ECOtago

Environmental Consultants Otago Ltd

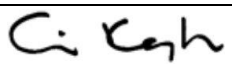
Preliminary Site Investigation

1484 Teviot Road
Millers Flat

for
Hawkeswood Civil Limited

June 2022

Environmental Consultants Otago Ltd
Environmental and Contaminated Site Assessments
PO Box 6 Hampden 9442 ▪ www.ecotago.co.nz

Task	Responsibility	Signature
Project Manager:	Ciaran Keogh, MBA, MRRP	
Prepared By:	Ciaran Keogh, MBA, MRRP	
Reviewed By:	Bernice Chapman, CEnvP, PhD, MEIANZ	
Approved For Issue By:	Ciaran Keogh, MBA, MRRP	

Prepared By:
Environmental Consultants Otago Ltd

PO Box 6
Hampden 9442
www.ecotago.co.nz
Email: ciaran@ecotago.co.nz

Client: Hawkeswood Civil Ltd
Job Ref.: 361-22 Millers Flat
Date: 28 June 2021

Executive Summary

Environmental Consultants Otago Limited (EC Otago) was commissioned by Hawkeswood Civil Limited to undertake a Preliminary Site Investigation (PSI) over part of the property at 1484 Teviot Road Millers Flat, in accordance with the *Resource Management (National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health) Regulations 2011* (NES). Part of the property, defined as the site, is proposed to be mined for alluvial gold. A section of the site was used for historical landfilling activity (Millers Flat Landfill). The purpose of this report is ascertain whether any Hazardous Activities and Industries List (HAIL) activity other than the one identified has occurred within the site, to determine the extent of the HAIL activity, and if contamination is present within the site.

The property consists of 9.7036 ha that is presently used for pasture and cropping. The site consists of 8.02 ha, part of which historically has been quarried for gravel with part subsequently used as a landfill which is now closed. The purpose of this PSI is to identify the extent of the HAIL activities within the site so that this area may be excluded from the proposed mining activity.

The information reviewed, and the sampling undertaken, confirmed that HAIL Category G3 (*Landfill Sites*) applies to part of the land. No other HAIL activities were identified within the site. The investigation has identified a mining perimeter, the boundary of which was shown to be unaffected by the HAIL activity with contaminant levels at or below background concentrations. As a result, the provisions of the NES do not apply to the part of the site outside the mining perimeter. The mining perimeter has been determined to ensure that the landfill contents are not disturbed during the proposed mining activity.

The investigation indicates it is highly unlikely that the soils outside the mining perimeter present a risk to human health or the environment in its current state or during the proposed mining operations, based on the preliminary sampling undertaken.

Based on this investigation, EC Otago finds the following:

- Based on the information examined during this investigation, no evidence was found that HAIL activities have historically been, or are currently being, undertaken on the part of the site outside of the identified mining perimeter. Consequently, the provisions of the NES do not apply to these parts of the site.
- Soil sampling and analysis did not identify any contaminants that exceed the natural background levels along the mining perimeter.
- There is highly unlikely to be a risk to human health or the environment from soil contamination due to past historical activities outside the mining perimeter.
- If waste materials, or other visual or olfactory indicators of potential contamination are observed during earthworks, a Contaminated Land Advisor must be consulted, and further sampling and analysis is required.
- The NES does apply to the former landfill site, contained within the mining perimeter (HAIL.00338.01). Any proposed disturbance of this land, contained within the mining perimeter, will require a full site investigation and consents to disturb a HAIL site / contaminated land from both Central Otago District Council and Otago Regional Council.

Table of Contents

Abbreviations

CODC	Central Otago District Council
HAIL	Hazardous Activities and Industries List
NES	Resource Management (National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health) Regulations 2011
OCP	Organochlorine Pesticides
ORC	Otago Regional Council
PAH	Polycyclic Aromatic Hydrocarbons
PSI	Preliminary Site Investigation
SCS	Soil Contaminant Standards
SGV	Soil Guideline Values

1 Introduction

Environmental Consultants Otago Limited (EC Otago) was commissioned by Hawkeswood Civil Limited to undertake a Preliminary Site Investigation (PSI), with limited soil sampling and analysis for contamination, at 1484 Teviot Road, Millers Flat. Investigation is required to facilitate assessment of the extent of past activities, to provide information as to the property's contamination status outside of the known landfill activity, and to ascertain suitability of the bulk of the land for the proposed mining activity. This PSI was undertaken in accordance with the proposal submitted by EC Otago on 10 May 2022. A statement of EC Otago's experience is attached as Appendix A.

1.1 Background and Objectives

If an activity or industry described in the Ministry for the Environment's Hazardous Activities and Industries List (HAIL) is being, has been or is more likely than not to have been undertaken on a property, then the *Resource Management (National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health) Regulations 2011* (NES)[1] apply when five specific activities (including soil disturbance, subdivision or change of use) take place on the property. The HAIL is a compilation of activities and industries that are considered to have the potential to cause land contamination as a result of hazardous substance use, storage or disposal. The presence of such activities on a property does not automatically mean contamination is actually present on the property.

A specific trigger for this PSI is the known historical landfilling activity (Millers Flat Landfill) that occurred on a part of the property. The proposed future development of the property comprises the excavation to bedrock of the alluvial gravel deposits for screening for the removal of gold and subsequent reinstatement of the gravels, requiring soil disturbance. The purpose of this study is to define a boundary between the HAIL site and the proposed mining activity, and to review the site history to ascertain whether any HAIL activity other than the one identified has occurred within the site.

The main objectives of a PSI are to gather information about a designated land area in order to determine whether it may potentially be contaminated, to assess the suitability of the land for its current or intended future land use, and to determine whether a detailed site investigation is required. This PSI has been undertaken in order to establish what current and historic activities have occurred at the property, the extent of the activity, and the potential for these activities to have resulted in contamination.

1.2 Scope of Work

Consistent with the Ministry for the Environment guidelines[2] for reporting on contaminated land, the following scope of work was undertaken:

- Source and review of all available relevant information, including any previous reports. Sources as follows:
    - Central Otago District Council (CODC) property files.
    - Otago Regional Council (ORC) HAIL database and property records.

[1] Ministry for the Environment, 2012. *Users' Guide - National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health*.

[2] Ministry for the Environment, 2011. *Contaminated Land Management Guidelines No. 1 - Reporting on Contaminated Sites in New Zealand (Revised 2011)*.

- Historical and recent photographs.
- Other sources of information as cited herein.

- Carry out a walkover to verify site conditions and inspect for indicators of potential contamination.
- Excavation of auger holes to 2.5 metres with soil sampling from selected auger holes. Analyse soil samples for heavy metals, pesticides and hydrocarbon contaminants.
- Prepare this report, which summarises our findings and assesses the following:
  - Whether previous and/or current on-site activities or adjoining land uses had or have the potential to cause contamination.
  - The likely nature of any contamination.
  - The risks to future users from any contamination.
  - The disposition of the property with respect to the NES.
  - The requirement for further investigations to define the degree or extent of any contamination.
  - Any conclusions and/or recommendations specifically pertinent to the objectives of this investigation.

2 Site Environment

2.1 Site Identification

The general location is shown in Figure 1, and the relevant property details are given in Table 1. The extent of the property is shown shaded lilac in Figure 2. The property has a total area of 9.7036 ha of which approximately 2.4 ha is identified as a Verified HAIL site (HAIL.00338.01). The ORC site records note that the location and extent of the identified HAIL site on the ORC database may not be accurate. The identified HAIL site is shown outlined in Figure 2 in turquoise.

The title includes two blocks of land separated by an accessway as shown in Figure 2. The larger of the two blocks (Sec 118 BLK VIII BENGER SD), outlined in yellow, is defined as the site for the purposes of this investigation. It consists of 8.02 ha that is proposed to be subject to mining. The smaller block (Sec 110 BLK VIII BENGER SD) is excluded from the mining area.

