IDENTIFY CLASSIFY RECTIFY

Site-specific risk assessment

Former Tokanui Psychiatric Hospital

Toitū te Whenua |
Land Information New Zealand

THE CONTAMINATED SITE CONSULTANCY

RECORD OF REVIEW

Roles	***Person responsible***	***Position***	***Relevant experience***	***Signature***
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SUMMARY

S.1. The issue

This report concerns the **former Tokanui Psychiatric Hospital** site at 149 Te Mawhai Road, Tokanui, Waipa District (the Pokuru 1B block: legal description Section 1 SO44852).

Pokuru 1B is currently managed by Toitū te Whenua | Land Information New Zealand (LINZ) on behalf of the Crown in the Treaty Settlements Landbank. Land held in the Landbank is Crown land that has been declared surplus and can be used as cultural or commercial redress in Tīriti o Waitangi Settlement claims. The former Tokanui Hospital is a deferred selection property in the Ngāti Maniapoto Deed of Settlement ('the Deed') and forms part of the Maniapoto Settlement Claims Act 2022, which gives effect to the Deed.

However, the land is presently in a damaged state. Many of the former Tokanui Hospital buildings remain, and these buildings are generally in very poor condition. There are also a range of site contamination issues. Accordingly, the Deed requires that before offering the land, **the Crown must demolish and remove buildings, structures, and agreed horizontal infrastructure, and remediate the land**, leaving it in a grassed state.

The Tokanui situation is unique as no other property included in a Treaty settlement has required demolition and remediation on this scale or required a commitment to undertake remediation in a Deed of Settlement. Under the Deed, Maniapoto and the Crown have agreed to a standalone process within the Property Redress Schedule, Part 9: Tokanui Hospital Deferred Selection Process, for the transfer of the Site; which details specific requirements for the demolition and remediation of the Site before it is available for transfer to Maniapoto. LINZ is the Government agency responsible for delivering this project. For detailed project background and context, please refer to the Project Background Document.

S.2. Site-specific risk assessment

Following the deferred selection process, LINZ commissioned HAIL Environmental Limited to carry out a site-specific (contamination) risk assessment – this report. This risk assessment attempts to establish remedial standards that define what the Crown must do to meet the requirements of the Deed.

The Deed requires two sets of remedial standards; one for rural residential use, and another for managed recreational use of some part of the site that LINZ may designate if it requires. In establishing both sets of standards, the overall objective has been to derive values that are as low as practicable, but no lower than necessary considering these specified future uses.

This assessment seeks to recognise Ngāti Maniapoto values, and those of the tangata whenua for Pokuru 1B in particular. Based on engagement with mana whenua to date, the remedial standards should be derived to pose minimal risk to food production, to people who live on the land, and to soil quality, in a rural residential context. In relevant parts of the block, the standards also seek to protect water quality and wetland values including the associated mahinga kai.

The resulting values are shown in Table S1 below.

Table S1 Site-specific remedial standards for Pokuru 1B

	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Zinc	DDT
Wetland	9	0.3	100	50	70	3	150	1
Rural residential	9	0.9	150	280	120	3	350	2
Managed	70	10	150	280	460	3	450	2

	ACM	AF/FA	Fuels and oils	Benzene	BaP_{eq}	Haz wastes
Wetland	0.01 %	0.001 %	No odour or staining	0.11	6	Absent
Rural residential	0.01 %	0.001 %	No liquid fuel or oil	0.11*	6	Absent
Managed	0.02 %	0.001 %	No liquid fuel or oil	0.11*	35	-

All concentrations milligrams per kilogram dry weight, except asbestos % weight for weight.
* Only within 100 m of surface water.

S.3. Implications

A key finding of this site-specific risk assessment is that the **Pokuru 1B land is not generally contaminated**. Indeed it is much less contaminated than was feared at the start of this settlement process.

On that basis, **the principal soil contamination issue at Pokuru 1B is asbestos and lead from building materials.** The following soils exceed the site-specific remedial criteria developed in this report:

- Topsoils close to several **buildings with external deteriorated asbestos** (buildings B29, B30, B58, B63, B74). Soil around these buildings generally had low to moderate levels of asbestos fines and/or fibrous asbestos.
- Topsoils close to most **buildings with high-lead exterior paint** (buildings B2, B5, B7, B8, B11, B13, B15, B17, B18, B21, B23, B24, B27, B29, B33, B35, B37, B38, B52, B58, B59, B73, and parts of B12, B19, B55, B74). Soil around these buildings generally had low to moderate lead levels.

These soils will require some remediation to meet proposed standards.

There are suspected additional filling areas in the southeast of the site, west of the Wharekōrino Stream. Fill materials encountered in these areas include construction debris, burnt timber, bitumen, plastic, clay pipe in a silt or sand matrix. Samples from these areas have identified elevated arsenic, copper, lead, zinc and asbestos. These areas require remediation, or management as part of the existing disposal areas.

Further, investigations have identified apparent **hotspots** of contamination:

- Within the greenhouse and shed footprints in the agricultural area in the north of the land, between buildings B34 and B35, where heavy metal concentrations are elevated.
- Where waste has been buried around substation S3, building B26 and possibly B12.

Limited remediation or management is also required in these areas.

1. INTRODUCTION

1.1. The issue

The land at issue

This report concerns the former Tokanui Psychiatric Hospital site at 149 Te Mawhai Road, Tokanui, Waipa District (the Pokuru 1B block: legal description Section 1 SO44852). Figure 1 shows the location of this land.

Returning the land to Maniapoto

Pokuru 1B is currently managed by Toitū te Whenua | Land Information New Zealand (LINZ) on behalf of the Crown in the Treaty Settlements Landbank. Land held in the Landbank is Crown land that has been declared surplus and can be used as cultural or commercial redress in Tīriti o Waitangi Settlement claims. The former Tokanui Hospital is a deferred selection property in the Ngāti Maniapoto Deed of Settlement ('the Deed') and forms part of the Maniapoto Settlement Claims Act 2022, which gives effect to the Deed.

However, the land is presently in a damaged state. Many of the former Tokanui Hospital buildings remain, and these buildings are generally in very poor condition. There are also a range of site contamination issues [Refs: AECOM1, GHD, Fraser Thomas]:

- Most buildings featured asbestos-containing cladding materials or lead-based paints. As a consequence, asbestos and lead have been found in soil close to those buildings.
- Some hospital activities used hazardous substances. Some of these hazardous substances gave rise to soil contamination. For example, in 2018, three underground fuel storage tanks were dug up and removed, along with around fifty tonnes of fuel-impacted soil and fill [Refs: AECOM3,4].
- The hospital also farmed some of its land. Farming in Aotearoa often uses pesticides, and historic pesticides can be quite persistent in soil. Also, in Aotearoa, superphosphate fertiliser contains heavy metals, such as cadmium, that can build up to harmful levels if a lot of fertiliser is applied for a long time.
- The hospital placed its waste in a series of landfills on the eastern side of the Wharekōrino Stream ('the existing disposal sites').

Accordingly, the Deed requires that before offering the land, the Crown must demolish and remove buildings, structures, and agreed horizontal infrastructure, and remediate the land, leaving it in a grassed state.

The Tokanui situation is unique as no other property included in a Treaty settlement has required demolition and remediation on this scale or required a commitment to undertake remediation in a Deed of Settlement. Under the Deed, Maniapoto and the Crown have agreed to a standalone process within the Property Redress Schedule, Part 9: Tokanui Hospital Deferred Selection Process, for the transfer of the Site which details specific requirements for the demolition and remediation of the Site before it is available for transfer to Maniapoto. LINZ is the Government agency responsible for delivering this project. For detailed project background and context, please refer to the Project Background Document [Ref: LINZ].

LINZ will obtain the necessary resource consents for the demolition and remediation activities. All future redevelopment falls to the future landowners, and any associated consenting is not part of the Crown responsibility.

1.2. Contamination risk assessment

Following the THDSP, LINZ commissioned HAIL Environmental Limited to carry out a site-specific (contamination) risk assessment – this report – as part of a series of investigations following the sequence set out in the Ministry for the Environment's *Reporting on contaminated sites in New Zealand* [Ref: CLMG1]:

Figure 2. This report within the site contamination reporting process

This risk assessment attempts to establish **remedial standards** that define what the Crown must do to meet the requirements of the Deed. These remedial standards may be **narrative** descriptions of the process to be followed or the state to be achieved; or they may be **numeric** thresholds indicating a concentration or mass of contaminant that can remain.

