Memo

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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.

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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.

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[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.

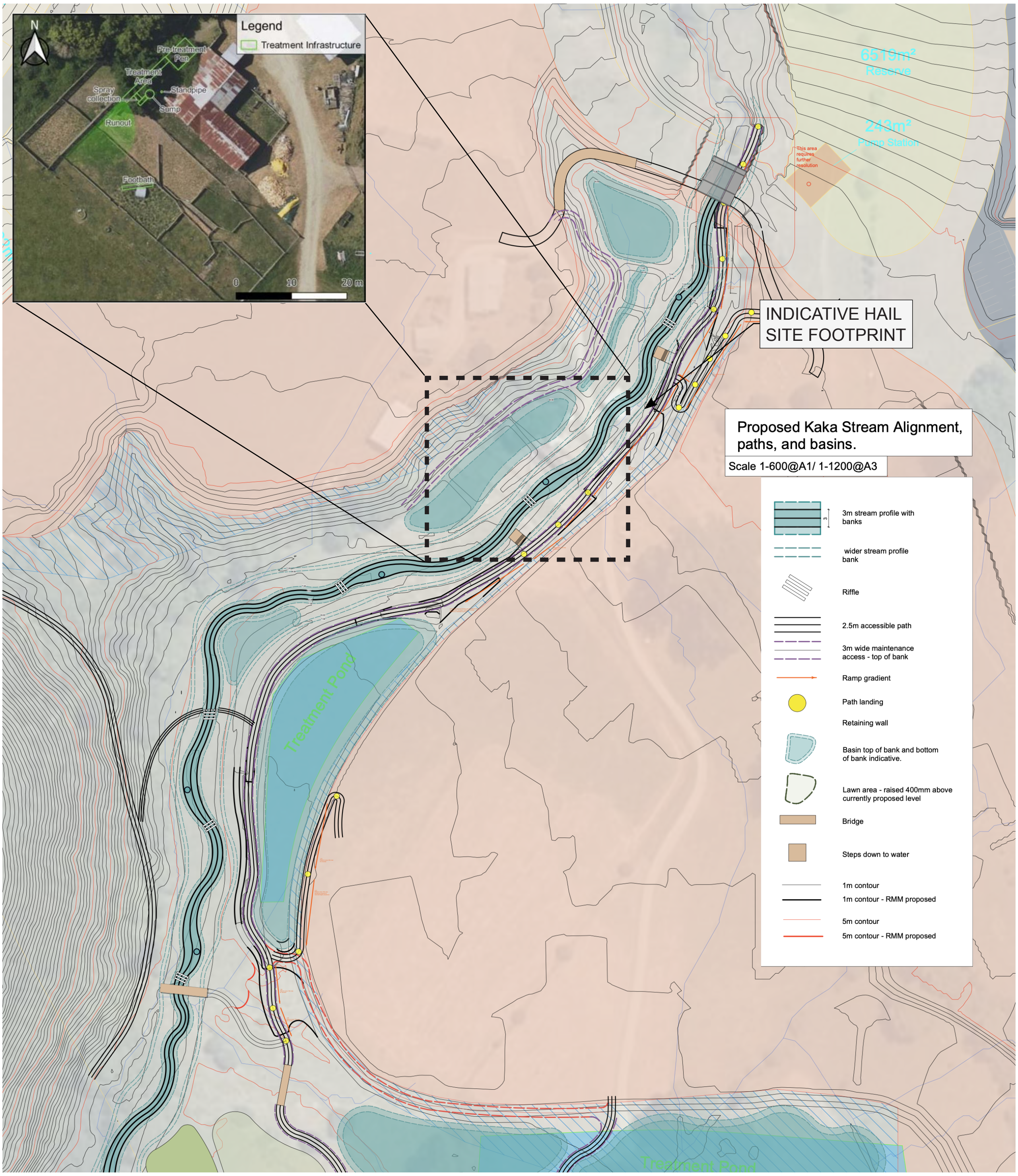

Figure 1. Indicative footprint of the contaminated (HAIL) site in relation to the proposed esplanade reserve and alignment of the lower Kākā Hill Tributary. The inset shows the Sheep Treatment Infrastructure, as shown in Figure 3 of the Envirolink DSI Report. Concept landscape drawings provided by RMM.