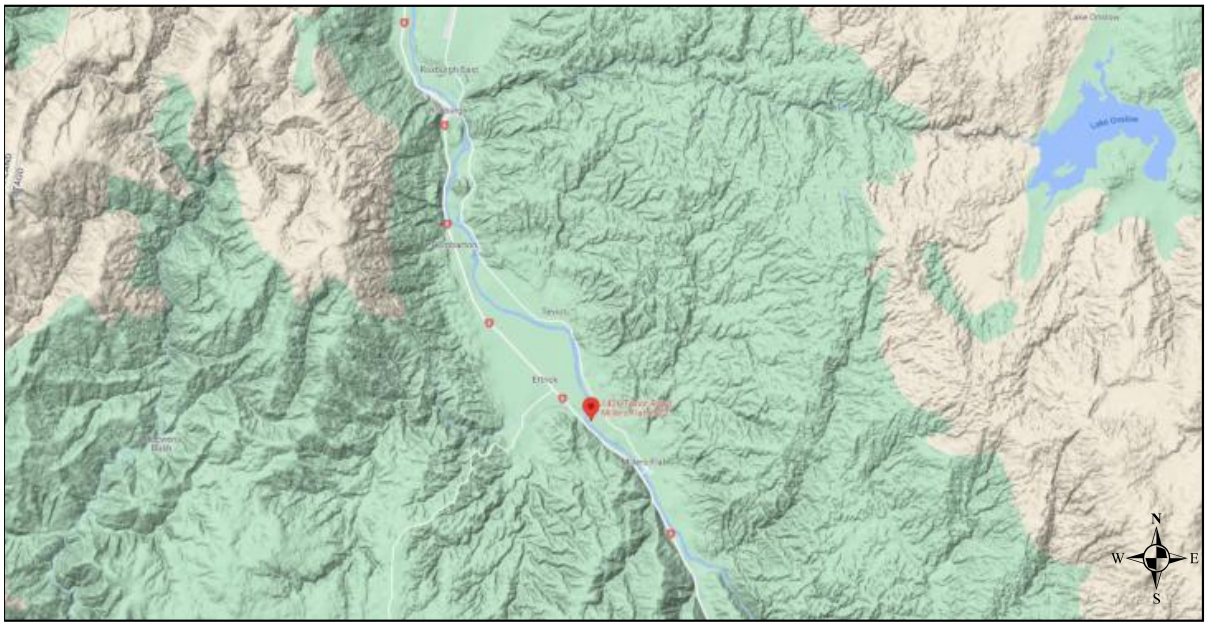


Figure 1: General location of the property, shown with a red tag (Map Data ©2022; Google Terrain).

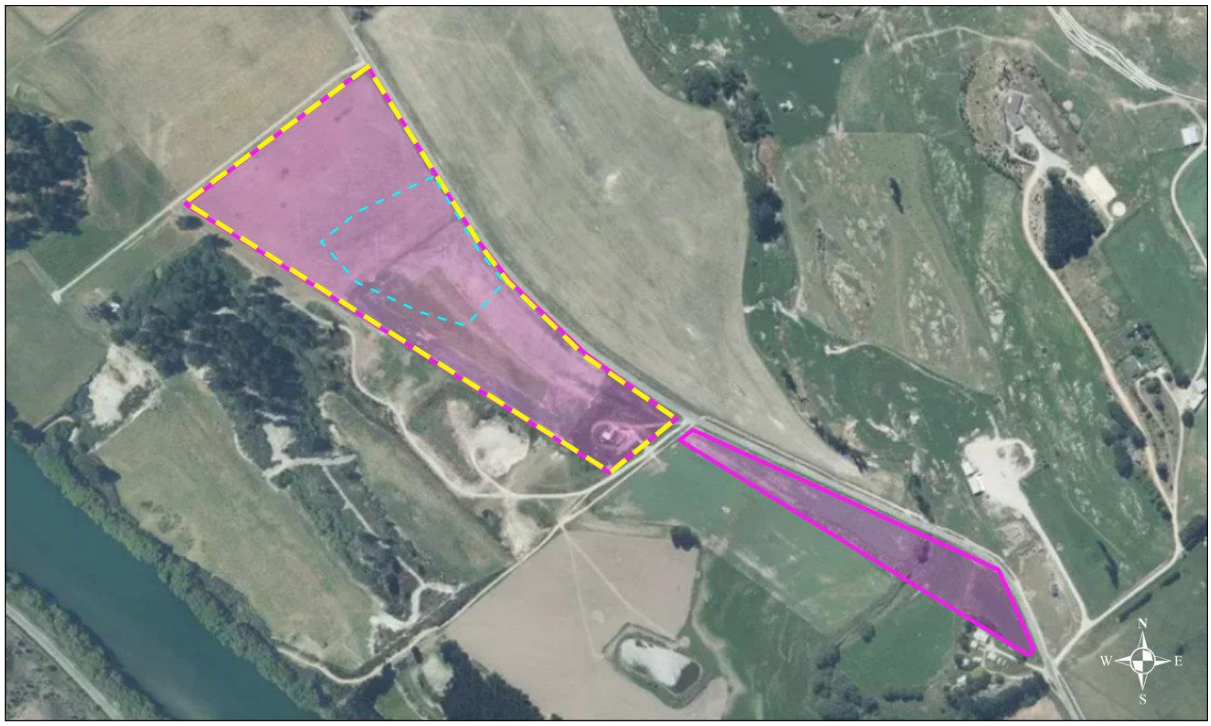


Figure 2: The extent of the property shaded lilac with the site outlined in yellow and the land identified on the ORC HAIL database as a Verified HAIL site outlined in turquoise (Central Otago District Council Geographic Information System, CC BY 4.0 NZ).

Table 1: Property details.

Owner	Alan Thomas Parker
Address	1484 Teviot Road
Legal description	SECS 110 118 BLK VIII BENGER SD
Certificate of Title	241193
Area	9.7036 ha
District Plan / zoning	Rural

2.2 Topography

The property is located on a terrace adjacent to the left bank of the Clutha River, 2.3 Kilometres upstream (to the northwest of) the township of Millers Flat. The property is generally flat to gently rolling sloping to the south and west. Elevation is around 70 m above sea level and the land is between five and ten metres above the Clutha River which lies between 400 and 500 metres to the west and south of the property.

2.3 Site Access

Teviot Road is located at the north-eastern boundary of the site with access from a formed driveway at the site southern boundary.

2.4 Geology

The site is formed of late Pleistocene river deposits bedded, locally derived, unweathered to slightly weathered sandy gravel in low terraces in non-glaciated catchments overlying undifferentiated Caples terrane schist[3]. The shallow geology is characterised in more detail by the bore log from the monitoring well (G43/0112) within the property as set out in Table 2.

[3] https://data.gns.cri.nz/geology/

Table 2: Bore log well G43/0112

Depth (m)	Description
0.00-4.00	Loose Sandy Gravels
4.00-8.00	Boulders
8.00-10.00	Loose Sandy Gravels
10.00-12.00	Sandy Gravels Wet
12.00-14.00	Sand Wet

The site is described by the ORC Hazards Database[4] as having has a low to no liquefaction potential (Domain A) being predominantly underlain by rock or firm sediments with Ground Class D (Deep or Soft Soil).

2.5 Hydrology

2.5.1 Surface Water

No surface water was visible on the site at the time of the inspection, and review of the ORC Hazards Database indicates that the site is not at risk of flooding. Tima Burn runs through the eastern part of the property and the ORC Hazards Database identifies a flood risk in this part of the property associated with the Clutha River. The CODC District Plan identifies this portion of the property as flood prone.

2.5.2 Groundwater

No groundwater was encountered during excavation of auger holes and the site is not located over any identified aquifer; however it lies approximately 650 m to the southeast of the Ettrick Basin Aquifer[5]. The bore records held by the ORC[6] identify one bore located on the site for groundwater investigation purposes. While the depth to groundwater is not reported on the database, a Landfill Monitoring Report[7] shows depth to groundwater during six annual inspections between September 2016 and November 2021 was within a range of 10.8 and 11.62 m.

One bore used for domestic water supply is located within 0.5 km of the centre of the site as shown in Table 3.

Table 3: Bore locations within a 0.5km radius of the centre of the property.

Well Number	Distance/Direction	Owner	Usage	Depth to Water
G43/0112	-	CODC	Groundwater Investigation	-
G43/0142	470 m NW	Liyawarachahi G	Domestic	-

3 Site History

3.1 Site Ownership

Three historical certificates of titles have been found for the site. The earliest of these, dated 10th March 1970 (OTA 5A/514, formerly Lands and Survey DPF 382), records Stanley N Parker (school teacher) as the License Holder pending sale of the land by the Crown. DPF Record 382 was not accessible but relates to Crown Ownership of the land formerly part of the Roxburgh railway line.

[4] https://maps.orc.govt.nz/portal/apps/MapSeries/index.html?appid=b24672e379394bb79a32c9977460d4c2
[5] https://data.mfe.govt.nz/layer/52675-location-and-extent-of-nzs-aquifers-2015/
[6] https://maps.orc.govt.nz/portal/apps/MapSeries/index.html?appid=052ba04547d74dc4bf070e8d97fd6819
[7] ENGEO Limited, 2021. *Annual Report Closed Landfills, Central Otago*.