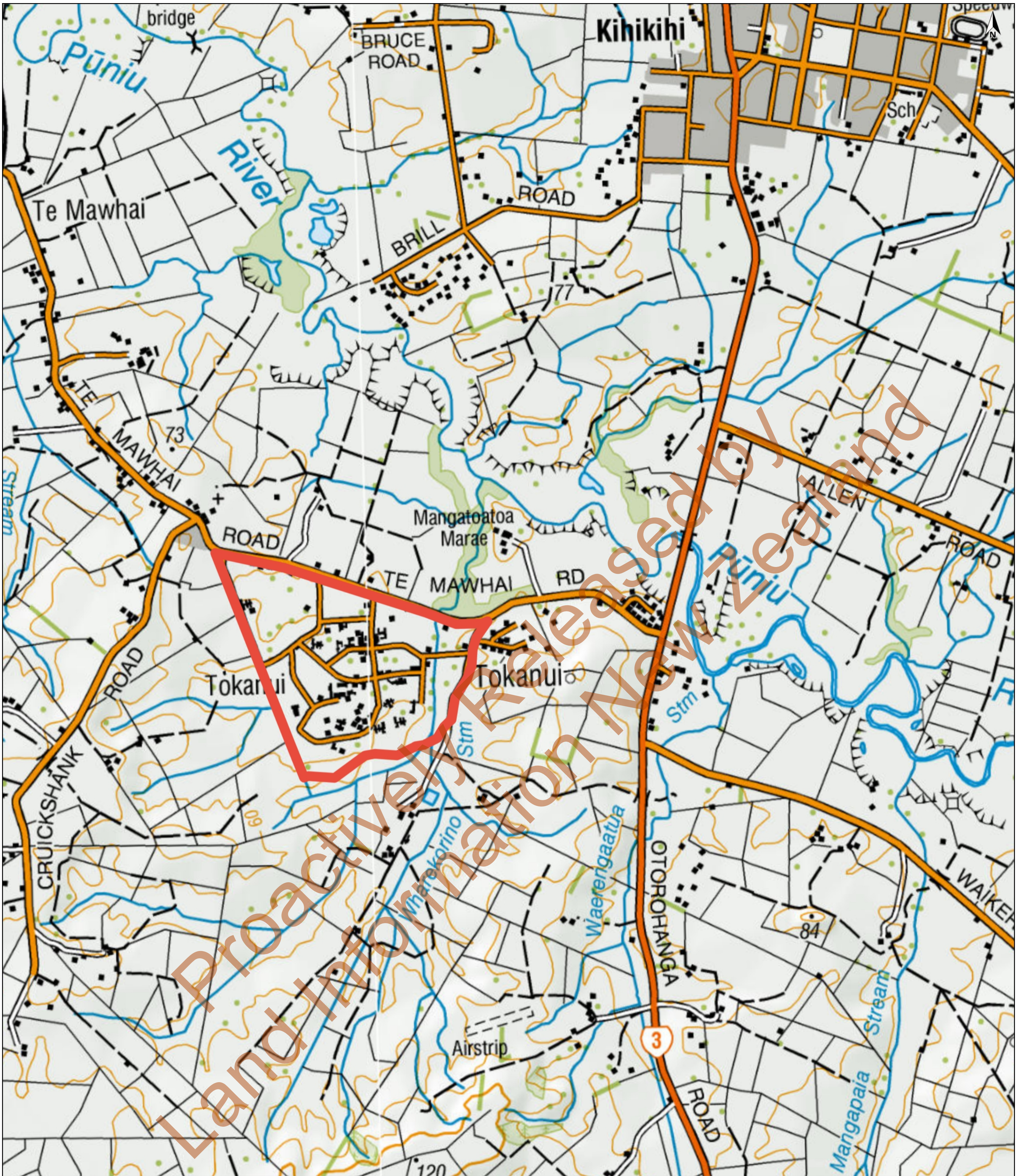
This risk assessment generally follows the Ministry for the Environment's *Reporting on contaminated sites in New Zealand* and *Hierarchy and application in New Zealand of environmental guideline values* [Refs: CLMG1, CLMG2].

It has been certified by the authors, see 'Record of review' above.

1.3. The authors

HAIL Environmental was founded by Brendon Love in 2014 to provide contaminated site specialist services to the Bay of Plenty. In 2016 Brendon was joined by the core of the current company, extending coverage across the North Island, and later down into Canterbury. Our organizational values are environmental responsibility, business agility and technical excellence. Our points of difference include a majority of certified staff, an office-free regional business model, and a commitment to sustainable remediation.

HAIL Environmental director Dr Dave Bull has prepared this report in his capacity as a 'suitably qualified and experienced practitioner' accredited as a Site Contamination Specialist under the Certified Environmental Practitioner scheme (see cenvp.org). It has been reviewed by a second director Sarah Newall, also a site contamination specialist. Neither of these authors is affiliated to Maniapoto.



Legend

Site Boundary

0 250 m 500 m

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HAIL Environmental

Produced by **Datanest.earth**

Title: Location of Pokuru 1B		
Client: LINZ		Size: A4
Project: Tokanui Hospital	Drawn: AC	Figure No.: 1
Date: 25-04-2024	Checked: DB	
Proj No: 1090A	Scale: 1:25000	Version: Final

2. GUIDING PRINCIPLES

2.1. Mana whenua concerns

> *He aha te mea nui? He whenua, he whenua, he whenua!*
>
> *What is the most important thing in the world? It is the land!*
>
> *[Ngāti Paretekawa, February 2023 hui]*

Mana whenua for this land is held by the hapū of Ngāti Ngutu, Ngāti Huiao, Ngāti Paia and Ngāti Paretekawa. The cultural impact assessment for this site [Ref: Te Muraahi and Maniapoto] states that:

> *Mokoroa was the only name used from ancient times when referring to what is now known as Tokanui Hospital campus. There are not many who remember this name and its meaning other than some of the descendants of the original owners. This has been a tino mamae rawa to Ngāti Paia. When a placename is replaced, over time its history, importance, essence, memory is lost. In this case, to be replaced by Tokanui Hospital, 'the place of the mad people, waahi porangi' where once it was 'waahi wairua.'*
>
> *Mokoroa was one of two swamps that were drained and filled to build the hospital; the name of the other swamp was Tarutuhi. Both of these swamps were located on the land where the hospital was built. The swamps were drained and filled to build the hospital.*
>
> *Mokoroa is also another name for taniwha. A kaitiaki in this case. It was and still is a very significant and special place for Ngāti Paia, a place of healing, learning, reflection, maara kai. Kai from the swamps (tuna) and surrounding plants, shrubs and trees, rongoā…*
>
> *"I still caught eels below the nurse's home at the hospital when the digger would come to clean the drains. They were plentiful and sweet and clean. I felt happy that I was catching tuna where my tupuna once had, but only a few tuna would be taken as the tikanga was to preserve kai uri-tuna, watercress was plentiful as well. My hope for the future is that Mokoroa is revived."*

Contamination may continue to harm the environment rendering the whenua unable to sustain cultural life. The mauri of the whenua and the wai will not be restored unless the hazardous materials and waste are removed from the whenua. These are issues of great concern to the tangata whenua. [Ref: Te Muraahi and Maniapoto]

2.2. What the Deed of Settlement requires

At subpart B *Demolition and remediation standards and works*, the Property Redress Schedule of the Deed states:

> 9.3. Subject to the terms of this part (including, without limitation, paragraphs 9.7 and 9.13), the Crown will use best endeavours to remediate:
>
> 9.3.1 85 % of the total land area of the Tokanui Hospital deferred selection properties to the **rural residential remediation standard**; and
>
> 9.3.2 A contiguous area not exceeding 15% of the total land area of the Tokanui Hospital deferred selection properties, to the **managed remediation standard**.

These terms are defined as:

9.1.14 **managed remediation standard** means an applicable standard or standards for recreational use chosen in accordance with CLMG2, or derived through a site-specific risk assessment, but where use may be subject to controls (for example, in relation to excavating, erecting buildings or domestic gardening); and

9.1.20 **rural residential remediation standard** means an applicable standard or standards for rural residential use chosen in accordance with CLMG2 [the Ministry for the Environment's Contaminated Land Management Guideline No.2: *Hierarchy and application in New Zealand of environmental guideline values,* Ref: CLMG2], or derived through a site-specific risk assessment.

The existing disposal sites east of the Wharekōrino Stream will remain under Crown management and are not included in the remediation requirements of the Deed.

2.3. What the Maniapoto Environmental Management Plan requires

Kaitiakitanga

A fundamental principle of the Maniapoto Environmental Management Plan (MEMP) is that the people of Maniapoto will determine for themselves if the overall effect of an activity is positive or negative, and what might be a suitable way to avoid, remedy, minimise, mitigate or balance the effects of a resource use or activity. The MEMP has been created to help others understand Maniapoto values and interests, and to help them engage and consult with Maniapoto, but following the MEMP is no substitute for engagement and consultation.

Water

The Wharekōrino Stream runs southwest to north through Pokuru 1B, joining the Pūniu River close by to the north.

> *Fresh water has a deep spiritual significance to Maniapoto. Water is the wellspring of life. Historically, the waters were such that they provided all manner of sustenance to Maniapoto, including physical and spiritual nourishment that has, over generations, maintained the functions of marae and the health and wellbeing of whānau, hapū and iwi. The health and wellbeing of the people of Maniapoto is closely linked to the health and wellbeing of freshwater resources.*
>
> *The degradation of waterways, declining water quality and the loss of fisheries and mahinga kai is a significant source of distress for Maniapoto. The restoration and protection of the mauri of all waterways is paramount to Maniapoto to ensure the quality and integrity of waterways continues to sustain the health and wellbeing of Maniapoto and the environment.* [Ref: MEMP, Part 14]

Accordingly, the MEMP has objectives and actions relating to the mauri of water, including:

14.3.2 To restore and enhance the mauri of Ngā Wai o Maniapoto and protect Te Mana o te Wai…

14.3.2.1(e) Protect mahinga kai and taonga species from damage and pollution…

14.3.2.3(a) Ensure resource users protect and restore waterways in proportion to the activity to be undertaken, any historical adverse effects and the state of degradation of the environment.