- **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

<u>Stream Flow Estimates</u>

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.

<u>Upstream Contaminant Concentrations</u>

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

<u>Extent of Contaminated Groundwater Front</u>

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.

<u>Reasonable Mixing Zone Requirements</u>

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*
    - *<u>the mixing zone does not utilise more than 25% of the flow</u>, 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 (027 823 8665) or email (ben.robertson@robertsonenviro.co.nz).

Robertson Environmental Limited

Report Prepared by:

Dr Ben Robertson

Principal Consultant Ecologist, Director

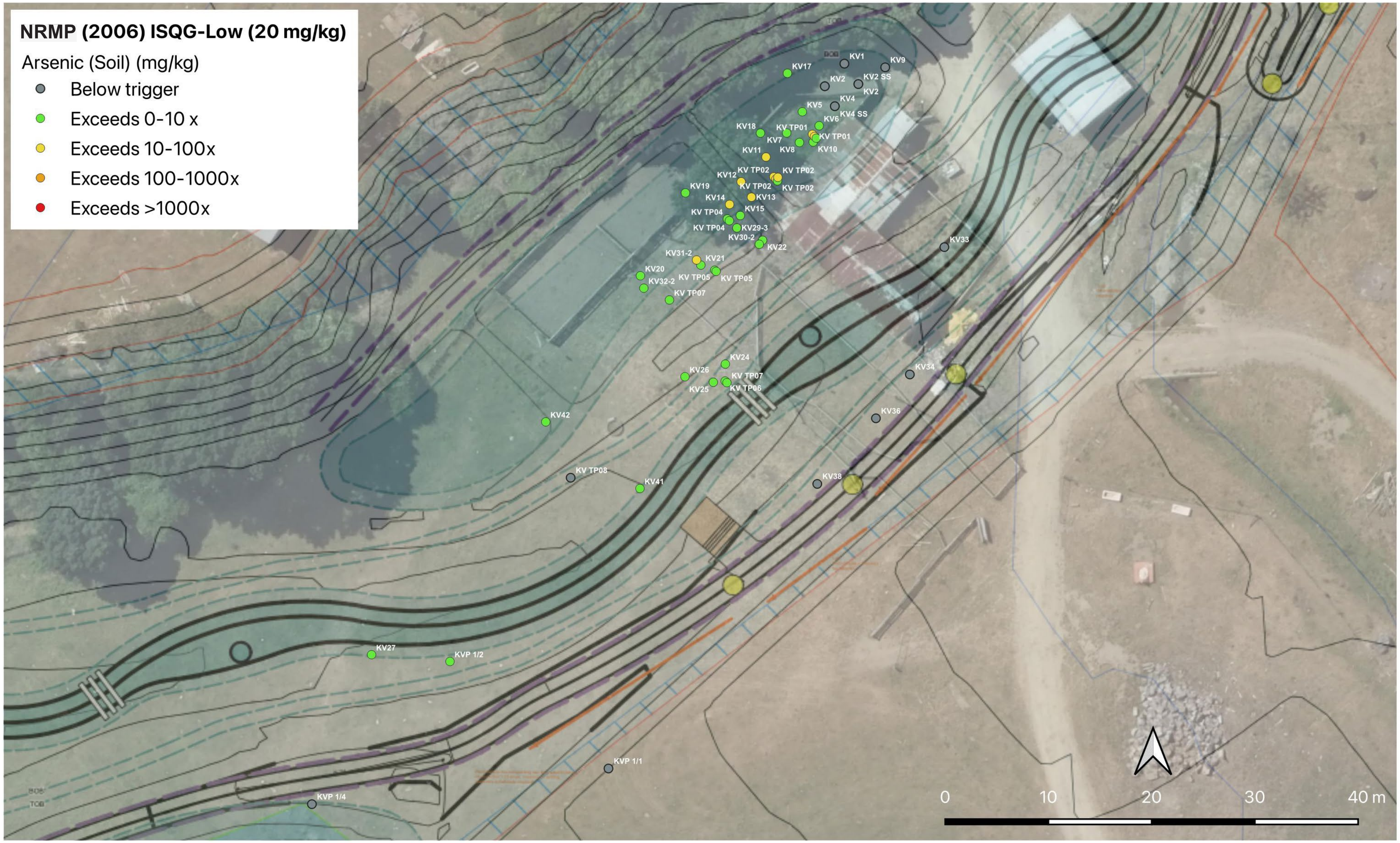

Figure 2A Arsenic concentrations in soils at sampling sites in vicinity of the former sheep dip area and proposed stream realignment and esplanade reserve. Refer to Figure 1 for an overlay of relevant features within the landscape plan.