Title OT8C/1327, issued 19th February 1981, notes transfer of the land to Miriam Helen Parker (widow) and Russell Douglas Checketts (solicitor) as Executors on the 24th April 1996. This title was cancelled and CT 241193 issued on 8th September 2005 with ownership transferred to the present owner Alan T Parker.

The titles note that the property is subject to Section 59 Land Act 1948 and a number of now expired mining exploration permits have been registered against the site.

3.2 Site Use History

The site history is well represented by the historical photographic record with the earliest image from 1903 and aerial images covering the site dating 1944, 1959, 1963, 1968, 1969, 1974, 1975, 1980 and 1983 from the Retrolens website, from 1951, from the VC Browne collection, and images from 2005 to 2020 from Google Earth, from 2008 and 2012 from Google Maps Street view, and undated more recent photography from the CODC GIS.

The earliest image of the property, in Figure 3, shows the site in 1903. At this date the site is in pasture. This image is one of a four-part panorama with the adjacent photo (not shown) showing gold dredging of the gravel deposits adjacent to the Clutha River occurring to the northwest of the property.

Figure 3: The property located in the centre of the image, and its surrounds in 1903 (Source Hocken Collections, Uare Taoka o Hākena, University of Otago; Title: CLUTHA RIVER - Goldmining Dredging c1903 (left) from near Ettrick to (right) Miller's Flat [Part 3 of 4 part panorama]).

The former Roxburgh Railway line was located along the road boundary of the site. Historical records relating to the construction indicate that the section of the line between Millers Flat and Roxburgh was constructed between 1925 and 1928[8].

"The Roxburgh Branch railway used to pass through the town; it was opened to Millers Flat in 1925 and was the terminus for approximately two and a half years, until the section to Roxburgh was

[8] https://en.wikipedia.org/wiki/Roxburgh_Branch

opened. The line was closed in 1968, though the town's station platform and some of the railway formation still exist"[9].

Gravel was quarried from within the site during construction of the railway with the gravel quarry forming a long trench adjacent to the north-eastern site boundary. This long, curved trench has the appearance of an access road that terminated in a quarried area extending roughly three quarters of the way across the site. The quarry and trench are visible in the image in Figure 4 showing the site in 1951. In this image the majority of the site remains bare of distinctive features and the disused quarry appears undisturbed from the earlier image in 1944 (not shown) with no evidence of landfilling or vehicle access being evident. The railway is present along the road boundary of the property.

Figure 4: The property in 1951, with the approximate property boundary outlined in yellow and the HAIL site outlined in turquoise (V.C. Browne and Son NZ Aerial Photograph Collection).

The image from 1963 (Figure 5) shows the site and the HAIL site in considerable detail. There is no evidence of significant landfilling at this date. A substantial gravel pit has been excavated adjacent to (outside of) the site southwestern boundary.

The next image of the site from 1980 in Figure 6 shows active landfilling occurring at the head of the former quarry closer to Teviot Road with the western part of the quarry already filled and covered over. The landfill area is served by a short access track. The railway formation remains present but appears less well defined. A further image from 1983 (not shown) show no change within the site from the 1980 image.

There is an interval of 22 years between the 1983 image and the first Google Earth Image of the site from 2005 shown in Figure 7. By this date the landfill area is no longer in use and appears to have been covered over and the railway formation is no longer visible. The entire head of the quarry has been filled and all that remains of the old quarry appears as a long narrow pit adjacent to the road boundary of the site. This remnant part of the quarry otherwise appears largely unchanged from the earliest image. By 2011 (Figure 8) the pit appears to have been "recontoured". The reshaping

[9] https://en.wikipedia.org/wiki/Millers_Flat

appears to have involved trimming and shaping the upper edges of the pit with the material derived from that being placed in the bottom of the pit as the contour of the pit reduced to a broad swale enabling the land to be integrated into the irrigated cropping regime presently occurring on the site. At present the site appears unchanged from the 2011 image.

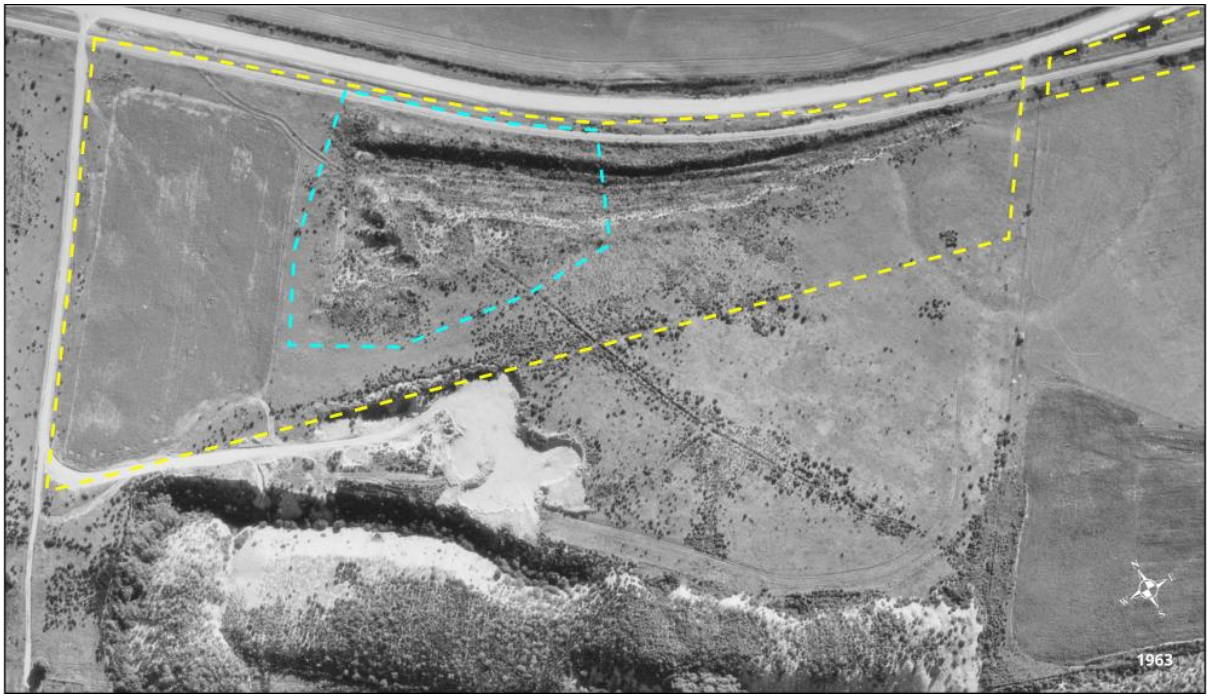


Figure 5: The site in 1963, with the HAIL site boundary outlined in turquoise and the property outlined in yellow (Sourced from http://retrolens.nz and licensed by LINZ CC-BY 3.0).

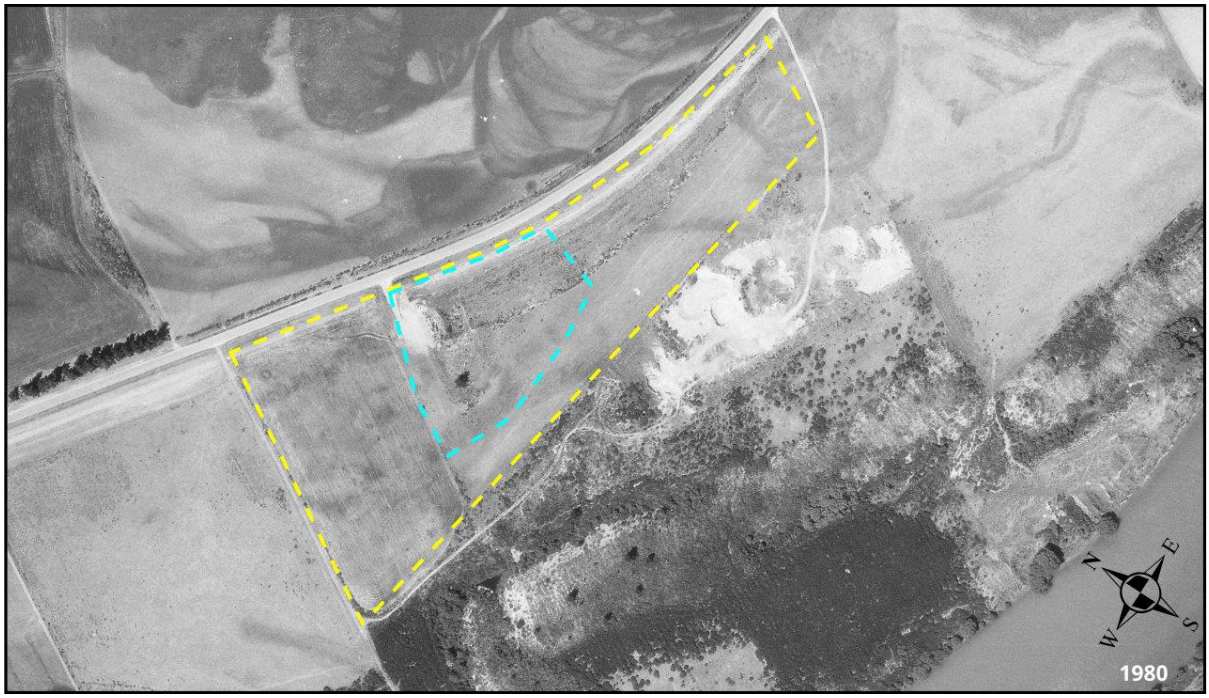


Figure 6: The site in 1980, with the HAIL site boundary outlined in turquoise. The landfilling activity is clearly present at this date with a short access track from Teviot Road. The western part of the gravel quarry appears to have been filled (Sourced from http://retrolens.nz and licensed by LINZ CC-BY 3.0).