From this, it is clear that risks from residual contamination to water quality must be taken into account.

Wetlands

Before Tokanui Hospital was constructed, much of Pokuru 1B was wetland.

> *For Maniapoto, wetlands and swamps are highly valued as traditional sources of fisheries and materials. They are part of the ancestral landscape and culturally important for sources of mahinga kai, including native fish, birds, indigenous flora and fauna and taonga species (e.g. harakeke, ducks, eels, inanga). Wetlands also provide materials and resources for rongoā, raranga and whakairo and were important places to store and preserve taonga.* [Ref: MEMP, Part 15]

Accordingly, the MEMP has objectives and actions relating to the mauri of wetlands, including:

15.3.2 To enhance and protect natural wetlands to produce an overall net gain in wetland area in the rohe as wetlands are restored…

15.3.2.1(c) Protect, restore and enhance existing wetlands.

From this it is clear that risks from residual contamination to future wetland health must be taken into account, at least in former wetland areas of the site.

Land

> *The relationship the people of Maniapoto have with land and the environment is inextricably linked to a sense of kinship with all things through whakapapa, history and cosmology. Land underpins physical and spiritual contemporary identity and wellbeing of the people of Maniapoto. Central to the protection, use and management of land and the environment is the recognition of the role of Maniapoto to exercise of rangatiratanga and kaitiakitanga – a responsibility and obligation inherited by Maniapoto from their tūpuna to take care of the land and environment within Maniapoto rohe.*
>
> *The loss of Maniapoto lands due to historical land wars, land sales, Crown policies and legislation, Public Works Act, Native Land Court and district planning schemes is a source of significant distress for Maniapoto and impacted on the health and wellbeing of the people of Maniapoto and the relationship between Maniapoto and land and natural resources.*
>
> *Today, only the remnants of the Maniapoto estate remain in Maniapoto ownership and/or management. This is approximately 80,000 ha or ten per cent of the estimated total land (800,000 ha) within Maniapoto rohe.*
>
> *Undeveloped and underutilised Māori lands, potential Treaty settlement lands, reserves and ancestral lands in the conservation estate are therefore highly valued by Maniapoto to increase the health and wellbeing of Maniapoto and to protect and enhance the mauri of land and natural resources for future generations.* [Ref: MEMP, Part 18]

Accordingly, the MEMP has objectives and actions relating to land, including:

> 18.3.1 Land management and land use enhance and protect the holistic functioning and interconnected relationships of the natural environment and are compatible with Maniapoto values and principles…
>
> > 18.3.1.1(a) Adopt best practice sustainable land management practices to improve soil nutrient balance and prevent erosion…
> >
> > 18.3.1.2(c) Ensure cleanup of contaminated sites and, where possible, those held responsible for the contamination of sites are held accountable…

From this it appears that land should be remediated so that residual contamination poses a minimal risk to future use, whether for food production or for living on; and soil quality should be optimised for its own sake. Furthermore, the emphasis on sustainable land management and on erosion suggests that topsoils should be kept in use if possible, and not discarded unless there is a need to do so.

2.4. The concept of 'risk'

In site contamination practice, we think of contamination using the metaphor of a chain. We only look to remediate where there is a source of contaminants, where there is a person or a waterbody or a structure or an ecology that could be harmed by those contaminants, and some way that the contaminants could reach these receptors and be taken up by them.

For example, arsenic and dieldrin might be spilt on the ground around a sheep dip. Many years later, after the farm is subdivided for residential use, a child might play on the impacted soil, touching and eating the dirt, or eating vegetables grown in the soil, or even stock that had been grazing in the area. Equally, the pesticides might leach down through soil to groundwater, making their way into the family's drinking water (Figure 3). In this example, both the groundwater and the child could be considered receptors at risk of harm.

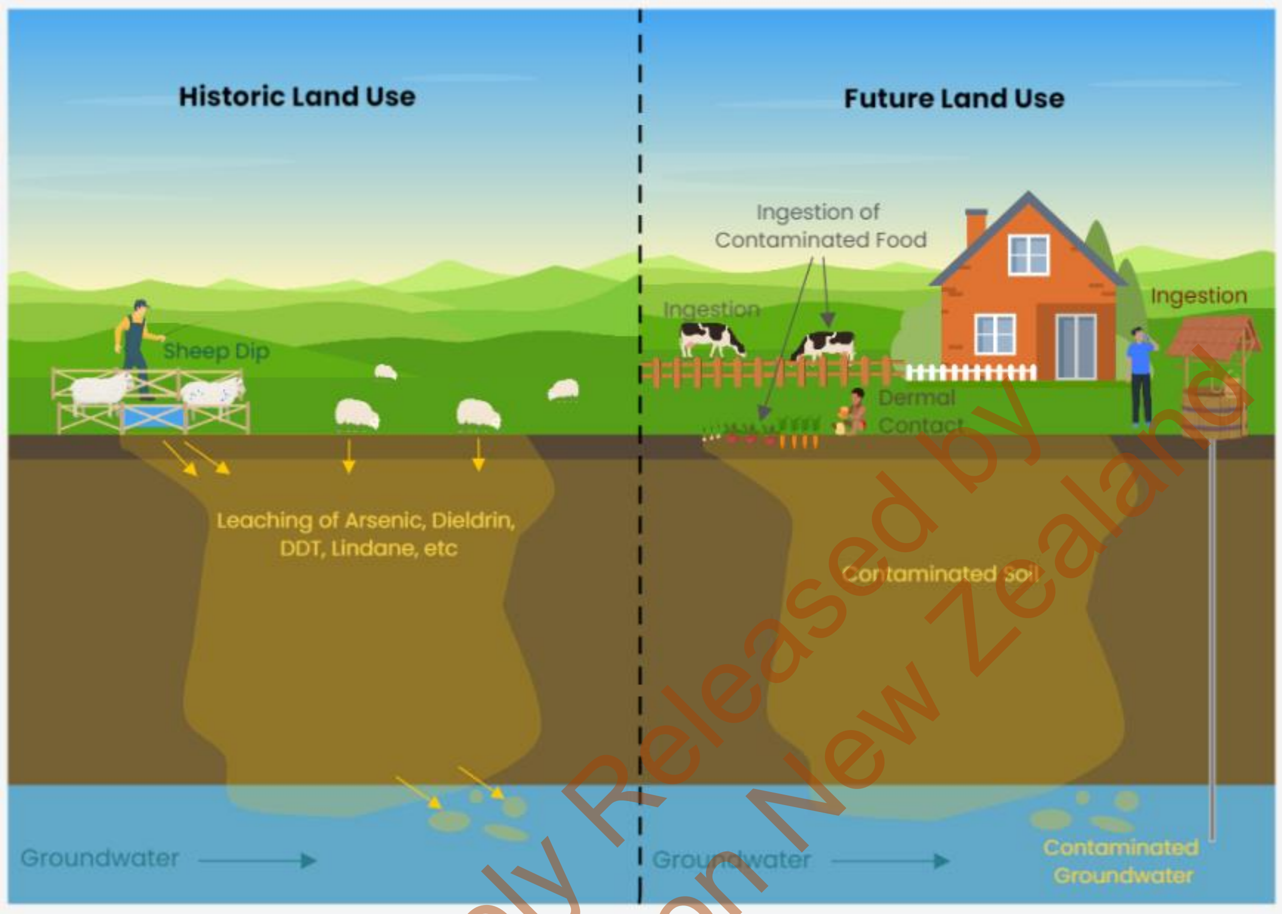

Figure 3 Examples of source-pathway-receptor linkages

If any of these elements – the source, the pathway, *or* the receptor – is not present, the chain is broken and there is no risk of harm.

Even then, remediation is only undertaken if there is enough contamination that there is a chance the receptor could be seriously harmed – if there is at least a minimal risk.

In practice, regulators set threshold concentrations at which they deem the risk is more than minimal. This is scientifically questionable: a threshold implies a 'black-and-white' situation where any concentration below the threshold is fine, while any concentration above it requires action. In reality, the risks just below and just above the threshold are indistinguishable. Moreover, every site is different, every receptor experiences their site differently, every receptor has a slightly different tolerance to harm, and all of these considerations vary over time. However, thresholds are easy to impose, and they do at least indicate the approximate concentrations that might lead to adverse effects. Thresholds are usually expressed in milligrams of contaminant per kilogram of soil – that is, parts per million by weight.

The Ministry for the Environment has set out what levels of contamination it generally considers a minimal health risk for New Zealanders in a document, *Toxicological intake values for priority contaminants in soil.* These levels are generally set contaminant by contaminant, but there is a particular policy position for cancer-causing contaminants: the acceptable level is a lifetime additional cancer risk of 1 case per 100,000 people, if they were all exposed to that contaminant at that concentration for that length of time [Ref: MfE3]. There is no particular scientific or legal reason for this 1-in-100,000 position, but it is common to a number of Western jurisdictions.