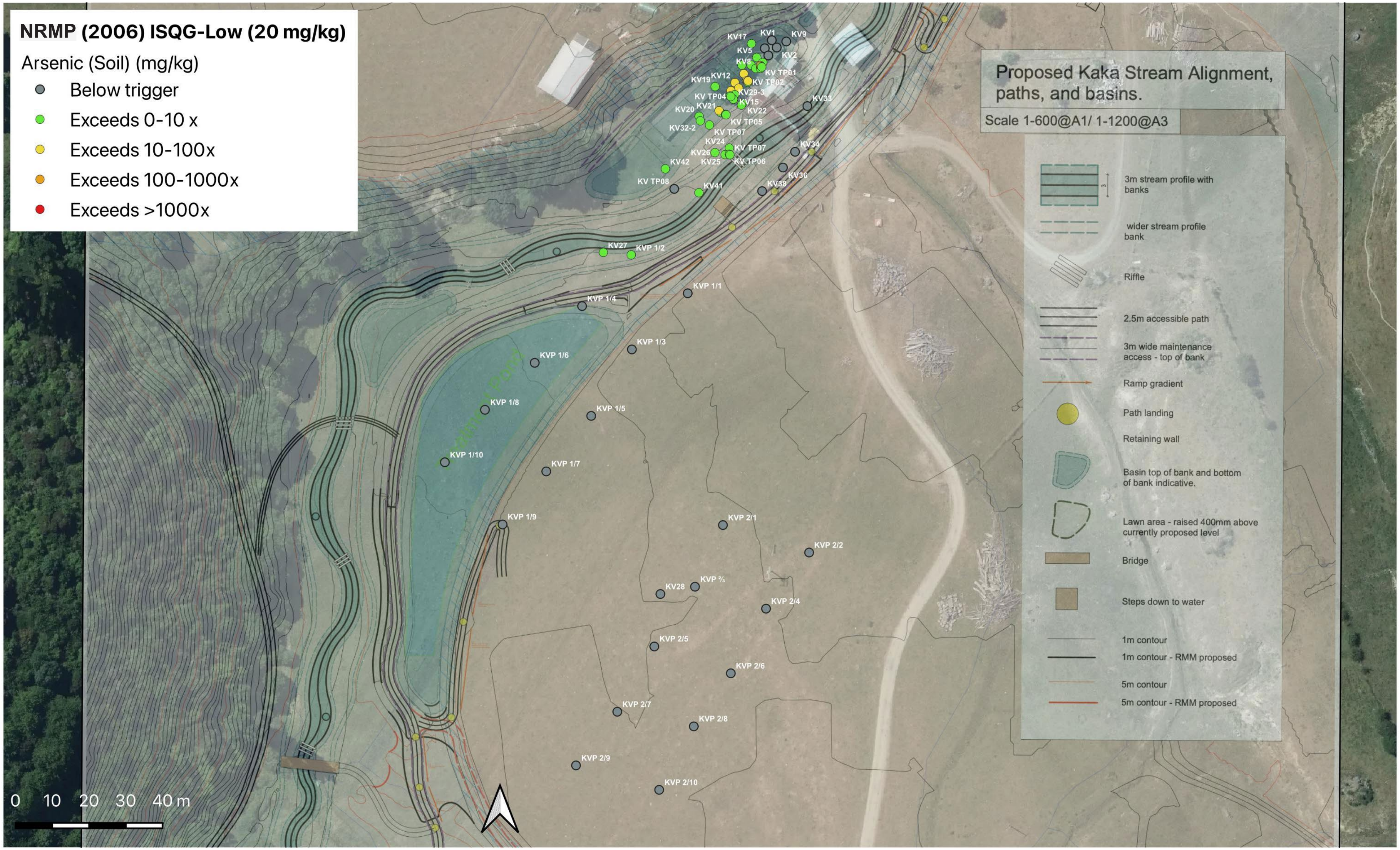

Figure 2B Overview of arsenic concentrations in soils at sampling sites in vicinity of the former sheep dip area and proposed stream realignment and esplanade reserve and the southeastern paddock. Refer to Figure 1 for an overlay of relevant features within the landscape plan.