Figure 7: The site in 2005, outlined in yellow and the landfill site outlined in turquoise. The landfilling activity evident in the image from 1980 is no longer occurring and the landfill access road has been removed. The parts of the former gravel quarry not used for landfilling remain otherwise unchanged (Image @ 2022 Maxar Technologies, Google Earth).

Figure 8: The site in 2011 showing the area formerly occupied by the quarry has been recontoured to remove the abrupt edges to the pit and to raise the lower parts such that the feature now forms a gentle swale in the paddock (Image @ 2022 Maxar Technologies, Google Earth).

3.3 Regulatory Matters

3.3.1 District Council Records, Consents and Licenses

The CODC provided a copy of the council's records relating to the site. The records all relate to the closed landfill (Millers Flat Landfill) and include excerpts from the site closure plan, 2021 Annual Report on Closed Landfills, Central Otago; 2022 Compliance Monitoring Report (by the ORC); Discharge Permit 95233 (discharge of leachate to land, expiring 2026); Discharge Permit 95234 (discharge of landfill gas, odour and dust to air, expiring 2026); and an ORC File Note on the HAIL extent for the Millers Flat Closed Landfill.

The records include note that a resource consent application by Duffill Watts & King Limited in February 1997 states that it is unknown exactly how long the landfill had been operating, but it is expected to be greater than 10 years. It estimates that waste filling occurred over an area of 10,000 m^2 in a long narrow pit that was created when gravel was taken for the construction of the local rail line.

The closure plan was prepared by Montgomery Watson in November 2000. The excerpts contain minimal information on the landfill but note that filling occurred over an area of approximately 10,000 m^2, that the nature of the waste was not recorded however is likely to comprise domestic waste with components of commercial and agricultural waste, and that the landfill was closed and covered in June 1997. A contour plan shows the possible landfill extent, monitoring well location and extent of the tip face.

The 2022 Compliance Monitoring Report by the ORC dated 1 June 2022 notes that there is moderate non-compliance with the conditions of the discharge consents:

"During the 2022 audit it was found that most of the site was covered in green crop for overwintering cattle. Furthermore, under section 2.3 'Future Use' the plan states that future uses of a closed landfill 'may include use for grazing (by owner or leased to adjacent land owners). This would be limited to grazing sheep to prevent damage to the landfill cap.' The Millers flat site is therefore not managed in accordance with this plan. There was no damage to the cap noted in the 2021 site inspections conducted by ENGEO nor during the ORC 2022 audit. However, the accumulative impact of using the Millers flat closed landfill for agricultural purposes has not been assessed. The carrying capacity for the site it not know and nor are the chemical interactions that are taking place at this site. Groundwater sample results were the highest they have ever been for Nitrate which was reported above the NPS value for freshwater in November 2021. This indicates that the agricultural use on this closed landfill site may be influencing groundwater quality."

The compliance report conclusions are as follows

- *There is a risk to the cap & groundwater by allowing overwintering of cattle on a closed landfill.*
- *Grazing cattle is also not in accordance with the closed landfill management plan.*
- *The accumulative impact of using the Millers flat closed landfill for agricultural purposes has not been assessed. The carrying capacity for the site it not known and nor are the chemical interactions that are taking place at this site.*
- *Groundwater sample results were the highest they have ever been for Nitrate which was reported above the NPS value for freshwater in November 2021.*
- ***Consents 95233 & 95234 will both expire in 2026.***
- *The 2019 annual report was submitted over 6 months late.*

- *There is no closed landfill sign for this site.*
- *Nitrate was reported above the NPS value for freshwater in 2021. It has been high historically too.*

The compliance report also notes an updated closed landfill management plan will be required for consent renewal.

The ORC Consent Decision Report observed

The small amounts of landfill gas produced will permeate through the cap and disperse into the air. The surface of the closed landfill is such that no dust should be generated from it and unless the waste is disturbed no odour should be produced[10].. Interaction with groundwater is not evident from the limited information contained in the ORC consent compliance monitoring report[11]. The base of the fill material also appears, from the bore monitoring data, to be isolated from groundwater as the depth to water measures indicate that ground water level is more than 6 metres below the base of the fill.

The CODC GIS also notes a 2005 S224c Certification for a subdivision boundary adjustment and a 2009 Code of Compliance Certificate for a new shed.

The land where the site is located is zoned Rural Resource Area in the CODC District Plan. The present land use (pasture) is consistent with the zone provisions and the proposed use is a discretionary activity under rule 4.7.4 and 4.7.6.

3.3.2 Regional Consent Records

The ORC database notes Discharge Permit 95233 (discharge of 1,020 m^3 per year of landfill leachate to land, expiring 2026) and Discharge Permit 95234 (discharge of landfill gas, odour, and dust to air, expiring 2026) in addition to Discharge Permit 95232 (discharge of contaminants to land resulting from the operation of the Millers Flat Landfill) and Consent 96420 (bore construction consent, expiring 1998).

3.2.3 HAIL/Contaminated Land Databases

The ORC HAIL database identifies a part of the site as a Verified HAIL site (HAIL.00338.01) due to HAIL activity G3 (Landfill Sites) noting that the site is managed through CODC consents (Figure 9).

[10] ORC Report No: 2002/366 Decision on Applications 95233 and 95234 s5.4

[11] ORC CONSENT AUDIT REPORT Inspection # 593722 & 593723 for consents 95233 and 95234 01 June 2022

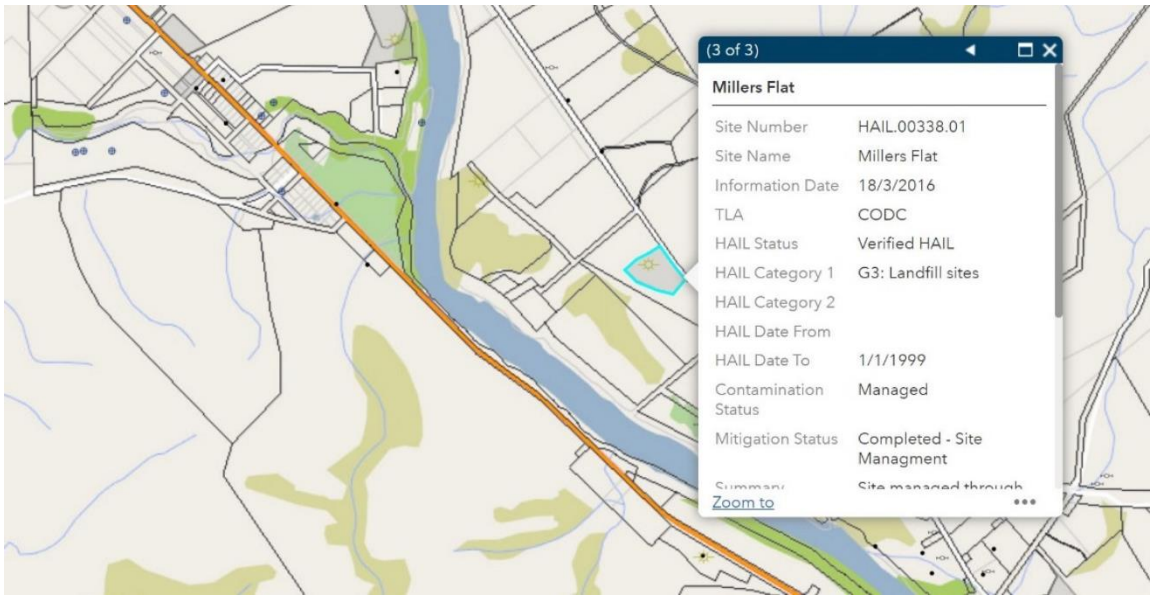


Figure 9: Extract from ORC Contaminated Land Database showing the recorded location of verified HAIL site HAIL.00338.01 recorded as being a managed site.

