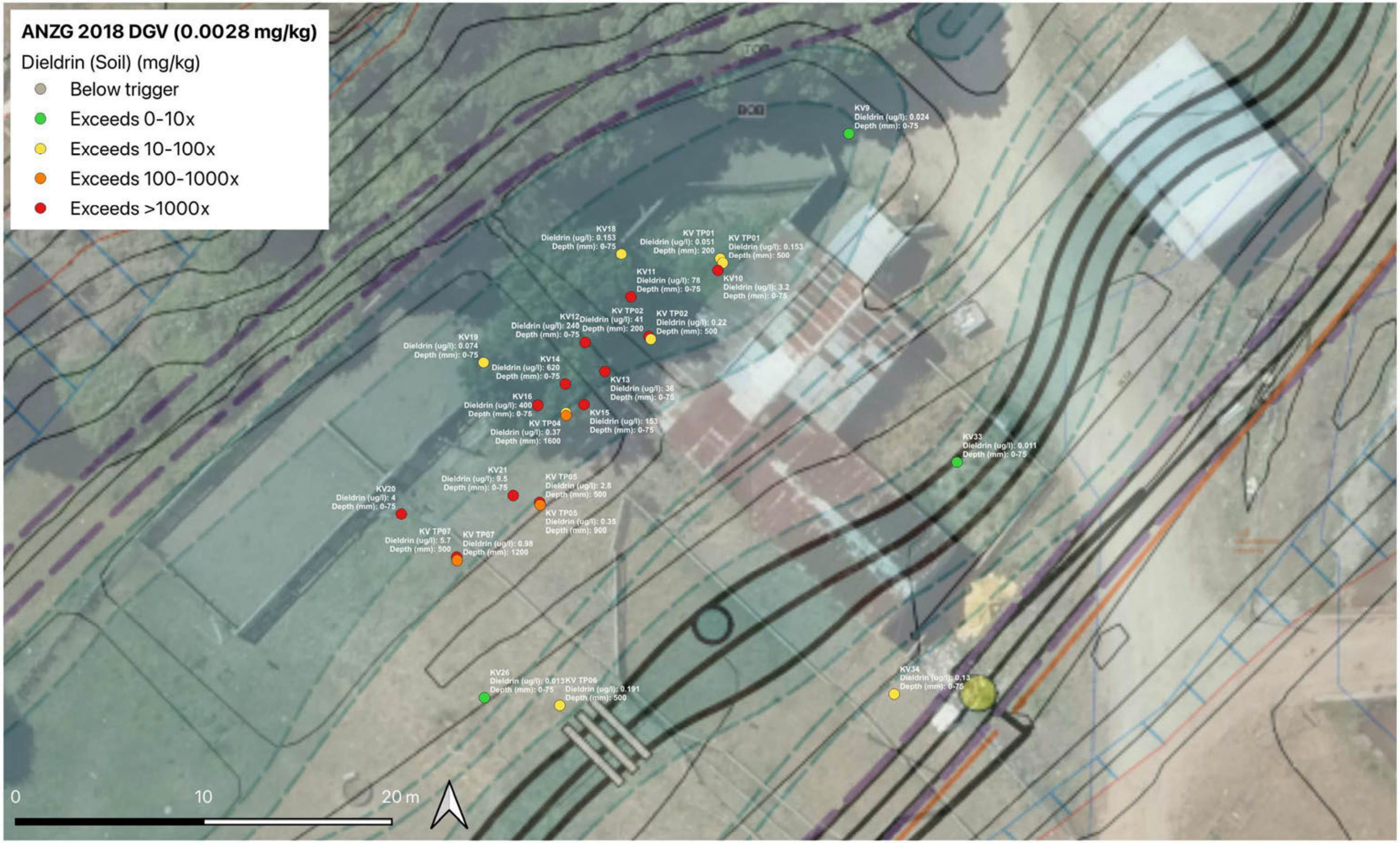


Figure 3 Deildrin concentrations in soils at sampling sites in vicinity of the former sheep dip area and proposed stream realignment and esplanade reserve. Refer to Figure 1 for an overlay of relevant features within the landscape plan.