So far as minimal risks to the environment are concerned, the Ministry for the Environment has no overarching policy position. Different organisms may respond very differently to a particular contaminant, so that what kills one species may have no effect on another. Accordingly, scientists developing guidelines for soil and water quality often try to express them in terms of what proportion of naturally occurring species they protect – 80, 90, 95 or 99 %. This approach does not consider *which* species would not be protected, it implicitly assumes all species have equal value, which is at least arguable.

For Maniapoto's part, it has reserved the right to decide what its people consider 'minimal risk' [Ref: MEMP]. There may well be circumstances where Maniapoto would not consider even the concept of 'risk' to be appropriate; where the mana of the whenua or the wai requires contamination to be removed if practicable, regardless of whether its presence is likely to cause harm.

2.5. Sustainable remediation

There is no official guidance in Aotearoa covering remediation practices. However, there is a relevant international standard ISO 18504:2017 *Soil quality – sustainable remediation*, which LINZ seeks to use in this project. This standard recognises that remediation has economic, social and environmental dimensions that need to be balanced. This sustainability principle needs to be taken into account in risk assessment, because risk assessment generates the remedial standards that determine how much remediation is done.

In keeping with the Treaty Settlement context, LINZ asked that cultural considerations be assessed as a dimension in their own right, rather than trying to account for them within ISO 18504's social or environmental dimensions.

Economic factors

According to ISO 18504, economic factors that should be taken into account include:

- Direct cost of remediation projects (from preparation through operation to decommissioning)
- Creating jobs
- Creating or removing land use restrictions
- Increasing land value
- Indirect costs such as borrowing, deferring reuse, temporary business interruption, temporary relocation
- Demonstration value of successfully executing a novel remediation
- Risk of damaging existing buildings and infrastructure

- Avoiding regulatory penalties such as fines
- Losing reputation or brand value

Several of these factors have little relevance to the former Tokanui Hospital, where there is already an agreement to carry out at least a minimum of remediation regardless of the cost. Still, as a general principle, evidently remedial standards should be no lower (no more stringent) than necessary, otherwise the remediation would incur unnecessary costs.

Social factors

Further according to ISO 18504, social factors that should be taken into account include:

- Community safety during remediation projects
- Nuisances such as odour, noise, dust, traffic
- Ground compaction and settlement
- Loss of amenity
- Aesthetic impact
- Community health and well-being after remediation
- Community social equity, vision and quality of life expectations

From the MEMP it is clear that future community health, well-being and vision should be particularly powerful influences on this risk assessment. As a general principle, then, remedial standards should be as low (as stringent) as practicable, to deliver the most benefit to the community.

Environmental factors

Environmental factors that should be taken into account under ISO 18504 include:

- Energy use and climate change implications
- Water resource use and water resource quality
- Ecosystem services and land use
- Raw material / resource use and pollution prevention.

This perspective supports both principles arising out of the previous considerations. Remedial standards should be set as low as practicable, so as to leave the environment in the best possible state. At the same time, remedial standards should be no lower than necessary, or remedial works may result in unnecessary fuel consumption and greenhouse gas emissions, unnecessary use of limited resources such as clean fill, water or engineered landfill space, etc.

Cultural factors

ISO 18504 does not specifically take cultural factors into account. Thus, it risks ignoring tangata whenua concepts such as mauri and the requirements of tikanga Māori (customary law). Assessments done too narrowly under ISO 18504 may not place sufficient weight on protecting wāhi tapu and wāhi tupuna [see Heritage New Zealand Pouhere Taonga Act 2014].

These concepts can be 'shoehorned' into the ISO 18504 framework via factors such as land value, community wellbeing, community vision or water resource quality, but in LINZ's view are better considered separately, along the lines set out in section 2.3.

2.6. Summary of guiding principles

The Deed requires two sets of remedial standards; one for rural residential use, and another for managed recreational use of some part of the site as LINZ may designate. In establishing both sets of standards, the overall objective has been to derive values that are as low as practicable, but no lower than necessary considering these specified future uses.

This assessment seeks to recognise Ngāti Maniapoto values, and those of the tangata whenua for Pokuru 1B in particular. Based on engagement with mana whenua to date, the remedial standards should be derived to pose minimal risk to food production, to people who live on the land, and to soil quality, in a rural residential context. In relevant parts of the block, the standards also seek to protect water quality and wetland values including the associated mahinga kai.

As a further consideration, if soil does not meet the remedial standards, then it may need to be removed from site. In that case it is important to determine what kind of landfill could accept it – or, in the worst case, determining if it is so highly contaminated that no landfill would accept it without treatment.

3. REMEDIAL STANDARDS

3.1. Background concentrations

Although we talk of them as contaminants, all heavy metals occur naturally in soils. In some soils, especially in geothermal or mining areas, concentrations of these metals can be as high as at any contaminated site. Some manmade contaminants such as the pesticide DDT were used so widely that they can be found in almost any topsoil in Aotearoa.

For contamination risk assessment purposes, it is important to understand background concentrations in the soil – that is, how much is naturally or ordinarily present. It would not make sense to set a remedial standard that was at or below background.

Soil sampling around open areas of Pokuru 1B generally encountered soils of volcanic origin – so-called 'allophanic' soils. These comprise a dark brown topsoil over an orange subsoil. Typically, allophanic soils are particularly good at binding and retaining a range of chemicals, including fertilisers but also including many contaminants. Laboratory analysis of these soils showed relatively low concentrations of heavy metals [Ref: GHD]

Even lower results were obtained for the wetter soils in the north of Pokuru 1B, which we associate with the Mokoroa swamp. We refer to these soils as 'hydric', meaning changed by water. As a result of the chemical changes they have undergone, hydric soils tend to be lower in heavy metals, which have leached away over time. Some hydric soils contain peat, the remains of ancient wetland plants. These are considered quite significant differences.

This evidence suggests that farming has resulted in very little contamination. We believe that those results generally represent natural background concentrations for those soils.

An exception is cadmium. The cadmium concentrations in these open space soil samples are not particularly low. We cannot rule out, indeed we think it likely, that cadmium was added regularly to the land over the years as an impurity in superphosphate fertiliser. We think it is more reasonable to use Waikato Regional Council's upper estimate of the background cadmium concentration range across the region, as shown on Council's website at the time of writing.

DDT was often added to superphosphate during the 1960s and 1970s to combat insect pests. In fact, DDT became so widespread in Aotearoa that traces could be detected in almost any topsoil, even on land that had not been deliberately dressed with fertiliser. The Ministry for the Environment established a typical 'background' level for soils that DDT was not directly applied to [Ref: MfE4].

To sum up, we take background concentrations to be generally as evident from the open space sampling in the GHD investigation, except for cadmium where we use regional natural background, and DDT where we use national typical levels in unfertilised soils.

Table 1 Background concentrations by soil type

	Arsenic	Cadmium	Chromium	Copper	Lead	Zinc	DDT
Hydric topsoil	4	0.22	6	16	19	64	0.1
Allophanic topsoil	6	0.22	13	30	18	104	0.1

All concentrations milligrams per kilogram dry weight.

3.2. Protecting soil quality, food production, and soil ecology

Crown research institute Manaaki Whenua | Landcare Research (Landcare) has developed guideline values for protecting soil quality from several contaminants [Refs: Landcare1,2]. These 'eco-SGV' are intended to be protective of all kinds of life that is dependent on soil (soil micro-organisms; invertebrates such as worms and insects; plants; birds and animals) whether native or introduced.

Landcare proposed more protective eco-SGV for ecologically sensitive environments such as conservation land. It proposed less protective eco-SGV for modified environments like residential properties or sports fields. Land used for food production falls in the middle; while it is obviously very important that such soil is healthy, it is not realistic to give it the highest level of protection, given that pesticides may be applied to it [Ref: Landcare1]. A drawback to this approach is that the degree of protection for any given species would vary depending on where it lives [Ref: Kim]. For some contaminants, there are different values depending on whether the contamination is fresh or aged, and whether the soil is sensitive, typical or tolerant of contamination.

A significant difficulty for Landcare in developing the eco-SGVs was that there is very little data for Aotearoa – we know almost nothing about how our native life responds to contamination. Consequently, it was forced to rely on international data. This means that the eco-SGVs were developed *in* Aotearoa and *by* Aotearoa scientists but they are *not* specific to the soils and species of Aotearoa. There is certainly no guarantee that meeting an eco-SGV will protect any particular taonga.

As one general principle, species from inherently pristine environments are more sensitive to contamination, and less likely to be protected by an eco-SGV. As another, top predators are particularly vulnerable to contaminants that accumulate along the food chain. For example, elevated levels of the persistent pesticide DDT have been reported in toroa and karearea, dioxins have been reported in tuna (eels), and polychlorinated biphenyls in tutumairekurai (Hector's dolphin), albeit all at lower concentrations than similar Northern Hemisphere species.

Moreover, some mahinga kai and other wild foods can take up contaminants to a level that makes them unsafe to eat, without their own health being significantly affected. In particular, several water plants and shellfish are known to 'hyperaccumulate' cadmium and other heavy metals at much higher concentrations than the surrounding environment.

So long as these limitations are understood, we believe that eco-SGVs are likely to be an adequate tool for this risk assessment. In any case we are not aware of any realistic alternatives.