3.4 Use of Land Adjacent to Site

The site is bordered by rural land used for grazing and cropping. A now closed green waste landfill is located in a disused gravel quarry adjacent to the site's southwestern boundary. The photographic record of the site from 1903 to the present show that the surrounding areas to the west and south have been in pasture with dredging of alluvial gravels for gold occurring between the site and the Clutha River in the late 1800's through to the early 1900's. The Teviot Road runs along the site north-eastern boundary and from the mid 1920's the Millers Flat - Roxburgh rail line occupied the north-eastern site boundary until it was removed in the 1968.

3.5 Previous Investigations

No previous investigations on the site were found. However several reports are available for the landfill. The landfill closure plan encompasses 12 CODC landfills closed following the opening of the Victoria Flats landfill. The site plan contained within the landfill closure plan noted the presence of one monitoring bore located to the south of the landfill site. The closure plan notes that an estimated 1,020 m^3 of leachate will be generated per year (2.8 m^3 per day) however this discharge will be substantially influenced by weather events. The closure plan does not record any investigations relating to gaseous discharge but the ORC Staff recommending report[12] makes a general statement that "*Gases arising from the decomposition of solid waste, such as methane and carbon dioxide, will migrate through the soil matrix to the surface and be dissipated in the atmosphere. The soil matrix will act as a natural 'biofilter' and remove much of the odour. Quantities of gases are expected not to be significant from these landfills. In addition, the high porosity of the soils will defuse the gases evenly dissipating them to the atmosphere without concentrating them.*"

The 2021 annual report[13] on annual monitoring of groundwater nitrate, chloride, pH and conductivity from 2016-2021. The 2022 ORC Compliance Monitoring Report notes the nitrate levels are elevated and highly variable and the agricultural activity on the land may be impacting

[12] ORC File No: 95233 and 95234 Report No: 2002/366

[13] ENGEO Limited, 2021. *Annual Report Closed Landfills, Central Otago*.

groundwater quality rather than the residual impacts from the landfill. Current and Proposed Future Use

The site is currently operated as a farm and the land is planted in winter feed crops. The proposed mining activity will be undertaken progressively over the site as a temporary activity with the land being restored to pasture on completion of the mining activity. The mining will comprise the progressive excavation of the alluvial gravels over the entire river terrace excluding the landfill area, for processing for extraction of gold with the excavated material being reinstated following processing.

4 Site Condition and Surrounding Environment

4.1 Site Inspection

A site inspection with soil sampling was undertaken by an EC Otago Senior Environmental Consultant on 20th May 2022. The site inspection included a walk-over and the excavation of thirteen auger holes outside the perimeter of the closed landfill, with collection of six soil samples for analysis.

The site is in open pasture with brassica crops for winter feed over the parts outside of the closed landfill. Part of the landfill area is sown in grass, but the bulk of the former landfill is covered with a winter turnip and kale crop.

The HAIL site is shown in Figure 10. The landfill occupies the lower lying parts of the land in the central and more distant parts of the land shown in this image. The landfill monitoring bore G43/0112 is visible in the foreground at lower left in the image. A farm fence crosses the HAIL site and irrigation sprinklers on pipe upstands are spread across the site in lines parallel with the Teviot Road boundary.

Figure 10: The site looking north with landfill area occupying the area from the depression at upper left of image to Teviot Road at right. The ground water monitoring bore is within the wooden structure at lower left (20 May 2022).

4.2 Conditions at Site Boundaries

The HAIL site boundaries are not distinctly identifiable within the site. The site is flat to slightly undulating with cropping occurring across both the site and the surrounding farmland. `. No erosion or instability is evident within or adjacent to the site.

4.3 Signs of Contamination

The site showed no indication of potential sources of contamination. There were no visible signs of spills or leaks, surface or soil staining or areas where the surface vegetation appeared to be damaged by gas emissions or toxic soil conditions. There were no visible or olfactory indicators of contamination evident during the augering.

5 Soil Sampling and Analysis for Contamination

5.1 Overview

According to the Ministry for the Environment's guidelines for contaminated land investigations, sampling and analysis are optional in a PSI, with information on this to be provided "as available". Ultimately, however, the disposition of any contamination can only be confirmed with results from field sampling and analysis for contaminants. The primary purpose of this site investigation was to establish a mining perimeter by confirming the absence of landfill in the land surrounding the landfill, effectively defining the boundary of the HAIL site. The mining perimeter is to be established as a margin to the mining operation where it is proximate to the landfill such that the mining activity can be assured of being able to be conducted without disturbance to the landfill and its contents

5.2 Sampling and Analysis Plan

The approximate landfill extent was established by measuring distances on Google Earth from fence lines and roads that were present when the landfill was in operation and that remain on site now. The perimeter has been based on establishing a minimum of 10 m separation between the landfill as indicated by the maximum extent of the gravel quarry in the 1963 aerial view in Figure 5 and recent Google Earth imagery with the fill area as shown in the closure plan overlaid as a guide (Figure 12). The boundaries forming the approximated perimeter were located in the field using a hand-held GPS unit with an accuracy to 2-5 m. Thirteen holes were augered to a depth of 2.5 metres along the identified perimeter as shown in Figure 11, to confirm that undisturbed ground was present at each location and that no visible or olfactory evidence of landfilling was observed. The site plan contained within the Landfill Closure plan showing the full extent of the landfill is overlain on this image so that the relationship with the sampling points to the surveyed location of the landfill can be seen. The location of the auger holes were recorded with a handheld Garmin InReach GPS with an accuracy of 2-5 m.

Figure 11: Location and dimensions of the HAIL site as measured on 2020 Google Earth imagery and with landfill extent as documented in the CODC Landfill Closure Plan overlaid with auger holes as recorded with handheld GPS (Image © 2022 CNES/Airbus, Google Earth).

Clothing and a plastic bag were brought to the surface from a depth of more than 1 m at the first auger hole as shown on Figure 12. While these items did not appear to be associated with other landfill material, the location was closer to the toe of the landfill and the perimeter holes at this end of the fill area were moved 15 metres to the south.

Four holes were augered along the south-eastern end of the HAIL site and a further eight holes were located along the western and northern sides. Soil samples were collected by hand selection from the soil extracted with the auger at six locations as shown in Figure 12 to determine the contamination status of the soil at each location.

The sampling plan was developed to provide an indication of the contaminant levels along the identified mining perimeter in the areas surrounding the landfill. The sampling plan is shown in Figure 14. A total of six samples were collected labelled MF1-MF6. Two samples (MF1, MF2) were collected from the augur holes across the down slope margin within the former quarry trench and four samples were collected on the upslope end of the fill area. The samples were analysed as two composites consisting of three subsamples each. Samples were not collected from auger holes 10-13 as these were all in undisturbed natural soils and are represented by samples MF4-6.