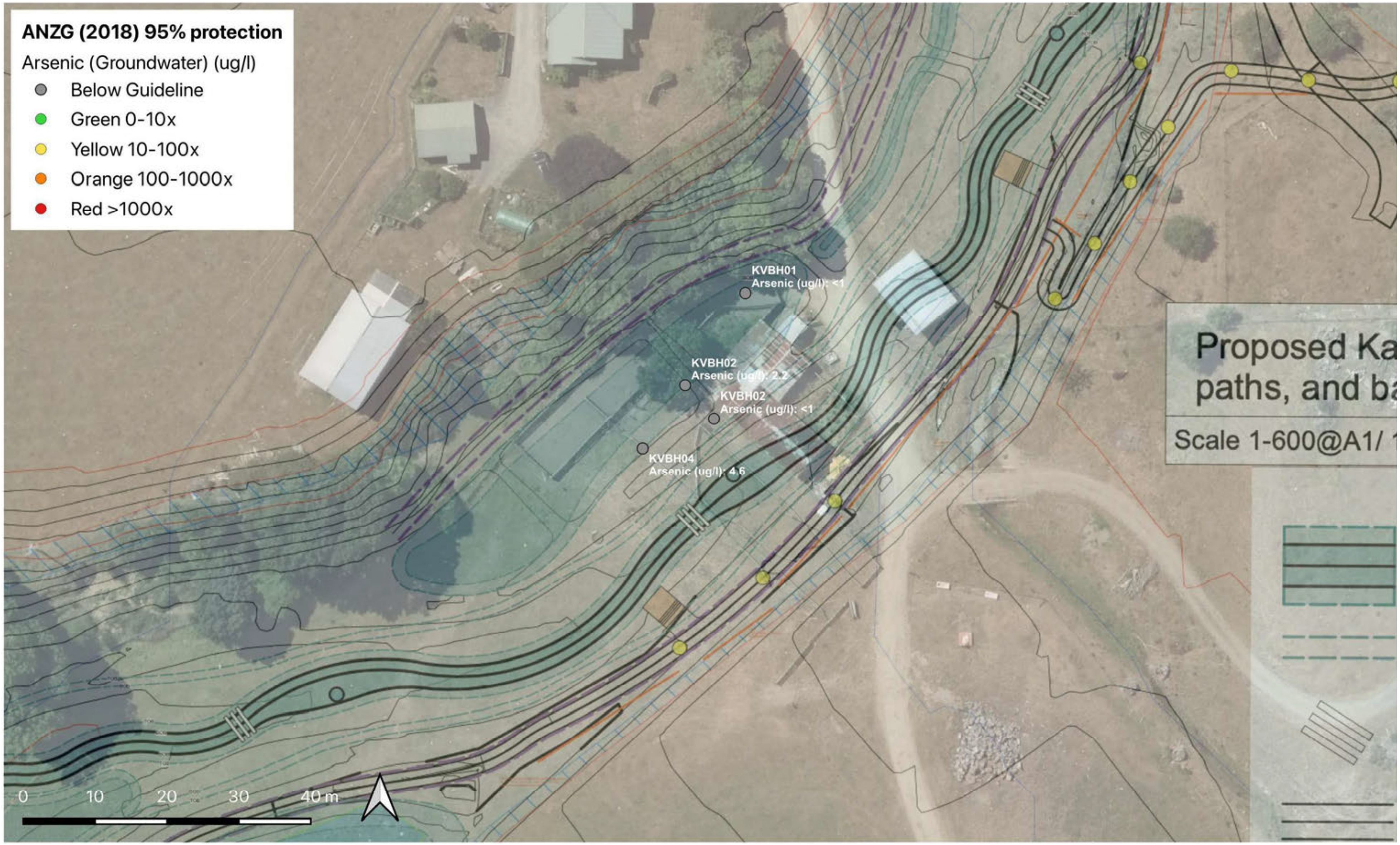


Figure 4 Arsenic concentrations in groundwater at sampling sites in vicinity of the former sheep dip area and proposed stream realignment and esplanade reserve. Refer to Figure 1 for an overlay of relevant features within the landscape plan.

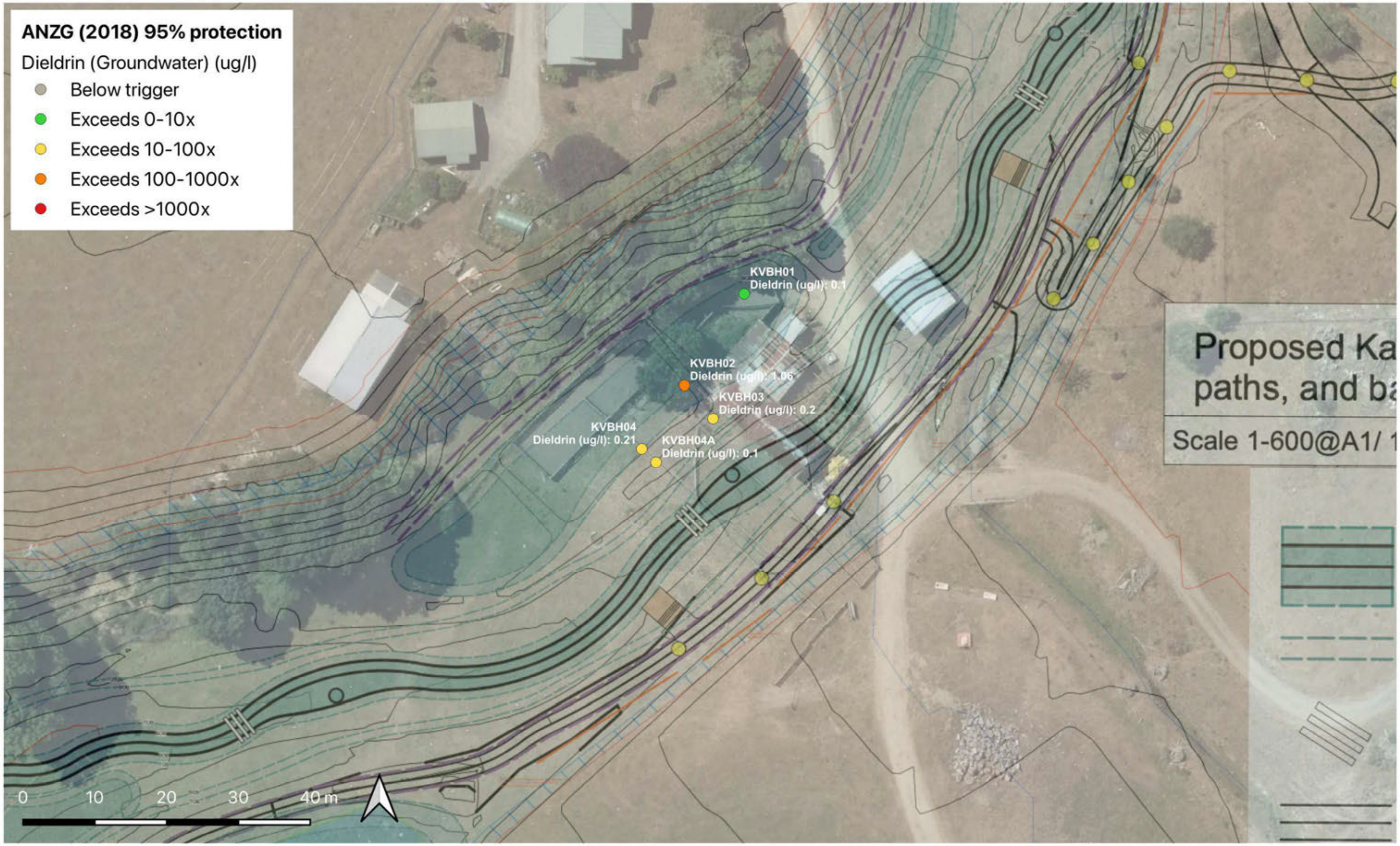


Figure 5 Deildrin concentrations in groundwater at sampling sites in vicinity of the former sheep dip area and proposed stream realignment and esplanade reserve. Refer to Figure 1 for an overlay of relevant features within the landscape plan.