An ecological assessment of the site [Ref: 4Sight1] confirmed large current wetland areas in the northwest of the site, and smaller areas along the drainage path from the centre of the site toward the Wharekōrino stream (Figure 4). It reported that pekapeka touroa (long-tailed bats) had been recorded roosting on site. Tuna had been seen in the Mangaone stream, both shortfin eel and longfin eel. As we set out below, it seems appropriate to provide additional protection for tuna, on the basis that they are top predators in fulltime contact with soil and water; but we have no particular reason to be concerned for pekapeka.

Ecologically sensitive land

For the Mokoroa wetland area in the north of Pokuru 1B, we propose the eco-SGV for areas of ecological significance, 99 % species protection 'including biomagnification'. The more stringent biomagnification values provide additional protection for predators such as tuna. These values are made site-specific by using the 'added contaminant limits' derived by Landcare, and the hydric topsoil background given in Table 1. For copper and zinc, we use the values for aged contaminant in sensitive soil. [Refs: Landcare 1,2]. Here is an example calculation:

Copper:	*38 mg/kg*	*+*	*16 mg/kg*	*=*	*~~52~~ 50 mg/kg*
	Added contaminant limit for areas of ecological significance, aged contaminant, sensitive soil		*Background concentration, hydric topsoil*		*Rounded remedial standard protecting wetland soil quality at Pokuru 1B,*

Land where food could be grown (rural residential remedial standard)

For other rural residential areas, following Landcare we propose the eco-SGV for agricultural land (95 % protection of plants, and 80 % of microbes and invertebrates), onto the allophanic topsoil background from Table 1. For copper and zinc, we use the values for aged contaminant in tolerant soil.

Land that can be used for recreation (managed remediation standard)

For land to be in managed recreational use, we propose the eco-SGV for residential/recreational areas (80 % species protection), again onto the allophanic topsoil background, aged contaminants in tolerant soil.

Table 2 Remedial standards protecting soil quality

	Arsenic	Cadmium	Chromium	Copper	Lead	Zinc	DDT
Wetland	9	1.5	100	50	70	150	1
Rural residential	22	1.5	300	350	500	350	2
Managed	70	12	400	350	1,300	450	5

All concentrations milligrams per kilogram dry weight

3.3. Protecting health

The national Soil Contaminant Standards (SCS, ref: MfE5) were derived using a simple mathematical model. The model attempts to estimate contaminant exposure to people incidentally swallowing or breathing in dust and dirt, for eating vegetables grown in the soil, and for handling soil. There are SCS for five different scenarios: rural residential, typical residential, high-density residential, recreational, and commercial-industrial land use. Each scenario contains a number of standard parameters describing people and how they interact with soil.

A potential problem with the scenarios is that the Ministry for the Environment intended them to protect the majority of Aotearoa. The tangata whenua community may well differ from the majority, and if those differences significantly increase their risk, the generic assumptions may be inappropriate. We propose site-specific modifications where we believe it advisable.

However, in saying that, we have very little evidence for changing most of the parameters. For example, we simply do not know if any particular contaminant is more toxic to Māori overall than to the general population, whether for genetic reasons, or due to a different diet, or due to greater workplace exposure, etc.

Children living on the land

The generic 'rural residential' scenario imagines a small child living on the land virtually all year round, playing outside and eating home-grown vegetables. Generically, quarter of the vegetables this child eats are taken to be grown in the home garden. [Ref: MfE5] Given the rich gardening tradition of the area, and a recent soil science assessment indicating that the land could be restored to land use classes 2 and 3 (providing that soil drainage is maintained) [Ref: Fraser] we prefer to assume **half of their vegetables are grown at home.**

Considering cadmium in particular, where the amount taken up by plants depends on how acid the soil is, the model assumes rather acid conditions (pH 5, to be precise) as this is often the case across Aotearoa generally [Ref: MfE5]. Based on recent analyses of the soils at Pokuru 1B [Ref: GHD], we believe that it would generally be more reasonable to assume **slightly acid soils**, pH 6, except for the hydric soils of the wetland where pH 5.5 seems most appropriate.

This scenario does not allow for eating other kinds of home-grown produce, such as eggs. In that regard, lead and persistent pesticides are of particular concern. A recent Australian study of backyard chickens concludes that, in order for eggs to meet Australian food standards for lead, the chickens must be run on soil with less than about 120 mg/kg lead [Ref: Yazdanparast]. We have not seen any similar study for pesticides such as DDT.

In this scenario, the SCS model predicts that copper and chromium will not pose a risk in practice, owing to their comparatively low toxicity, and so we do not give any remedial standards for them.

We assume that, in future, tangata whenua will want to gather mahinga kai from the land, perhaps tuna and puha from a regenerated Mokoroa. Any contamination of that food would result in additional uptake by children. Our intent is that the quality of mahinga kai should be maintained by applying the stringent eco-SGV for ecologically sensitive land to wetland areas, so that there is no need to make additional allowance for contaminants from food in these remedial standards for protecting health.

People enjoying the land

The generic 'recreational' scenario imagines the same child playing in a suburban reserve around 200 days in the year. This scenario generates higher (less stringent) values than the residential scenario because the child spends less time there and does not eat produce from the land.

For a few contaminants, the generic 'commercial / industrial' outdoor worker scenario, which imagines an adult in regular contact with the soil – gardening or landscaping, for example – generates lower (more stringent) values than the recreational scenario. Arsenic is one such contaminant.

In order not to constrain 'managed' use, we use the lower of the recreational and commercial / industrial SCS as the remedial standards protective of people's health.

Asbestos – a special case

Asbestos is a soil contaminant at Pokuru 1B due to the amount of asbestos-containing material (ACM) that was used in constructing many of the hospital buildings, some of which is now in a damaged condition. Intact ACM is not dangerous, but when it is damaged, free asbestos fibres can be released into air and soil. When breathed in, asbestos fibres damage the lungs, increasing risks of developing lung cancers.

There is no SCS for asbestos. A Crown-funded building research organisation, BRANZ, has put forward risk-based soil guideline values for asbestos [Ref: BRANZ]. There are values both for fragments of ACM and for asbestos fines and fibrous asbestos (AF/FA). These values are copied from Western Australian guidance, itself based on Dutch guidance. Because asbestos is considered dangerous only when it is in the form of breathable dust, and the Waikato region is rather less dry and dusty than Western Australia, these values are probably on the conservative side. However, we have not attempted to change them.

Fuels and oils – a special case

Fuels and oils are minor concerns at Pokuru 1B, as there were fuel tanks on site until removed in 2018 [Refs: AECOM2,3,4] and there was a solid-fuelled boiler for heating. There are no SCS for fuels and oils; soil acceptance criteria (SAC) from older guidance remain in use [Ref: MfE6].

The risk posed by residual fuels and oils in soil depends strongly on a number of factors including:

- The type of fuel – whether it is 'light' or 'heavy', and the extent to which it is composed of 'aromatic' or 'aliphatic'-type hydrocarbons. Generally, lighter, more aromatic fuels such as petrol are more volatile and toxic than heavier, less aromatic fuels such as diesel, while oils are heavier still and correspondingly less dangerous. However, when burnt, solid fuels and oils can yield polycyclic aromatic hydrocarbons (PAH); many PAH can cause cancer.
- The quantity of fuel. If there is enough residual to form a free liquid fuel (a 'light non-aqueous phase layer,' LNAPL), rather than soaking into the soil or dissolving into groundwater, this is particularly dangerous. Liquid fuels in ground can still be ignited and can also damage plastic pipes and cable sheaths.
- The type of soil. Fuels and fuel vapours can move easily through sands and gravels, but not through 'cohesive' clays and fine silts.

- The depth of the contamination in soil. Fuel and oil residues near the surface can be in direct contact with people and garden produce; but if they are well buried it is only fuel vapours that pose a risk, and the deeper they are buried the less the risk.
- The use of the land. There are SACs for agricultural, residential and commercial / industrial use.
- In particular, whether buildings are present. Fuel vapours can be drawn into buildings, where they can accumulate and cause harm to the occupants; but in the open air vapours can dissipate easily. If the building is large enough, air cannot get under it, and so the fuels cannot be degraded by natural soil processes.

For Pokuru 1B, the principal concerns are:

- Petrol range fuel residues, and in particular the aromatic hydrocarbons benzene, ethylbenzene, toluene and xylenes (BTEX).
- PAH from solid fuels and oils, especially cancer-causing compounds such as benzo[a]pyrene (BaP). These PAH are usually assessed using the total concentration of sixteen of the most common compounds, weighted according to their different potencies ('BaP equivalents', BaP_{eq}).

In the areas where fuel was stored below ground, the predominant soil type was sandy clay [Refs: AECOM3, GHD]. The SACs for 'Silty Clay' at a depth of 1-4 m below ground are therefore used here. In this context, petrol as a whole is only considered a significant risk if liquid fuel is still present; even among the aromatic components of petrol, only benzene has SACs in this situation [Ref: MfE6].

BaP and related PAH have a BaP_{eq} SCS that supersedes the SAC; this is another of the cases in which the commercial / industrial SCS is lower than the recreational SCS, and is therefore used here.