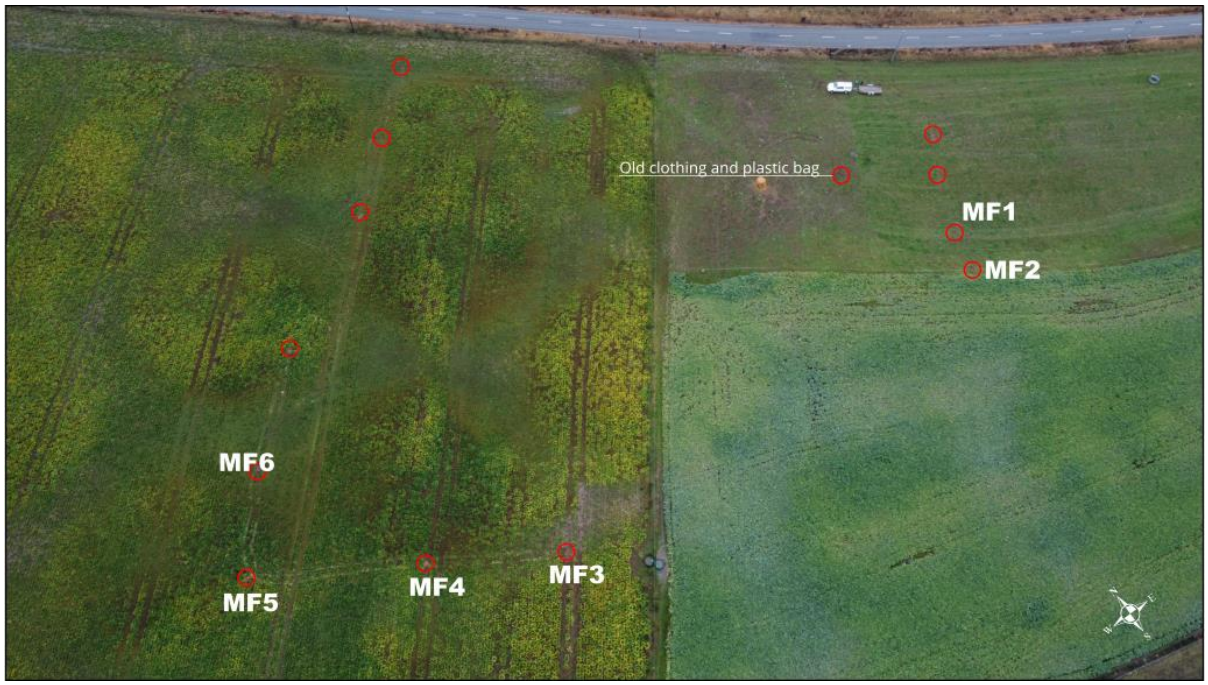


Figure 12: Aerial drone image showing auger locations circled in red and sample locations annotated MF1-MF3 and MF4-MF6. The first auger hole encountered some items of clothing and a plastic supermarket bag as shown. All of the remaining auger holes were observed to be in undisturbed or unmodified natural material (20 May 2022).

5.3 Sampling Methods

Samples from the auger holes were collected by hand selection of material representative of the full 2.5 m depth of each hole, using freshly gloved hands.

Samples were transferred into clean, contaminant-free containers provided by the testing laboratory and placed into a chilly bin cooled with icepacks. During sampling, the date and time of collection was recorded, and the location was recorded. Containers were labelled with sample name, date and time on both label and lid as the samples were taken, and the location was recorded with a handheld Garmin InReach GPS unit with a locational accuracy of ±5 m. The chain of custody form was completed during field operations, and samples were immediately dispatched to the analytical laboratory by courier. The samples were received and analysed by RJ Hill Laboratories Limited, an International Accreditation New Zealand (IANZ) accredited laboratory.

6 Results from Sampling and Analysis

6.1 Soil Acceptance Criteria

As part of the process of determining the risk to human health from potential contaminants, results from analysis must be compared to Soil Contaminant Standards (SCSs) which reflect acceptable risk levels of contamination in soil for the appropriate use scenarios[14]. For some analytes, the Ministry for the Environment has not established SCSs, in this case, Soil Guideline Values (SGVs) from other sources may be used according to an established hierarchy[15]. For contaminants without an SCS in the NES, the Australian National Environment Protection (Assessment of Site Contamination) Measure (NEPM)[16] were applied.

The soils are also compared to the Canadian Council of Ministers of the Environment (CCME) Soil Guidelines for the Protection of Environmental and Human Health[17] as an indication of the environmental risk from potential contaminants.

The land where the site is located is zoned Rural in the District Plan. The nature of the proposed activity is commercial, however for assessment purposes the *Rural residential* SCS/SGV are shown as a conservative assessment.

6.2 Results of Analysis

The full analysis report is provided in Appendix C and the results are summarised in Table 4.

The results show that contaminant concentrations across the site are consistent with the predicted background concentrations based on the underlying geology for heavy metals. Results for organochlorine pesticides and polycyclic aromatic hydrocarbons were below the laboratory limits of detection.

The results confirm that the perimeter identified has not been affected by landfill activity and the contaminant levels are at or below background concentrations.

[14] Ministry for the Environment, 2011. *Methodology for Deriving Standards for Contaminants in Soil to Protect Human Health*.

[15] Ministry for the Environment, 2011. *Contaminated Land Management Guidelines No. 2: Hierarchy and application in New Zealand of environmental guideline values (revised 2011)*.

[16] National Environment Protection Council (Australia), 2013. *National Environment Protection (Assessment of Site Contamination) Measure 1999.*

[17] Canadian Council of Ministers of the Environment, 2021. *Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health*.

Table 4: Summary results of soil analysis.

Sample [A]	Arsenic	Cadmium	Chromium	Copper	Lead	Nickel	Zinc	DDT[B]	BAP_{eq}[C]
MF1, MF2 & MF3	6	< 0.10	7	15	19.7	6	32	< 0.07	< 0.03
MF4, MF5 & MF6	4	< 0.10	4	6	16.6	4	18	< 0.07	< 0.03
Average	*5*	*< 0.10*	*6*	*11*	*18*	*5*	*25*	*< 0.07*	*< 0.03*
Soil Acceptance Criteria (Human Health) – Rural residential									
NES[C] SCS	17	0.8	290	>10,000	160	-	-	45	6
NEPM[D] SGV	-	-	-	-	-	400	7,400	-	-
Soil Quality Guidelines (Environmental Health)									
CCME [E]	17	3.8	64	63	70	45	250	0.7	20
Predicted Background [F]									
Median	2.38	0.065	11.76	11.23	7.11	6.24	23.61	0.024	0.052
95th Quantile	9.97	0.33	56.88	48.14	25.83	35.15	97.97	0.245	0.64
Landfill Screening Acceptance Criteria [G]									
Class A	100	20	100	100	100	200	200	500	300
Class B	10	2	10	10	10	20	20	50	30
Burnside	100	20	400	400	400	200	800	500	300

[A] Results for total concentration analysis, average, 95% upper confidence limit (UCL) and SCSs/SGVs in mg/kg dry weight; relative standard deviation (RSD) in %. Sample numbers are as marked in Figure 17. Cells highlighted yellow exceed the predicted background concentration and red cells exceed the Soil Acceptance Criteria for Human Health.

[B] The total DDT isomers is reported.

[C] The benzo(a)pyrene equivalent (BAP_{eq}) is calculated as the sum of each of the detected concentrations of nine carcinogenic PAHs (benzo(a)anthracene, benzo(b)fluoranthene, benzo(j)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, chrysene, dibenzo(a,h)anthracene, fluoranthene and indeno(1,2,3-cd) pyrene), multiplied by their respective potency equivalency factors from Table 40 in the *Methodology for Deriving Standards for Contaminants in Soil to Protect Human Health* (Ministry for the Environment, 2011. Wellington).

[D] Ministry for the Environment, 2012. *Users' Guide, National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health.* Wellington. Cr SCS is reported as Cr(VI). Rural residential scenario applied.

[E] National Environment Protection Council (Australia), 2013. *National Environment Protection (Assessment of Site Contamination) Measure 1999.* The values applied represent a Health Investigation Level (HIL) for Low Density Residential land use (HIL A).

[F] Canadian Council of Ministers of the Environment, 2021. *Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health*. Soil quality guideline for environmental health for agricultural land use quoted. Orange cells indicate the site average exceeds the guideline.

[G] Landcare Research, 2015. *Background soil concentrations of selected trace elements and organic contaminants in New Zealand*. Predicted median and 95th Quantile reported for the site (Chemical4 Factor: mudstone Pakihi). Also refer: https://lris.scinfo.org.nz/layer/48470-pbc-predicted-background-soil-concentrations-new-zealand/. BAP_{eq} and DDT for provincial land applied.

[H] Ministry for the Environment, 2004. *Module 2: Hazardous Waste Guidelines - Landfill Waste Acceptance Criteria and Landfill Classification.* And Burnside Landfill in Dunedin (RM17.198.01.V2). Blue cells indicate Landfill Acceptance Criteria that are exceeded by the average.

7 Site Characterisation

7.1 Type and Extent of Environmental Contamination

The limited sampling described above found contaminant levels along the established perimeter are at or below background concentrations. The results for polycyclic aromatic hydrocarbons and organochlorine pesticides were found to be below the levels of detection.

Based on these results, it is highly unlikely that the part of the site beyond the perimeter (outside of the defined HAIL site) presents a risk to human health or the environment in its current state or during development works.

The GPS coordinates of the perimeter are given in Table 5.

Table 5: GPS Coordinates of Perimeter

GPS Location	Latitude	Longitude
3	45.647511	169.392919
5	45.647729	169.392594
6	45.647431	169.391360
8	45.647127	169.390958
13	45.646570	169.392198

7.2 HAIL Activities

The information reviewed during this PSI and the site inspection have confirmed that HAIL Category G3 (*Landfill Sites*) applies to part of the land. No other HAIL activities were identified within the site. The investigation has identified a mining perimeter, the boundary of which was shown to be unaffected by the HAIL activity with contaminant levels at or below background concentrations.