Attachment A:

Maitahi Development (Draft) Concept Landscape Masterplan (RMM)

Maitahi Development Landscape Masterplan

1. Stormwater retention basins, planted with native rushes and sedges. Temporally inundated.
2. Informal play including stream access, boulders, planting, and balancing logs.
3. Pause Location with seating at outlook over stream.
4. Stairs to development entrance (100 steps 300mm treads and 160mm risers).
5. Shared Accessible Path with an average grade of 1:20/5%, with some areas including accessible ramps with handrails.
6. Maintenance Track
7. Basketball half court
8. Shared paths connecting to Botanical Hill Reserve.
9. Connection over Kaka Stream via Pedestrian Bridge.
10. Possible future connection to Maitai River Pedestrian Bridge
11. Informal path and stepping stone stream crossing.
12. Public Neighbourhood Reserve including accessible picnic areas with accessible long feast benches, shared vegetable growing areas and a hangi pit
13. Information and Sculpture point
14. Open space
15. Bush Walkway
16. Native Bush
17. Roundabout/ Raised paving intersection
18. Overland Flow path with native planting and stone lined channel
19. Grassed area with Stream access for stormwater asset management.
20. Kaka Stream realignment to include pools, runs, riffles, woody debris, logs, and boulders to provide variety in habitat.
21. Pump Station.
22. Playground including a skate path, balancing/ climbing logs and rocks, a climbing net over a slope, accessible basket swing, slide and multiple climbing elements
23. Stream side riparian planting zones including: Shallow Marsh, Littoral Edge, and Terrestrial Riparian planting.
24. Native parkland amenity planting and green connections planting.
25. Informal Orchard

Scale 1:1500@A1

Draft Masterplan

19 April 2024

CCKV Maitai Development Co LP and Bayview Nelson Ltd

RMM

Appendix C
Data Summary Tables and Figures

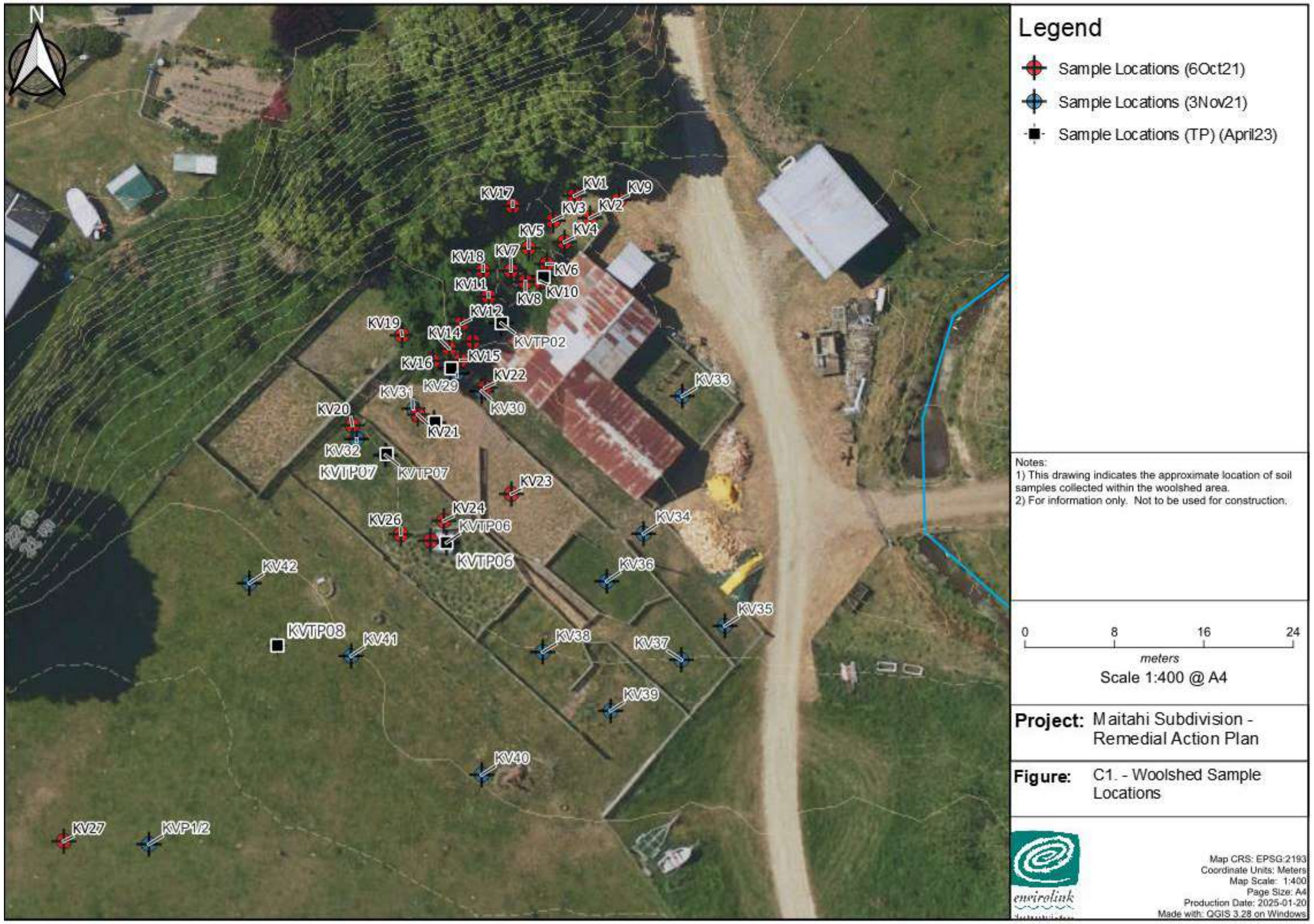


Figure C1. Woolshed Sample Locations

Table C1: Summary of Key Indicator Contaminants in Woolshed area and surrounds.