Table 3 Remedial standards protecting people's health

	Arsenic	Cadmium	Lead	Mercury	DDT
Rural residential	9	0.9 (0.5 wetland)	120	120	45
Managed	70	400	880	1,800	400

	ACM	AF/FA	Fuels and oils	Benzene	BaP_{eq}
Rural residential	0.01 %	0.001 %	No LNAPL	4.6	6
Managed	0.02 %	0.001 %	No LNAPL	20	35

All concentrations milligrams per kilogram dry weight, except asbestos % weight for weight

3.4. Protecting water quality

Water quality can be protected if contaminant concentrations leaching out of soil are within both drinking-water standards and freshwater ecology trigger values. This is typically determined in a laboratory leaching test using artificial rainwater, the 'synthetic precipitation leaching procedure' (SPLP). Estimates of the soil concentrations at which leachate concentrations become unacceptable are also available, based on several hundred samples from around Aotearoa [Ref: PDP]. These estimates are probably conservative (low) for the allophanic soils covering most of Pokuru 1B, so they are generally suitable, and have been adopted for use as remedial standards here.

For fuels, as set out in section 3.3 above, the key component is benzene. There are SACs specifically for the protection of groundwater quality, and the benzene criterion cited here is the SAC for 'Silty Clay' at a depth of 1-4 m below ground with groundwater at 4 m [Ref: MfE6]. These SACs are known to be highly conservative in most situations, as benzene breaks down effectively in aerobic soils, which limits the distance that it can travel from source: this remedial standard should only be applied within 100 m of surface water [Ref: MfE6].

Oil sheen, staining or odour would also be considered unacceptable in potable water and therefore in wetland soils.

Table 4 Remedial standards protecting water quality

Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Zinc	DDT	Benzene	BaP_{eq}
140	10	150	280	460	3	1,200	2	0.11*	125

All concentrations milligrams per kilogram dry weight. * Within 100 m of surface water.

3.5. Hazardous waste

In rural residential areas the presence of hazardous wastes such as sharps (needles, broken glass, etc.) or pharmaceuticals would be unacceptable, whether fly-tipped or buried. There should also be no putrescible or odorous wastes in those areas.

3.6. Proposed rural residential remediation standard

The proposed rural residential remediation standard is the most stringent (lowest values) of the corresponding standards set out in the previous sections.

We believe this standard should be particularly stringent within Mokoroa and other wetland areas, in order to better protect their potential mahinga kai value, and recognise the different soil type.

Table 5 Rural residential remedial standards

	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Zinc	DDT
Wetland	9	0.3	100	50	70	3	150	1
Rural residential	9	0.9	150	280	120	3	350	2

	ACM	AF/FA	Fuels and oils	Benzene	BaP_{eq}	Hazardous wastes
Wetland	0.01	0.001	No odour or staining	0.11	6	Absent
Rural residential	0.01	0.001	No LNAPL	0.11	6	Absent

All concentrations milligrams per kilogram dry weight, except asbestos % weight for weight

3.7. Proposed managed remediation standard

The proposed managed remediation standard (if LINZ elects to use it) is the most stringent of the corresponding standards set out in the previous sections.

Table 6 Managed use remedial standards

Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Zinc	DDT
70	10	150	280	460	3	450	2

ACM	AF/FA	Fuels and oils	Benzene	BaP_{eq}
0.02	0.001	No LNAPL	0.11	35

All concentrations milligrams per kilogram dry weight, except asbestos % weight for weight

3.8. Landfill waste acceptance criteria

If soil is removed from Pokuru 1B it will have to be disposed of to an appropriate location. Soil that falls within regional background concentrations can be freely reused as cleanfill. Soil that is not cleanfill may still be reused on a site that holds resource consents to receive it.

If no such site can be identified, then soil would have to go to landfill. Landfill waste acceptance criteria (WAC) can vary from fill site to fill site according to the details of a site's resource consents: recommended WAC are given in *Technical guidelines for disposal to land* [Ref: WasteMINZ]. There are different WAC for different types of landfill; in ascending order, class V cleanfills, class IV controlled fills, class III managed fills, class II construction and demolition (C&D) fills, class I municipal landfills.

Cleanfill, controlled fill and managed fill criteria are simply total concentrations of contaminants in soil. Municipal landfill criteria and C&D landfill criteria are based on contaminant leachability. This is because these landfills are engineered with liners and caps to keep waste contained, but they still have to collect and dispose of leachate from the waste. A special leaching test is used, the 'toxicity characteristic leaching protocol' (TCLP), which is supposed to mimic the chemical processes that happen in typical municipal landfills. There is no leachability criterion for DDT as it is not considered leachable: acceptance would depend on the landfill, and possibly the Stockholm Convention disposal limit of 50 mg/kg (total concentration) ought to apply [Ref: WasteMINZ].

Asbestos-containing wastes require special handling and can generally only be accepted at municipal landfills, even then subject to various requirements [Ref: WasteMINZ]. Some specific managed fills may be consented to accept low levels.

Table 7A Landfill soil waste acceptance criteria – total concentrations

	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Zinc	DDT
Cleanfill	17	0.8	56	120	78	1	175	0.7
Controlled fill	17	0.8	150	220	160	0.7	190	2.0
Managed fill	140	10	150	280	460	3	1,200	2.0

	ACM	AF/FA	Petrol	Benzene	BaP_{eq}	Boron
Cleanfill	Not acceptable		110	0.0054	2	Not set
Controlled fill	Not acceptable		110	0.11	2.8	Not set
Managed fill	Usually not acceptable		200	0.11	125	Not set

Cleanfill and managed fill criteria are total concentrations in mg/kg

Table 7B Landfill soil waste acceptance criteria – TCLP leachable concentrations

	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Zinc
C&D fill	1	0.2	1	0.5	1	0.04	1
Municipal fill	5	1	5	5	5	0.2	10

	ACM	AF/FA	Benzene	Naphthalene	Boron
C&D fill	Site specific		0.05	1	2
Municipal fill	By arrangement		0.5	10	20

Criteria are TCLP leachable concentrations in mg/L. Usually no criteria are set for DDT or PAH (other than naphthalene).

4. DATA COMPARISON

4.1. Overview

Sources of soil contamination confirmed at Pokuru 1B include:

- Buildings that had asbestos cement roofs or cladding panels, and/or had been painted with lead-based paints.
- Farming.
- Using and storing fuels.
- Landfilling.

Data for each of these sources is assessed below. The locations of the sources are shown on Figure 4, together with key pathways and receptors:

- The stormwater network.
- The Wharekōrino Stream.
- The apparent historic wetland area.
- Areas requiring cultural oversight.

Fraser Thomas
ENGINEERS • RESOURCE MANAGERS • SURVEYORS

Figure 2: Sources, pathways and receptors at Pokuru 1B

Toitū Te Whenua Land Information New Zealand
Former Tokanui Hospital Demolition and Remediation Project
Tokanui
Te Awamutu

Date:	17/04/2024
Figure Reference:	33097/HUI/002
Drawn by:	EB
Reviewed by:	SF
Job Number:	33097

N

0 70 140 280 420 560
Meters

4.2. Buildings

Asbestos

The pre-demolition asbestos survey identified several buildings with asbestos cement roofing (Super Six corrugated sheets):

- Admin (B1)
- Ward 7 (B29)
- The Rec Hall (B58)
- Workshop (B63)
- The store (B65)
- The main boiler house (B68)
- The fire station (B69), and
- The laundry (B74).

While not considered friable asbestos, Super Six roofs are often found with surrounding soil asbestos exceeding guideline values. The pre-demolition asbestos survey also identified Ward 8 (B30) as having asbestos cement cladding panels with medium damage, which it considered to pose a high risk [Ref: 4Sight2]. Buildings B20-B23 were also rated high risk due to internal asbestos lagging and debris.

AECOM collected soil samples from around three of these buildings – B29, B58, B74 – and found that surface soil 0.5 m from the walls more often than not (10 of 16 such samples) contained asbestos fines and fibrous asbestos (AF/FA) exceeding the remedial standard. The highest concentration of 0.039 % was well above the 0.001 % standard (which is the same for both rural residential and managed use). At a depth of 0.25 m, or at a distance of 1.5 m, half of analysed samples (9 of 18) had AF/FA exceeding remedial standard, or present but not quantified. [Ref: AECOM]. Some samples from around B30 also exceeded AF/FA standard [Ref: GHD].

However, asbestos in soil was otherwise uncommon. Investigations of B1, B65, and B69 found no asbestos exceedances in the surrounding soil. B68 is completely surrounded by hard standing and hence had no asbestos in soil issues. Sampling around the buildings with internal asbestos issues suggested that it had not been transported outside. Asbestos was below reporting limits in a further 20 surface soil samples collected by GHD within the 'industrial area' where most of the asbestos-roofed buildings are [Refs: AECOM, GHD].

Based on those findings, we infer that asbestos is likely to exceed remedial standards in 'haloes' around buildings as shown in Table 8:

Table 8 Asbestos exceeding standards in soil around buildings

Location	Rural residential remedial standard	Managed remedial standard
Buildings with external deteriorated asbestos B29, B30, B58, B63, B74	To 2 m distance To base of topsoil	
Other buildings	Unlikely to exceed	

Lead and zinc

LINZ has provided a lead paint survey recently undertaken by its building consultants [Ref: 4Sight2], which identified high-lead paint in cladding on a number of buildings, typically older weatherboard buildings. In the DSIs, according to field portable X-ray fluorescence spectroscopy (XRF) measurements, soil lead and zinc were generally elevated close to most of these buildings [Refs: AECOM, GHD]. This is generally consistent with what we know about the use of lead-based paints in Aotearoa [Refs: Hinton, Reeves et al, Kennedy et al, MoH, and others].