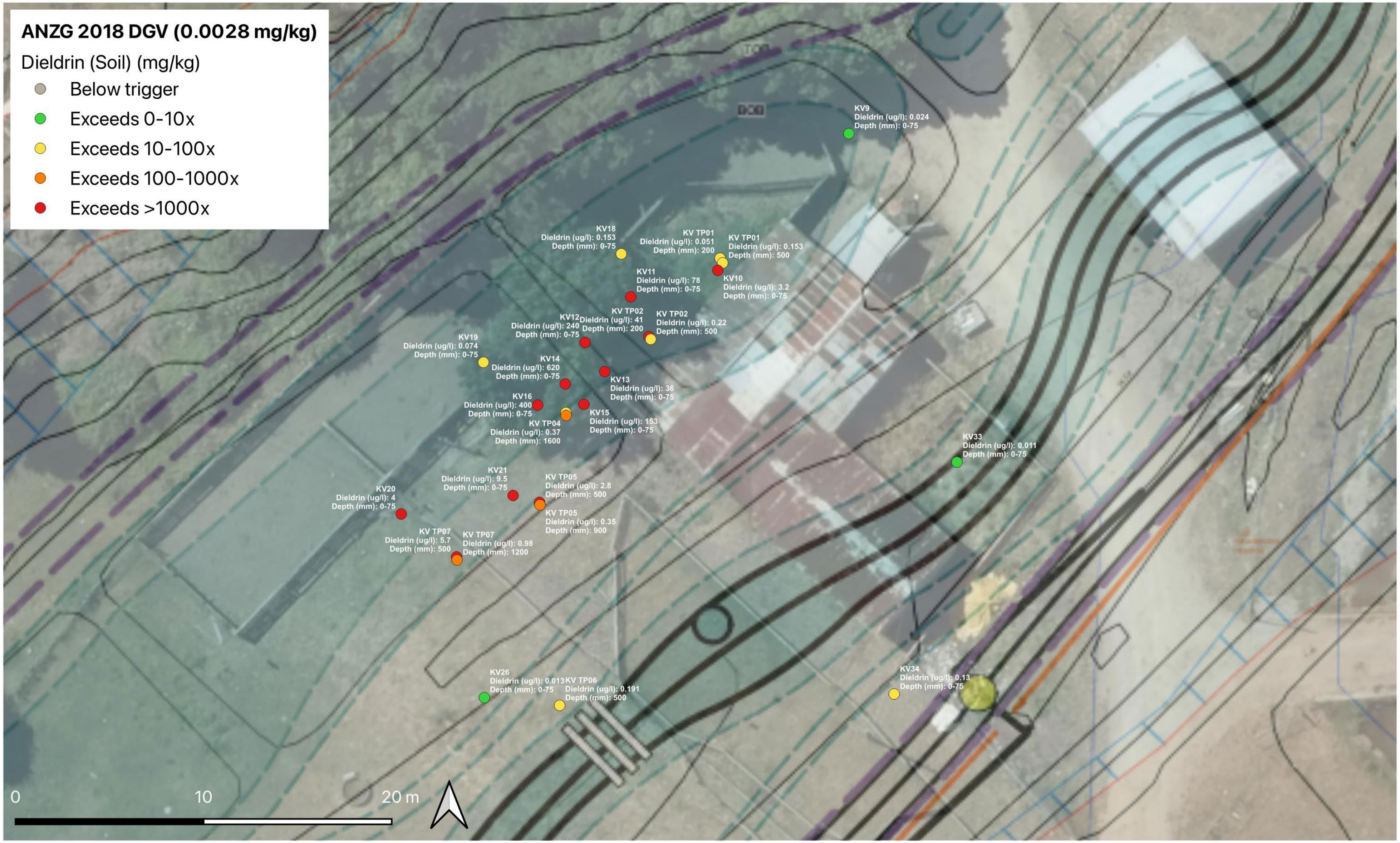

Figure 3 Deildrin concentrations in <u>soils</u> at sampling sites in vicinity of the former sheep dip area and proposed stream realignment and esplanade reserve. Refer to Figure 1 for an overlay of relevant features within the landscape plan.