Wool Shed and Surrounds	Depth (mm)	Arsenic	Dieldrin
KV1-4 (composite)	0-75	20	< 0.013
KV1-4-SS (composite)	200-275	8	< 0.011
KV5-8 (composite)	0-75	32	0.13
KV9	0-75	17	0.024
KV10	0-75	108	3.2
KV11	0-75	**450**	***78***
KV12	0-75	**580**	***240***
KV13	0-75	**270**	36
KV14	0-75	**420**	***620***
KV15	0-75	**158**	***153***
KV29-2	300-375	**810**	22
KV29-3	600-700	**141**	3.1
KV16	0-75	-	***400***
KV17	0-75	31	-
KV18	0-75	35	0.153
KV19	0-75	31	0.074
KV20	0-75	89	4
KV32-2	350-425	63	0.59
KV21	0-75	90	9.5
KV31-2	300-375	**430**	4.7
KV22	0-75	53	-
KV30-1	0-75	-	1.48
KV30-2	300-375	71	0.099
KV24	0-75	86	-
KV25	0-75	49	-
KV26	0-75	39	-
KV33	0-75	16	-
KV34	0-75	18	-
KV36	0-75	16	-
KV38	0-75	19	-

Wool Shed and Surrounds	Depth (mm)	Arsenic	Dieldrin
KV41	0-75	32	-
KV42	0-75	59	1.32
KV TP01	200	**1190**	0.051
KV TP01	500	**1020**	0.153
KV TP01	800	40	-
KV TP02	200	**360**	41
KV TP02	500	**470**	0.22
KV TP02	1000	128	-
KV TP02	1500	**240**	-
KV TP04	800	112	0.27
KV TP04	1600	110	0.37
KV TP05	500	133	2.8
KV TP05	900	55	-
TP06	500	30	0.191
TP07	500	**172**	5.7
TP07	1200	57	-
TP08	300	18	-
Background		11	0
NCC Cleanfill		12	-
Ecological Value (DGV Low)		20	0.0028
NESCS - Recreational		80	70
NES CS - High Density Residential		20	2.6
Low POP content threshold		-	*>50*
Encapsulation Cell WAC		**140**	**50**

Table C.2 - Summary of Full Analytical Results – Woolshed Area

Sample Location	Depth (mm)	As	Cd	Cr	Cu	Pb	Ni	Zn	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

Sample Location	Depth (mm)	As	Cd	Cr	Cu	Pb	Ni	Zn	Total DDT	Total HCH@	Total 'drins'^
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	20	1.5	80	65	50	21	200	0.0012	7*	0.0028**
	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

- 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
**Value for dieldrin

Table C.3: Summary of Analytical Results - Additional Investigation – Woolshed area

Sample Location	As	Cd	Cr	Cu	Pb	Ni	Zn	Total HCH	Total DDT Isomers	Total drins
KV TP01 0.2m	1,190	< 0.10	67	80	20	35	92	< 0.012	< 0.07	0.08
KV TP01 0.5m	1,020	0.31	111	74	59	60	280	< 0.014	< 0.08	0.18
KV TP01 0.8m	40	-	-	-	-	-	-	-	-	0.00
KV TP02 0.2m	360	6.9	125	76	250	93	1050	0.073	0.16	41.31
KV TP02 0.5m	470	0.46	159	121	1,750	115	430	< 0.016	< 0.10	0.25
KV TP02 1m	128	0.27	130	52	15	49	63	-	-	0.00
KV TP02 1.5m	240	0.45	132	59	32	55	111	-	-	0.00
KV TP04 0.8m	112	0.15	150	54	3.7	60	86	< 0.013	< 0.08	0.30
KV TP04 1.6m	110	0.29	122	54	4.9	52	147	< 0.012	< 0.08	0.39
KV TP05 0.5m	133	0.17	113	71	24	79	140	< 0.012	< 0.07	2.83
KV TP05 0.9m	55	-	-	-	-	-	-	< 0.012	< 0.07	0.37
TP06 0.5m	30	0.21	151	90	31	200	410	< 0.012	< 0.07	0.22
TP07 0.5m	172	0.32	128	740	72	153	210	< 0.013	< 0.08	5.73
TP07 1.2m	57	-	-	50	-	-	-	< 0.012	< 0.08	1.00
TP08 0.3m	18	-	-	-	-	-	-		-	
Background	11	0.9	183	41.5	33	274.4	141.5	0	0.48	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		0.4
Ecological Guideline Value	20	1.5	80	65	50	21	200	7*	0.0012	0.0028**
NESCS – Residential	20	3	460#	>10,000	210	400	7,400	140	70	2.6
NESCS – Residential (High-density)	45	230	1,500	>10,000	500	1,200	60,000	700	240	45
NESCS – Recreational	80	400	2,700#	>10,000	880	1,200	30,000	1,400	400	70