The AECOM investigation confirmed soil lead exceeding 120 mg/kg around B13, B18, B24, B29, B33, and B58, and on the south side of B74 where the cladding was painted. The GHD investigation confirmed lead impact around B2, B5, B7, B8, B11, B12, B15, B17, B21, B27, B35, B52 and B59. Concentrations generally decreased with distance from the building and with depth into the soil. [Refs: AECOM, GHD].

Elevated lead was recorded on the west side of B12, the east side of B19, and close to B55. This was not expected. It may be a result of severely deteriorated lead paint on minor elements such as windowframes, but at B12 it may also indicate fill material, as lead distributions at these locations do not follow the general trend of decreasing away from the building and with depth.

Conversely, generally elevated lead was expected but not seen around B39, B41, B45, B46, and B47. These buildings are not as old and may have been maintained differently.

The XRF measurements were corrected to match laboratory results for matched soil samples [Ref: GHD]. A statistical analysis of the resulting data shows that, with 95 % confidence, the average lead concentration (UCL95 statistic) will exceed the proposed remedial standards as per Table 9:

Table 9 Lead exceeding standards around buildings

Location	Rural residential remedial standard	Managed remedial standard
Lead-impacted buildings B2, B5, B7, B8, B11, B13, B15, B17, B18, B21, B23, B24, B27, B29, B33, B35, B37, B38, B52, B58, B59, B73: parts B12, B19, B55, B74	To 3 m distance To base of topsoil	To 1 m distance To 0.25 m depth
Other buildings	Unlikely to exceed	

For most of these buildings, zinc is also significantly elevated in the halo, especially close to the building. This could be from timber paints, galvanised roofing, or both. Furthermore, AECOM data shows zinc exceeding managed remedial standard close to **buildings B16 and B49** absent lead, and XRF data suggests the same is true of **building B56** and the **north side of B71**.

On this basis, some remediation around affected buildings will be required even if they fall within the managed area.

A limited number of TCLP leaching tests done as part of the GHD investigation, later supplemented by HAIL Environmental, show that lead in soil around affected buildings generally meets typical waste acceptance criteria for construction and demolition landfills [Refs: GHD, FTL].

Isolated observations of contamination around buildings

Some soils between the former glasshouse and shed in the gardening area in the northeast (buildings B34 and B35) contain elevated concentrations not just of lead, but also of other metals, including arsenic and nickel – it is not clear why [Ref: GHD]. With lead at up to 630 mg/kg, these soils may not meet even the managed remedial standards, and are therefore considered a **hotspot**.

Additionally, in several instances, a single contaminant was elevated in a sample or measurement from 0.5 m distance from a building, including:

- Arsenic at B10, B30, B41 and B37
- Copper at B10
- Lead at B38, B56, at depth adjacent to S1
- Zinc at B5, B48, B51, B75 and S5.

Lead was also elevated in one sample 6.5 m from B18, in a test pit near B19, and one test pit within the old church footprint, as was arsenic in a test pit near B43 [Refs: AECOM, GHD].

These isolated results do not seem to indicate systematic contamination from paint systems or demolition, nor do they indicate contamination over a significant area. If desired they could be further delineated with high-density sampling. Alternatively a routine surface scrape could be undertaken close around all buildings following demolition, which would have the advantage of capturing all instances of highly localised contamination adjacent to buildings whether identified by sampling or not.

Sediment

Given the sheer number of buildings making up the former Tokanui Hospital, LINZ had concerns that stormwater had carried significant amounts of building-derived lead to the Wharekōrino Stream. Accordingly the GHD investigation included soil sampling along overland drainage pathways and sediment sampling within the stream. Table 10 presents the results.

Table 10 Assessment of sediment results

	Arsenic	Cadmium	Chromium	Copper	Lead	Zinc
HSP SED 01-05 STR SED 01-04 WWTP DIS SED WWTP SEEPAGE	<2-7	0.11-**0.45**	7-12	10-**67**	11-**140**	47-**260**
Allophanic topsoil – Pokuru 1B	6	0.22	13	30	18	104

All results in mg/kg dry weight. Boldface indicates result exceeds selected background.

These sediments are not dominated by lead paint residues (the average is just 45 mg/kg). However some samples clearly have been somewhat impacted by contaminants including cadmium, copper, lead and zinc. Whether those contaminants are from Tokanui Hospital buildings, farming activities, closed landfills, or from other land upstream, we cannot tell, but most likely all of the above.

Still, we caution that any sediment encountered within the stormwater network could be contaminated, and should be sampled and analysed for appropriate reuse or disposal.

4.3. Farming

The GHD investigation included ten composite topsoil samples COMP1-COMP10 from ten open space areas around Pokuru 1B, and nine composite topsoil samples from the former gardening area in the northeast. The AECOM investigation included six test pits from open space areas, TPA-E and TPZ.

Table 11 compares laboratory results from these samples to the rural residential remedial standards from Section 3.5, and to cleanfill acceptance criteria from Section 3.7. Two of the open space areas, in the north of the site alongside Te Mawhai Road, appeared to have hydric soils, so they are assessed against wetland standards (even though this includes the area that was levelled and used as playing fields).

Table 11A Assessment of open space and market garden results – north of site

	Arsenic	Cadmium	Chromium	Copper	Lead	Zinc
COMP1, COMP2	4, 4	0.46, 0.29	6, 6	16, 15	19, 18	63, 64
TPA	3	0.16	8	18	24	61
Wetland	9	0.5	100	50	70	150
Cleanfill	17	0.8	56	120	78	175

Table 11B Assessment of open space and market garden results – rest of site

	Arsenic	Cadmium	Chromium	Copper	Lead	Zinc
COMP3-COMP10	5-6	0.31-0.60	7-13	23-38	15-71	79-142
COMP A-COMP H	2-8	<0.1-0.51	8-11	11-64	17-83	33-157
TPB-E, TPZ	3-6	0.02-0.15	6-29	5-67	17-34	30-99
Rural residential	9	0.9	150	280	120	350
Cleanfill	17	0.8	56	120	78	175

All concentrations milligrams per kilogram dry weight

Organochlorine pesticides (OCP) were only detected in COMP02 as a trace (0.016 mg/kg) of 4,4-DDE, a metabolite of DDT, and COMP E, as 0.1 mg/kg of DDT; both well below the wetland remedial standard of 1 mg/kg, and also below the ambient background of 0.1 mg/kg.

These tables show that open space and agricultural area samples collected during the investigations meet proposed rural residential remedial standards, and indeed meet cleanfill criteria. That is, **Pokuru 1B is not generally contaminated.**

There were traces of DDT in some of the topsoil samples around the former glasshouses and shed in the agricultural area (buildings B34 and B35) suggesting that small quantities of DDT were present on site at some point. However, as the highest reported concentration was 0.74 mg/kg, below the 2 mg/kg rural residential remedial standard, these traces are not considered significant or indicative of industrial-scale use of persistent pesticides.

Some other herbicides – 2,4,5-T, 2,4-D, dicamba and oxadiazon – were detected in some samples collected east of the 'Gardener' building (B59) at milligram-per-kilogram levels [Ref: GHD]. Of these, 2,4,5-T and oxadiazon are considered persistent pesticides [Ref: PPDB]. Neither is particularly toxic to people – the United States Environmental Protection Agency has regional screening levels of 6,300 and 3,200 mg/kg respectively for these herbicides in residential use (after adjusting to a lifetime risk of 1-in-100,000) [Ref: USEPA]. Moreover, while persistent, concentrations will drop in the future as the pesticide residues attenuate. However, technical grade 2,4,5-T can contain traces of dioxins, which are highly persistent and much more toxic. Also, as herbicides, obviously these compounds are toxic to many plants.

In supplementary sampling, HAIL Environmental collected a further seven samples from the same area, none of which contained the above herbicides or any other acid herbicides (method reporting limit 0.05 mg/kg). The affected area is inferred to be very small. Given that this is a lead-impacted building anyway, we conclude that the herbicide detections are of no consequence and can be satisfactorily managed along with the lead.

Finally, historic aerial photographs suggest that there was once a dairy shed in the location subsequently occupied by building B26. If this included a cattle dip or foot baths using persistent pesticides, there is no sign of any associated contamination in the sampling from around B26. However, there does seem some demolition waste to the south of this building, and it seems possible that some contamination could be exposed after demolition.

4.4. Using and storing fuels

The three tank removal reports showed that traces of fuels and oils remained in tank pits at the former service station (B16) and store (B65), and under fuel lines. Those reports did not cover the workshop (B63) or some parts of the fuel storage systems, which were picked up in the GHD investigation; again only traces of fuels and oils were seen.

Thinking particularly of benzene, a petrol constituent for which we propose a remedial standard of 0.11 mg/kg; this compound was only detected once, at 1.5 mg/kg in one wall of the tank pit by the store [Ref: AECOM4]. Because this sample was in clay soil that would be expected to block the movement of fuels, it is not expected to represent a risk to groundwater, and in any case is likely to represent a very small volume of soil, thus it does not appear to indicate a hotspot.