Any proposed disturbance of the land within the mining perimeter will require a full site investigation and consents to disturb a HAIL site / contaminated land from both CODC and ORC.

7.3 Conceptual Site Model

Based on the results of the soil sampling presented in this report, it is highly unlikely that there will be a risk to human health from the proposed mining of the land surrounding the landfill and there are no contaminants upon which to base a conceptual site model.

7.4 Integrity Assessment

The site historical record spans a period of almost 120 years and is fairly continuous from 1944. The proposed mining area (excluding the site of the quarry and subsequent landfill) has been rural land for the duration of the historical record.

Based on the continuity and amount of evidence, the information available provides a reasonable record of activity at the site, which reflects data integrity. Whether all activities at the site have been discovered cannot be answered with confidence.

A preliminary programme of investigative sampling and analysis was undertaken as a part of this PSI. Sampling and analysis provide a reliable indicator of the presence of contamination that might arise from prior and/or present land use. This provides an evidentiary basis from which to assess the site's status with respect to the HAIL and associated potential risks for human exposure.

8 Conclusions and Recommendations

EC Otago has undertaken a PSI on the site at 1484 Teviot Road, Millers Flat. The PSI included undertaking historical research, a site inspection and preliminary soil sampling. During this investigation, 6 soil samples were collected and analysed for heavy metals, organochlorine pesticides and polycyclic aromatic hydrocarbons. Twelve auger holes were excavated to a depth of 2.5 metres along the identified mining perimeter to confirm the absence of landfill material.

The information reviewed, and the investigation undertaken, confirmed that HAIL Category G3 (*Landfill Sites*) applies to part of the land. No other HAIL activities were identified within the site. The investigation has identified a mining perimeter, the boundary of which was shown to be unaffected by the HAIL activity with contaminant levels at or below background concentrations. As a result, the provisions of the NES do not apply to the part of the site outside the mining perimeter.

The investigation indicates it is highly unlikely that the soils outside the mining perimeter present a risk to human health or the environment in their current state or during the proposed mining works, based on the preliminary sampling undertaken.

Based on this investigation, EC Otago finds the following:

- Based on the information examined during this investigation, no evidence was found that HAIL activities have historically been, or are currently being, undertaken on the part of the site outside the mining perimeter. Consequently, the provisions of the NES do not apply to these parts of the site.
- Soil sampling and analysis did not identify any contaminants that exceed the predicted natural background levels along the mining perimeter.
- There is highly unlikely to be a risk to human health or the environment from soil contamination due to past historical activities outside the mining perimeter.
- If waste materials, or other visual or olfactory indicators of potential contamination are observed during earthworks, a Contaminated Land Advisor must be consulted, and further sampling and analysis is required.
- The NES does apply to the former landfill site, contained within the mining perimeter (HAIL.00338.01). Any proposed disturbance of this land, contained within the mining perimeter, will require a full site investigation and consents to disturb a HAIL site / contaminated land from both CODC and ORC.

9 References

ENGEO Limited, 2021. *Annual Report Closed Landfills, Central Otago*. Project Number #13716.000.005.

Landcare Research, 2015. *Background soil concentrations of selected trace elements and organic contaminants in New Zealand*. Landcare Research Contract Report: LC2440.

Ministry for the Environment, 2012. *Users' Guide - National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health*. Publication number: ME 1092; ISBN 978-0-478-37281-6 (print); 978-0-478-37282-3 (electronic).

Ministry for the Environment, 2011. *Contaminated Land Management Guidelines No. 1 - Reporting on Contaminated Sites in New Zealand (Revised 2011)*. Publication number: ME 1071; ISBN 978-0-478-37258-8.

Ministry for the Environment, 2011. *Contaminated Land Management Guidelines No. 2 – Hierarchy and Application in New Zealand of Environmental Guideline Values (Revised 2011)*. Publication number: ME 1072; ISBN 978-0-478-37259-5.

Ministry for the Environment, 2011. *Methodology for Deriving Standards for Contaminants in Soil to Protect Human Health*. Publication number: ME 1055; ISBN 978-0-478-37237-3.

National Environment Protection Council (Australia), 2013. *National Environment Protection (Assessment of Site Contamination) Measure 1999 (April 2013)*. (https://www.legislation.gov.au/Details/F2013C00288).

10 Limitations

Services for this project have been performed in accordance with current professional standards for environmental site assessments. No guarantees are either expressed or implied. This report meets the requirements of the NES as it has been undertaken in accordance with the *Contaminated Land Management Guidelines (No. 1 and No. 5)* and is certified by a suitably qualified and experienced practitioner. A statement of EC Otago's experience is attached as Appendix A. This report does not attempt to fulfil the requirements of legal due diligence.

There is no investigation that is thorough enough to preclude the presence of materials at the site that presently, or in the future, may be considered hazardous. As regulatory criteria are subject to change, a status with respect to contamination that is presently considered to be acceptable may, in the future, become subject to different regulatory standards that cause the site to become unacceptable for existing or proposed land use activities. Any recommendations, opinions or findings stated in this report are based on circumstances, facts and assessment criteria as they existed at the time that we performed the work and on data obtained from the investigations and site observations as detailed in this report.

Opinions and judgments expressed in this report, which are based on an understanding and interpretation of assessment standards, should not be construed as legal opinions. This report and the information it contains have been prepared solely for the use of Hawkswood Civil Limited. Any reliance on this report by other parties shall be at such party's own risk without prior agreement to the contrary.

Appendix A - EC Otago Statement of Experience

Environmental Consultants Otago Limited (EC Otago) was established in Dunedin in 2014 when the principal, Ciaran Keogh, recognized the need for a dedicated environmental consultancy in the region. The company is particularly focused on contaminated land issues. EC Otago undertakes the preparation of Preliminary and Detailed Site Investigation Reports, Assessments of Environmental Effects, Site Remedial Action Plans, Soil Disposition Reports and Site Validation Reports, working together with other environmental consultancies when a broader range of experience is required.

Ciaran Keogh - Principal and Senior Environmental Consultant
Master of Regional and Resource Planning, Master of Business Administration.

Ciaran has over 11 years' experience focussing specifically on contaminated land investigations in Otago with more than 200 site investigations completed, and over 30 years' experience in environmental and RMA planning, and executive management in regional and local government. His experience includes feasibility, planning and visual assessments, site rehabilitation projects for landfills, mines and transmission lines and switchyards, and management of the preparation of regional and district plans and the supporting policy.

Ciaran has previously worked as the Director of Planning with Taupo District Council, CEO of Clutha District Council, General Manager of Wakool Shire Council (Australia) and CEO of Environment Southland.

Bernice Chapman - Senior Contaminated Land Consultant
CEnvP, PhD in Biochemistry, Member of the Environment Institute of Australia and New Zealand.

Berni is a Certified Environmental Practitioner (Certification Number 1376) who has worked in small consultancy firms for 20 years in the waste management, waste-to-energy and contaminated land sectors. She has a strong ethos of waste minimisation, containment and management, the effective operation of existing resources with beneficial reuse where possible, protection of the environment and overall sustainability coupled with a pragmatic approach from direct involvement in day-to-day operations. Her experience includes preliminary and detailed site investigations, sampling and analysis, site remediation, feasibility studies, problem solving and process design. This work includes the management of a range of environmentally polluting industrial effluents, contaminated land investigations and site remediation.

Berni has previously worked as Laboratory Manager for Waste Solutions Ltd, an Associate for CPG New Zealand Ltd, and a Wastewater Treatment Specialist for ADI Systems.

Aleasha King – Contaminated Land Consultant
Graduate diploma in Geology, Master in Geophysics.

Aleasha is a Contaminated Land Consultant with a background in geology and geophysics and a strong commitment to the environment. Her experience in contaminated land investigations includes preliminary and detailed site investigations, sampling, data analysis and site remediation.

Aleasha has previously worked in Engineering Geology with experience in site soils investigations and bearing capacity assessments. For her master's degree, she studied the structure of the Alpine Fault at a formerly unmapped location on the West Coast of New Zealand.

Appendix B – CODC Landfill Closure Plan (Extracts)

Appendix C - Hill Laboratories Analysis Report

2.6 Millers Flat

2.6.1 Location and Ownership

The Millers Flat site is located on the south side of Roxburgh Hydro Milers Flat Road, approximately 1.5 kilometres east of Millers Flat.

Grid Reference:	NZMS G43 287 006
Legal Description:	Section 118, Block VIII, Benger Survey District

The site is owned by [redacted]

Access to the site is via the Roxburgh Hydro-Millers Flat Road.