* ANZECC SQG-H value **Value for dieldrin

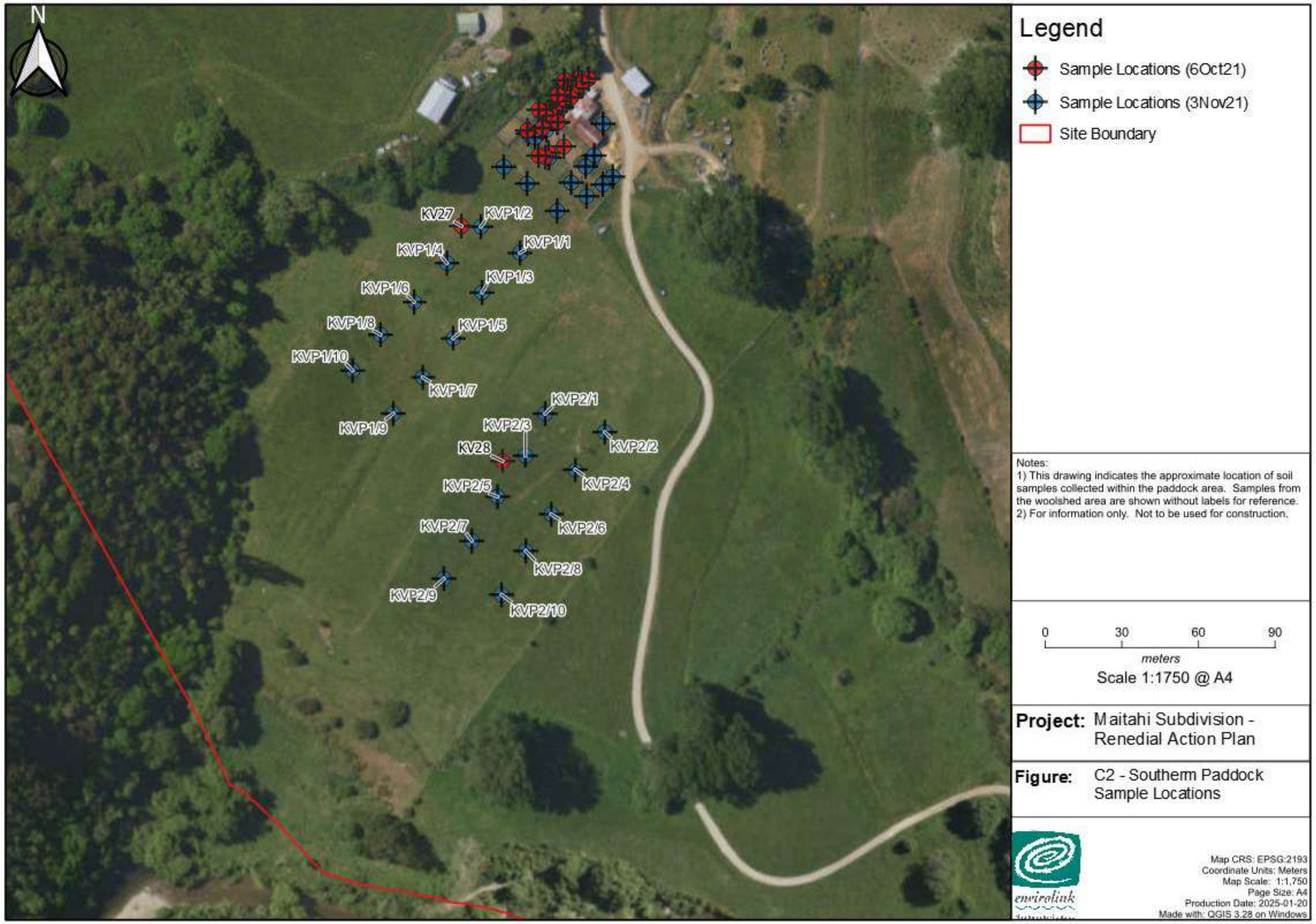


Figure C.2 Sample Locations – Southern Paddock

Table C.4 - Summary of Analytical Results – Southern Paddock Area

Sample Location	Depth (mm)	As	Cd	Cr	Cu	Pb	Ni	Zn
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
95% UCL of the mean		**6.4**	**0.18**	**145.1**	**56.2**	**32.8**	**87.9**	**92.4**
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
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