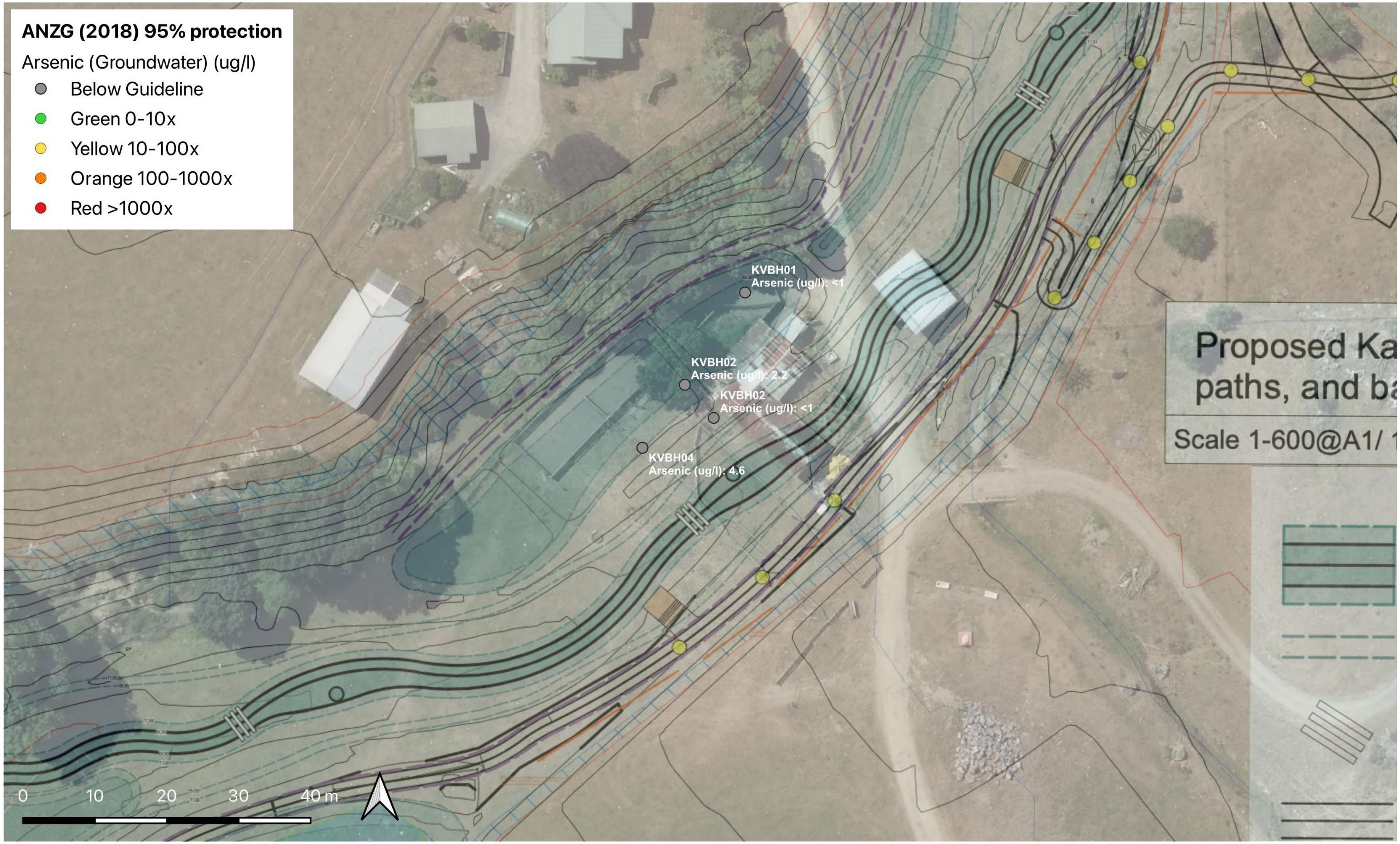

Figure 4 Arsenic concentrations in groundwater at sampling sites in vicinity of the former sheep dip area and proposed stream realignment and esplanade reserve. Refer to Figure 1 for an overlay of relevant features within the landscape plan.