PAH are hydrocarbons associated with partially burnt fuels, which can often be found in waste oils, incinerator residues and the like. In the GHD investigation, PAH were not often found, and even then, were generally at trace levels. One exception was by the store (B65), with 7.2 mg/kg BaP_{eq} in a shallow soil sample. From the description, this appears most likely due to cross-contamination with historic asphalt from the surfacing at that location, and as such does not appear to be a hotspot. PAH bound up in asphalt is not generally considered to present a risk.

4.5. Landfilling

The Deed requires the Crown to manage the existing disposal sites on the true right bank of the Wharekōrino Stream in perpetuity, not to remediate them. Accordingly, they are not assessed here, but in a separate report [Ref: Fraser Thomas].

However, that report found that the existing disposal sites are greater in extent than had been realised; there are suspected additional filling areas in the southeast of the site, west of the Wharekōrino Stream. Fill materials encountered in these areas include construction debris, burnt timber, bitumen, plastic, clay pipe in a silt or sand matrix. Samples from these areas have identified elevated arsenic, copper, lead, zinc and asbestos [Refs: Fraser Thomas, AECOM].

4.6. Other activities

Dentist

Historically, dentists made substantial use of mercury in amalgam fillings. Given the size of the hospital, poor waste disposal practices at the dentist (building B8) could conceivably have resulted in significant mercury contamination. Accordingly, this was considered a potential source of contamination.

However, in the GHD DSI, only the closest sample B8 HA01 below the dentist contained elevated mercury, 1.2 mg/kg at surface, below the rural residential remedial standard of 3 mg/kg. Mercury was much lower in composite sample COMP10 from below the dental surgery, at 0.11 mg/kg, and was not detected in the XRF transects adjacent to the dentist. Similarly, mercury levels were low in nearby AECOM samples S1-S5, at 0.07-0.12 mg/kg. On this basis we consider there is insufficient evidence for this contamination source.

Laundry

Some anecdotal accounts suggested that the hospital laundry (B74) might have done dry cleaning. Dry cleaning is a well-known source of contamination, especially where chlorinated solvents such as trichloroethylene (TCE) and perchloroethylene (PCE) were used. However, during the GHD DSI, no chlorinated solvents were reported in soil samples from around B74, nor were there any field observations of volatile compounds (which would include solvents) or solvent odours [Ref: GHD]. On this basis we consider there is insufficient evidence for this contamination source.

Morgues

The 'old morgue' B19 and 'new morgue' B25 were also considered potential sources of contamination; for example if any cremation had occurred, heavy metals such as mercury might have been elevated in the vicinity. Again the DSIs found no evidence to support this. [Ref: GHD] Embalming solvents such as formaldehyde have not been investigated, but are highly biodegradable and leachable, thus if they were used they are highly unlikely to have persisted to the present day.

Sheep dip

Early reports suggested other possible sources of soil contamination including sheep dipping. The GHD DSI found no evidence for this [Ref: GHD].

Sports turfs

Historically, persistent pesticides such as arsenicals and OCPs were often used on sports turfs. Accordingly, the historic bowling green and tennis court areas were sampled. No OCPs or other herbicides were detected and arsenic was within site background [Ref: GHD]. Again, we conclude that persistent pesticides were not used for this purpose.

Substations

The key contaminants of interest around electrical substations are polychlorinated biphenyls (PCBs), which were used in transformer oils between the 1940s and 1970s [Ref: MfE7]. No PCBs were reported in samples around the substations [Ref: GHD] so, although PCBs were almost certainly used here, it does not appear that there was any systematic contamination as a result.

However, while sampling around substation 2, asbestos sheeting was unearthed at one location, SB2_TP3 [Ref: GHD]. This is a **hotspot** that will require delineation and removal, albeit unrelated to electrical activities.

Wastewater treatment plant, water treatment plant, swimming pool

Soil samples from these locations [Refs: GHD, WSP] overall met rural residential remedial criteria for heavy metal contaminants, and were not reported to contain asbestos. While simple water treatment chemicals such as oxidisers, alkalis and algaecides were presumably stored at these locations, it is considered unlikely that they are sources of significant residual contamination.

Waste disposal

Fly-tipped waste and dirt on hard standing near B66 contained asbestos, lead and zinc above managed remedial criteria, as well as substantially elevated arsenic and boron [Ref: GHD], and should be **removed.**

Demolition material was encountered at several locations. While this generally appears to be inert material, around Ward 21 (B26) "rubble and other fill material, brick and wire" were observed, and some samples contained lead [Ref: GHD] above rural residential remedial criteria, which is considered a **hotspot.**

5. IMPLICATIONS

A key finding of this site-specific risk assessment is that the **Pokuru 1B land is not generally contaminated**. Indeed it is much less contaminated than was feared at the start of this settlement process.

On that basis, **the principal soil contamination issue at Pokuru 1B is asbestos and lead from building materials.** The following soils exceed the site-specific remedial criteria developed in this report:

- Topsoils close to several **buildings with external deteriorated asbestos** (buildings B29, B30, B58, B63, B74). Soil around these buildings generally had low to moderate levels of asbestos fines and/or fibrous asbestos.
- Topsoils close to most **buildings with high-lead exterior paint** (buildings B2, B5, B7, B8, B11, B13, B15, B17, B18, B21, B23, B24, B27, B29, B33, B35, B37, B38, B52, B58, B59, B73, and parts of B12, B19, B55, B74). Soil around these buildings generally had low to moderate lead levels.

These soils will require some remediation to meet proposed standards.

There are suspected additional filling areas in the southeast of the site, west of the Wharekōrino Stream. Fill materials encountered in these areas include construction debris, burnt timber, bitumen, plastic, clay pipe in a silt or sand matrix. Samples from these areas have identified elevated arsenic, copper, lead, zinc and asbestos. These areas require remediation, or management as part of the existing disposal areas.

Further, investigations have identified apparent **hotspots** of contamination:

- Within the greenhouse and shed footprints in the agricultural area in the north of the land, between buildings B34 and B35, where heavy metal concentrations are elevated.
- Where waste has been buried around substation S3, building B26 and possibly B12.

Limited remediation or management is also required in these areas.

LIMITATIONS

This draft site-specific risk assessment is the property of Toitū te Whenua | Land Information New Zealand and HAIL Environmental. It was produced for the purpose stated above in accordance with the conditions of the contract dated 14 October 2020, consultancy work request dated 17 December 2021, and statement of work dated 31 March 2022. It does not purport to provide legal or financial advice. HAIL Environmental accepts no liability to any other party or for any other purpose.

This report is current as of 11 September 2023. Site conditions may change in future, as may regulations and guidance. Readers must make their own judgements as to whether this report remains current at the time of reading, and/or seek further advice from HAIL Environmental.

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Appendix A: Lead data analysis

Data from transect soil sampling at set distances from buildings at Pokuru 1B is summarised in tables A1 and A2 below. This dataset comprises nearly 1000 points: 720 *in situ* XRF measurements corrected using matched pair laboratory samples, and 273 laboratory analyses of soil samples.

This summary excludes transects from the following difficult to classify buildings:

- B12, an unpainted brick building. Lead concentrations are not dependent on distance / depth: suspected fill material.
- B19/1, a transect with several lead concentrations exceeding rural residential criterion, absent high-lead cladding paint.
- B55, a building which does not appear to have high-lead cladding paint, though it has lead flashing and deteriorated timber window frames. Transect 2 from this building generally exceed rural residential criterion at 0.5 m distance; one sample exceeds rural residential at 1.5 m.

It also excludes a single outlier result of 657 mg/kg at 6.5 m from building B18, which appears unlikely to relate to that building's paint system.

Table A1 Surface lead concentrations with distance from buildings

Building Group	Distance	Number of Samples	Average Concentration	Standard Deviation	95 % Upper Confidence Limit on Average
High Lead Paint on Cladding	**0.5**	59	**580**	580	**710**
	1.5	60	250	370	330
	2.5	59	160	290	220
	3.5	45	84	68	100
	6.5	27	52	25	60
Other	0.5	90	82	100	99
	1.5	89	36	23	40
	2.5	86	33	23	37
	3.5	65	31	24	35
	6.5	50	28	20	33

All concentrations are mg/kg dry weight, rounded to two significant figures.

Concentrations exceeding rural residential remedial standard of 120 mg/kg are shown in orange, those exceeding managed remedial standard of 460 mg/kg in **bold orange.**

Table A2 Lead concentrations with depth at 0.5 m from buildings

Building Group	Depth	Number of Samples	Average Concentration	Standard Deviation	95 % Upper Confidence Limit on Average
High Lead Paint on Cladding	**0**	59	580	580	**710**
	0.1	30	240	290	330
	0.2	22	230	350	350
	0.25	27	300	490	460
	0.3	18	120	140	180
	0.4	10	93	120	160
	0.5	19	150	160	210
Other	0	90	82	100	99
	0.1	68	49	35	57
	0.2	59	31	17	34
	0.25	11	42	29	58
	0.3	17	32	22	42
	0.4	5	32	28	59
	0.5	3	33	15	59

All concentrations are mg/kg dry weight, rounded to two significant figures.

Concentrations exceeding rural residential remedial standard of 120 mg/kg are shown in orange, those exceeding managed remedial standard of 460 mg/kg in **bold orange**.