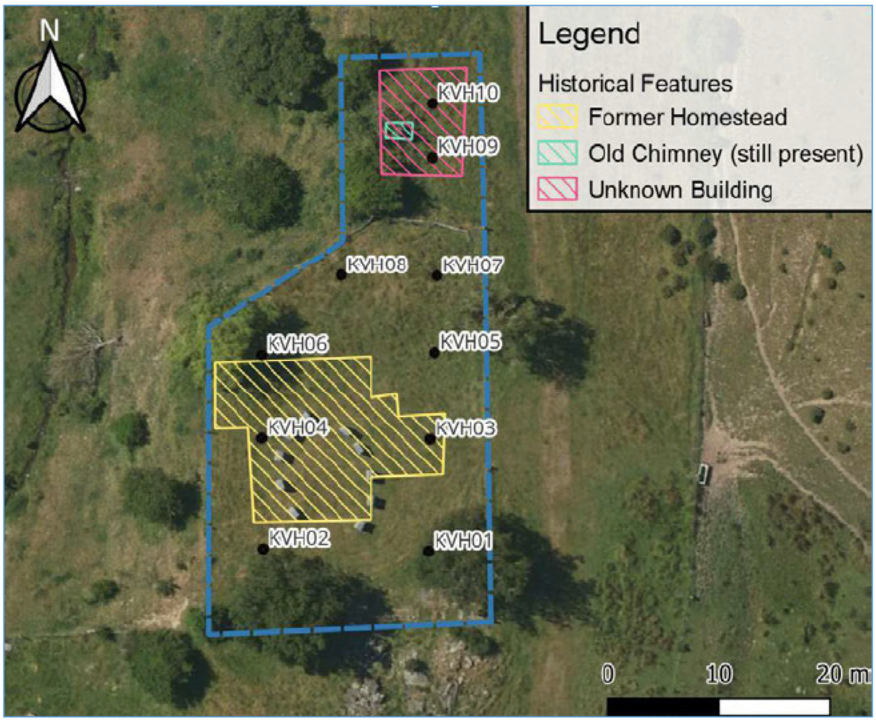


Figure C.3. Former Homestead Sample Locations

Table C5: Soil Contaminant Results – Former Homestead

Sample Location	As	Cd	Cr	Cu	Pb	Ni	Zn
KVH - 01	9	0.51	136	63	270	102	410
KVH - 02	8	0.53	134	65	310	134	540
KVH - 03	12	0.61	135	60	310	110	420
KVH - 04	10	0.5	131	65	370	103	510
KVH - 05	9	0.53	113	66	210	76	320
KVH - 06	8	0.53	145	70	210	114	450
KVH - 07	9	0.43	118	52	161	61	260
KVH - 08	16	0.45	119	67	510	57	350
KVH - 09	7	0.35	132	40	96	55	300
KVH - 10	5	0.26	141	42	107	57	200
Background	11	0.9	183	41.5	33	274.4	141.5
NCC Cleanfill	12	0.75	183	83	86	274.4	300
NES CS – High Density Residential	45	230	1500	>10,000	500	1,200	60,000

Table C6 - Summary of Analytical Results – TCLP/Leachate Analysis

Sample Location	Depth (mm)	As	Cd	Cr	Cu	Pb	Ni	Zn	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*	0.004	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 C7– Grab Sample Water Results

Sample Location	As	Cd	Cr	Cu	Pb	Ni	Zn	Aldrin	DDT	Dieldrin	Lindane
Sump (KVS1)	< 0.021	0.0025	< 0.011	< 0.011	0.006.8	<0.0 11	0.164	< 0.0004	< 0.0004	< 0.0004	< 0.0004
Standpipe (KTV2)	2.4	0.181	0.34	0.76	9.9	0.31	540	0.029	< 0.0004	0.0036	< 0.0004
ANZG 80% protection	0.14	0.0008	0.04	0.0025	0.0094	0.017	0.031	0.000001	0.00004	0.00001	0.001

Notes: All concentrations expressed as mg/L
Water samples were analysed for total metals only
they were not filtered prior to analysis rather than filtered.
Guideline values are the Australian and New Zealand Guidelines for Fresh and Marine Water Quality. The 80% species protection values were used.

Table C7 (continued) – Groundwater Results – Woolshed (November 2021)

Bore Reference	pH	As	Cd	Cr	Cu	Pb	Ni	Zn	Lindane	DDT	Aldrin	Dieldrin	Endrin
KVBH01	6.8	<0.001	<0.00005	0.0007	0.0022	<0.0001	0.002	0.0071	<0.0002	<0.0002	<0.0001	<0.0001	<0.0001
KVBH02	6.8	0.0022	<0.00005	0.0011	0.0017	<0.0001	0.0013	0.0102	<0.0002	<0.0002	0.00015	0.00106	<0.0001
KVBH03	6.9	<0.001	<0.00005	0.0006	0.0029	<0.0001	0.0013	0.004	<0.0002	<0.0002	<0.0001	0.0002	<0.0001
KVBH04	6.9	0.0046	<0.00005	0.0014	0.0033	<0.0001	0.002	0.0063	<0.0002	<0.0002	<0.0001	0.00021	<0.0001
KVBH04A	6.8	0.0016	<0.00005	0.0013	0.0105	<0.0001	0.0031	0.04	<0.0002	<0.0002	<0.0001	0.0001	<0.0001
ANZG 80% protection		0.14	0.0008	0.04	0.0025	0.0094	0.017	0.031	0.001	0.00004	0.000001	0.00001	0.00006
ANZG 95% protection		0.013	0.0002	0.0004	0.0014	0.0034	0.011	0.008	0.0002	0.00001	0.000001	0.00001	0.00002

Notes: All concentrations expressed as mg/L
Water samples were analysed for dissolved metals only
They were field filtered.
Guideline values are the Australian and New Zealand Guidelines for Fresh and Marine Water Quality. The 80% & 95% species protection values were used.