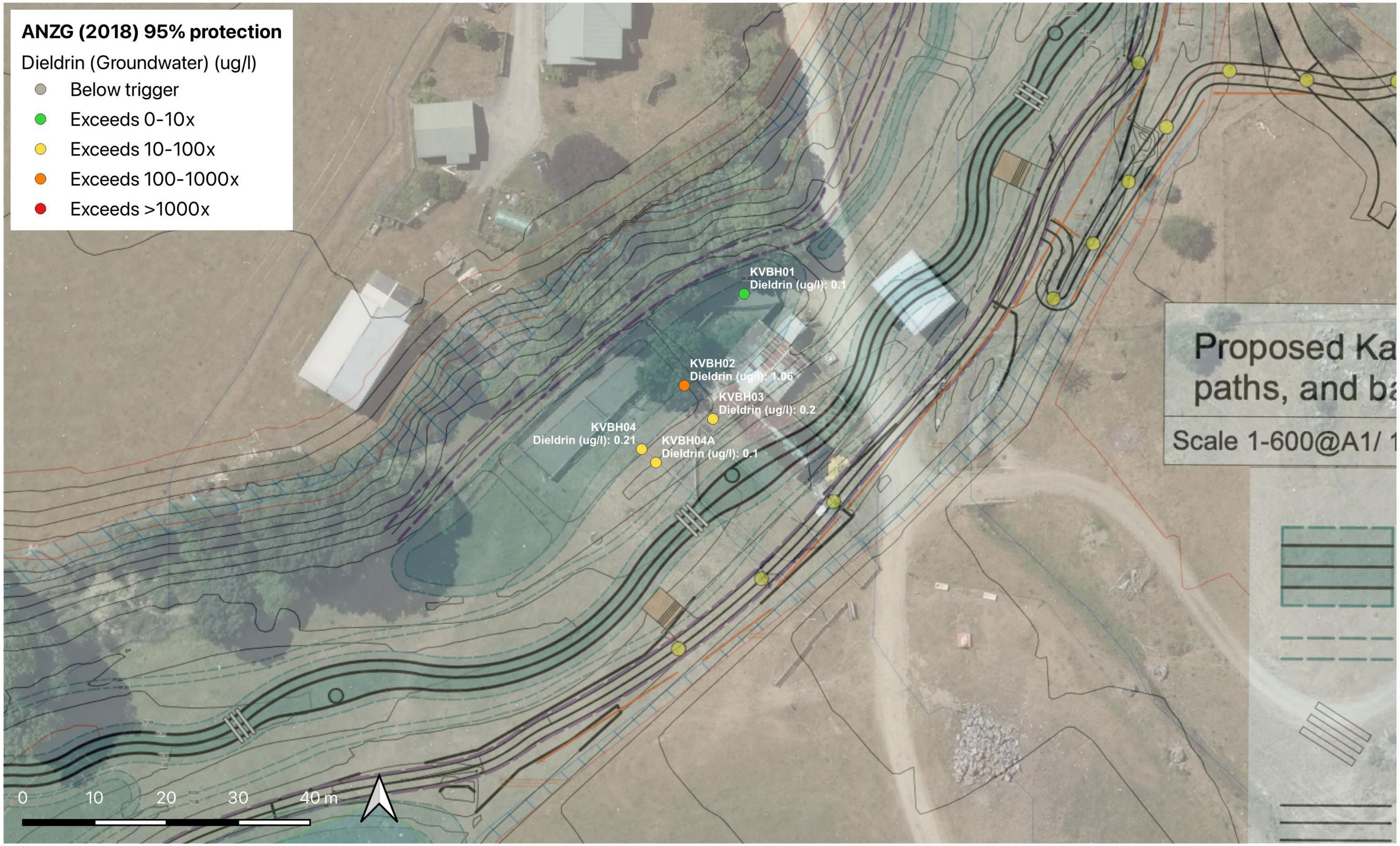

Figure 5 Deildrin concentrations in groundwater at sampling sites in vicinity of the former sheep dip area and proposed stream realignment and esplanade reserve. Refer to Figure 1 for an overlay of relevant features within the landscape plan.

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