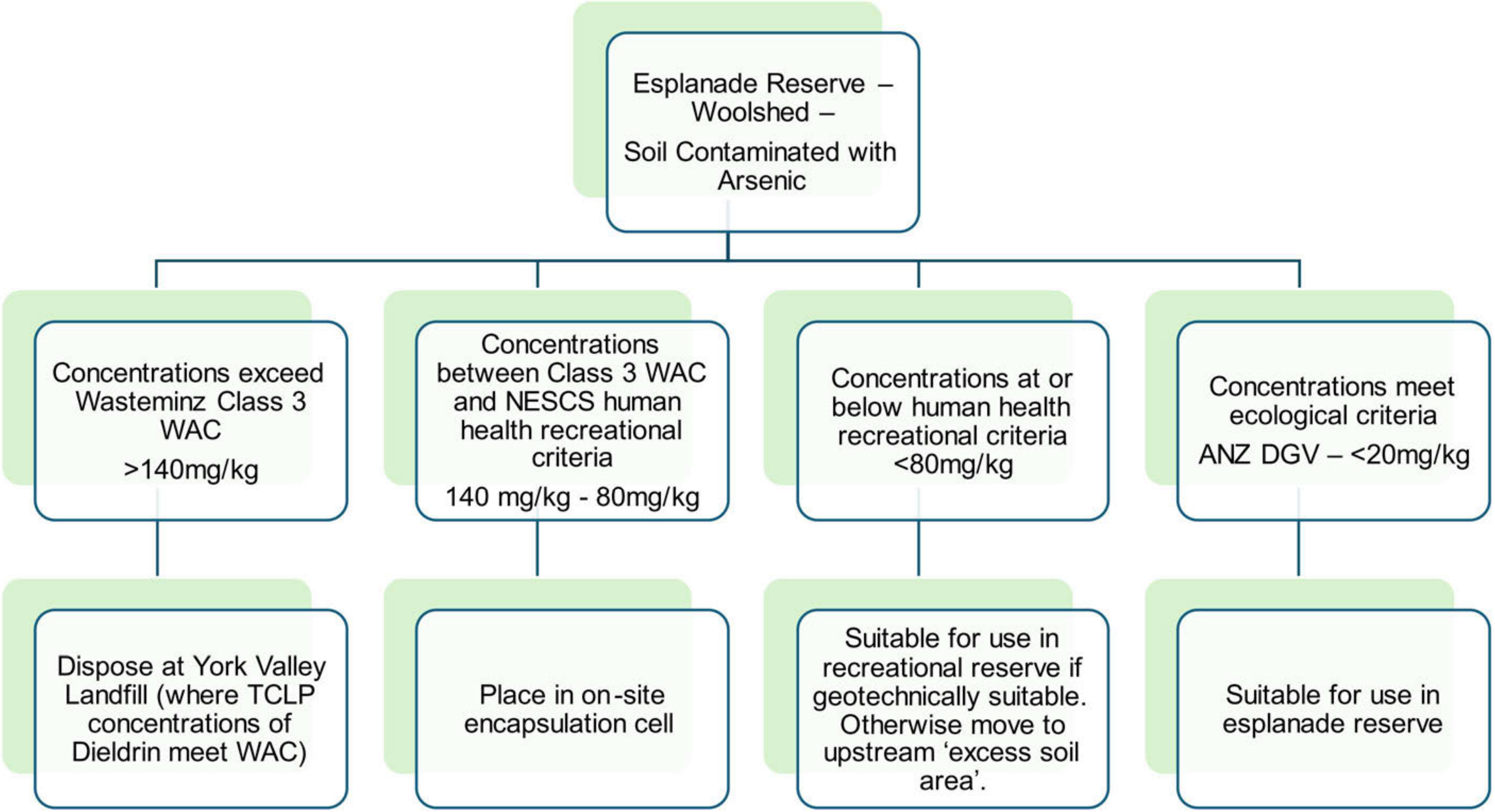
Appendix D
Remediation Options

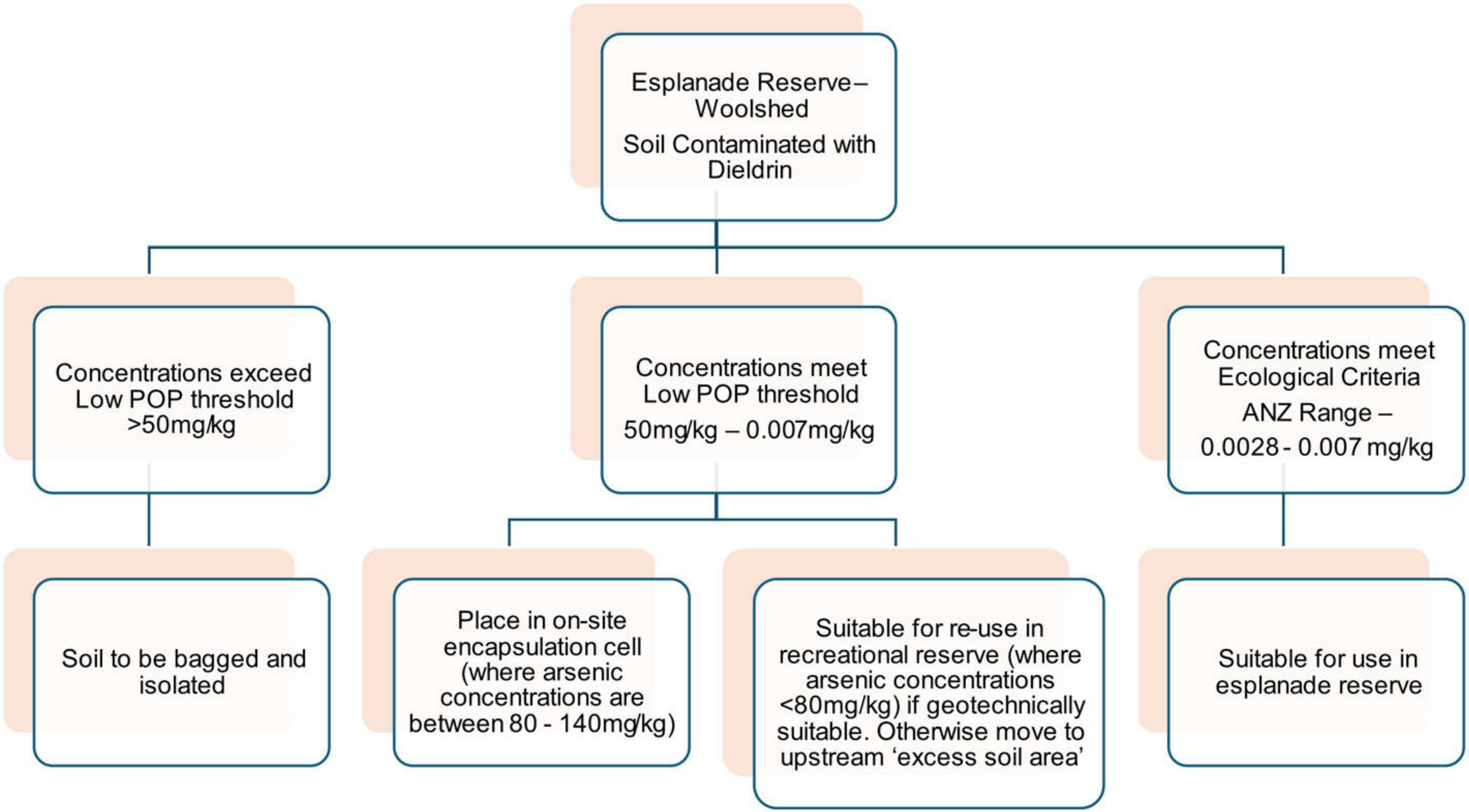
Table D.1 Remedial Options – Sheep Treatment Infrastructure

Remediation Option	Advantages	Disadvantages	Indicative Cost
1 Excavation and off-site disposal to an approved landfill	Source removal is a permanent solution, reducing the need for long term management/ potential groundwater monitoring and reducing the risk to human health and the environment on site. Some of the soil should be suitable for this method, however soil would need to meet landfill acceptance criteria and may require pre-treatment / blending. Some soil may not be suitable for this approach.	Substantial costs for disposal, transport, and reinstatement. Depth of excavation may require benching and lead to over-excavation. May require dewatering, with water treatment needed. Not considered to be a sustainable remediation technique. Controls on site and full-time supervision by SQEP.	$$$
2 In-situ management / encapsulation Retain soil in an encapsulation bund	Low physical works costs. Cheapest option. Most sustainable from a carbon emissions perspective.	Soil source remains on site. Ongoing site management plan would be required. Would need to be placed away from watercourses and groundwater table. May not adequately address potential risks from groundwater migration. Potentially unattractive to future tenants or purchasers. Future ground disturbance, change of use, or subdivision activities likely to require additional resource consents.	$

Remediation Option	Advantages	Disadvantages	Indicative Cost
		May require dewatering, with water treatment needed.	
Soil sorting Excavated soil passed through a plant which would sieve out larger particle size for separate recovery or disposal.	Soil source removal. Reduce volume of soil requiring disposal to an offsite facility further reducing the overall disposal and carbon costs. Larger factions likely to be suitable for reuse on-site, reducing the volume of imported soil required to reinstate excavations.	Contaminated soil would still require disposal or additional remediation. Soil needs to be excavated and taken to sorting plant (on or off-site) thus resulting in truck movements. Lead in time for set up and removal. Further assessment of soil type likely to be necessary to demonstrate the viability of this solution. Detailed discussion with regulator required. Possible additional consents required. Depth of excavation may require benching and lead to over-excavation. May require dewatering, with water treatment needed. Requires an experienced contractor.	$$

Appendix E
Remediation Procedure Summary Flow Diagrams


Esplanade Reserve – Woolshed –
Soil Contaminated with Arsenic
Concentrations exceed Wasteminz Class 3 WAC
>140mg/kg
Concentrations between Class 3 WAC and NESCS human health recreational criteria
140 mg/kg - 80mg/kg
Concentrations at or below human health recreational criteria <80mg/kg
Concentrations meet ecological criteria
ANZ DGV – <20mg/kg
Dispose at York Valley Landfill (where TCLP concentrations of Dieldrin meet WAC)
Place in on-site encapsulation cell
Suitable for use in recreational reserve if geotechnically suitable. Otherwise move to upstream 'excess soil area'.
Suitable for use in esplanade reserve


Esplanade Reserve – Woolshed
Soil Contaminated with Dieldrin
Concentrations exceed Low POP threshold >50mg/kg
Concentrations meet Low POP threshold
50mg/kg – 0.007mg/kg
Concentrations meet Ecological Criteria
ANZ Range –
0.0028 - 0.007 mg/kg
Soil to be bagged and isolated
Place in on-site encapsulation cell (where arsenic concentrations are between 80 - 140mg/kg)
Suitable for re-use in recreational reserve (where arsenic concentrations <80mg/kg) if geotechnically suitable. Otherwise move to upstream ‘excess soil area’
Suitable for use in esplanade reserve

Appendix F
Additional Investigation

It is recommended that the following scope of works is carried out following source removal and demolition of the woolsheds. This work should be undertaken by a SQEP in accordance with CLMG guidelines. This scope of works may be refined following the source removal works.

- Further investigate local background values, including in water.
- Collection of 5 x surface samples beyond the area of source removal for TCLP analysis (dieldrin) to confirm soil disposal options.
- Completion of 12 test pits to delineate the lateral and vertical extent of dieldrin impact.
- An additional round of groundwater monitoring within existing boreholes (BH01,BH02,BH03,BH04 and BH04a) using low flow techniques. Additional bores may also be added.

The proposed location of the test pits is shown on Figure C.1 below. Test pits should be advanced to the depth of groundwater, which is estimated to be at 1.5 m below ground level.

Samples should be collected at the following depth intervals (or where any observations of contamination or changes in ground conditions are made) 0-75mm, 200-300mm, 500-600mm, 1-1.1m, and at the groundwater table. Samples should be analysed through an IANZ accredited laboratory for dieldrin and arsenic. Initially only the shallowest two samples will be analysed, the remaining samples should be held cold in the laboratory. Ultra trace methods should be used for dieldrin analysis in the laboratory.

Figure F1. Indicative Location of Proposed Test Pits

Appendix G
SQEP Certification

The CEnvP Scheme Certification Board
hereby attests that

Martyn O'Cain

having fulfilled all the requirements of the Board
has been certified as a

Certified Environmental Practitioner
Site Contamination Specialist

with Registration Number

SC40027

on the date

12-May-2016

President EIANZ

30/06/2026

Certification Expiry Date

CEnvP - An Initiative of the Environment Institute of Australia and New Zealand.