2.6.2 Site Description

The Millers Flat site is located on a river terrace on the true left bank of the Clutha River. The river terrace containing the landfill site extends approximately 700m from the edge of the Clutha River to the toe of hills which rise above the river. Waste filling occurred over an area of approximately 10,000m^2 in a long narrow pit running parallel with Roxburgh Hydro- Millers Flat Road.

The surrounding land is rural.

3. Waste Present at the Sites

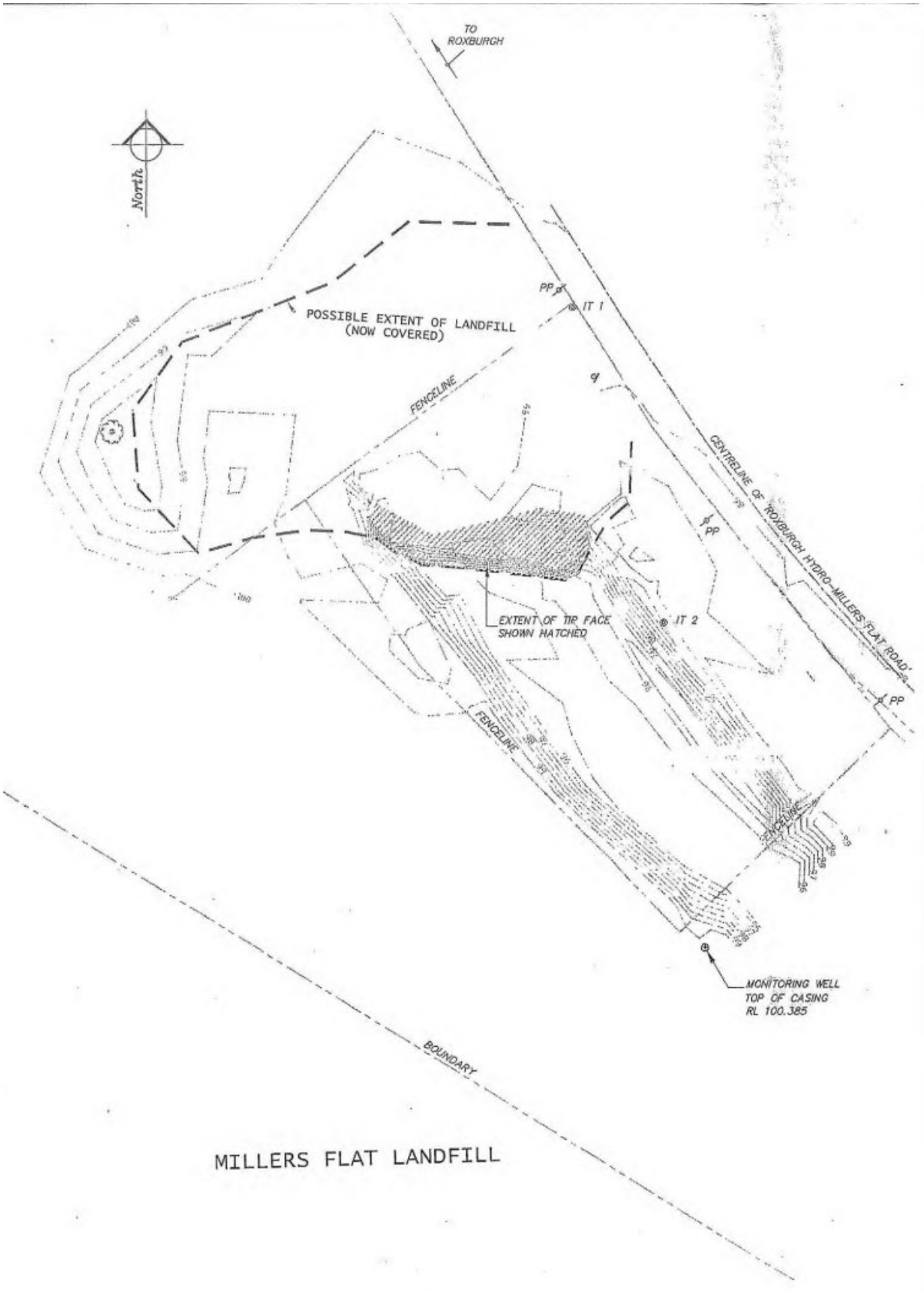
No records of the nature of waste at the site have been kept for any of the closed landfills. However the surrounding waste catchments suggest that waste will primarily comprise domestic waste with components of commercial and agricultural waste.

Generally exposed refuse at the former tip faces comprised domestic waste, plastic, scrap metal, car components, corrugated iron, glass and garden waste.

1.6 Millers Flat

This landfill was closed and covered in June 1997. It now has pasture established on it.

Millers Flat Closed Landfill – After Covering



MILLERS FLAT LANDFILL

Hill Laboratories
TRIED, TESTED AND TRUSTED

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

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

Certificate of Analysis

Client:	Environmental Consultants Otago Limited	**Lab No:**	2994809	SPv1
Contact:	Ciaran Keogh	**Date Received:**	23-May-2022	
	C/- Environmental Consultants Otago Limited	**Date Reported:**	26-May-2022	
	PO Box 5522	**Quote No:**	86979	
	Dunedin 9058	**Order No:**		
		Client Reference:	1426Teviot	
		Submitted By:	Bernice Chapman	

Sample Type: Soil

Sample Name:		Composite of MF1, MF2 & MF3	Composite of MF4, MF5 & MF6			
Lab Number:		2994809.7	2994809.8			
Individual Tests						
Dry Matter	g/100g as rcvd	95	93	-	-	-
Heavy Metals, Screen Level						
Total Recoverable Arsenic	mg/kg dry wt	6	4	-	-	-
Total Recoverable Cadmium	mg/kg dry wt	< 0.10	< 0.10	-	-	-
Total Recoverable Chromium	mg/kg dry wt	7	4	-	-	-
Total Recoverable Copper	mg/kg dry wt	15	6	-	-	-
Total Recoverable Lead	mg/kg dry wt	19.7	16.6	-	-	-
Total Recoverable Nickel	mg/kg dry wt	6	4	-	-	-
Total Recoverable Zinc	mg/kg dry wt	32	18	-	-	-
Organochlorine Pesticides Screening in Soil						
Aldrin	mg/kg dry wt	< 0.011	< 0.011	-	-	-
alpha-BHC	mg/kg dry wt	< 0.011	< 0.011	-	-	-
beta-BHC	mg/kg dry wt	< 0.011	< 0.011	-	-	-
delta-BHC	mg/kg dry wt	< 0.011	< 0.011	-	-	-
gamma-BHC (Lindane)	mg/kg dry wt	< 0.011	< 0.011	-	-	-
cis-Chlordane	mg/kg dry wt	< 0.011	< 0.011	-	-	-
trans-Chlordane	mg/kg dry wt	< 0.011	< 0.011	-	-	-
2,4'-DDD	mg/kg dry wt	< 0.011	< 0.011	-	-	-
4,4'-DDD	mg/kg dry wt	< 0.011	< 0.011	-	-	-
2,4'-DDE	mg/kg dry wt	< 0.011	< 0.011	-	-	-
4,4'-DDE	mg/kg dry wt	< 0.011	< 0.011	-	-	-
2,4'-DDT	mg/kg dry wt	< 0.011	< 0.011	-	-	-
4,4'-DDT	mg/kg dry wt	< 0.011	< 0.011	-	-	-
Total DDT Isomers	mg/kg dry wt	< 0.07	< 0.07	-	-	-
Dieldrin	mg/kg dry wt	< 0.011	< 0.011	-	-	-
Endosulfan I	mg/kg dry wt	< 0.011	< 0.011	-	-	-
Endosulfan II	mg/kg dry wt	< 0.011	< 0.011	-	-	-
Endosulfan sulphate	mg/kg dry wt	< 0.011	< 0.011	-	-	-
Endrin	mg/kg dry wt	< 0.011	< 0.011	-	-	-
Endrin aldehyde	mg/kg dry wt	< 0.011	< 0.011	-	-	-
Endrin ketone	mg/kg dry wt	< 0.011	< 0.011	-	-	-
Heptachlor	mg/kg dry wt	< 0.011	< 0.011	-	-	-
Heptachlor epoxide	mg/kg dry wt	< 0.011	< 0.011	-	-	-
Hexachlorobenzene	mg/kg dry wt	< 0.011	< 0.011	-	-	-
Methoxychlor	mg/kg dry wt	< 0.011	< 0.011	-	-	-

Sample Type: Soil						
Sample Name:		Composite of MF1, MF2 & MF3	Composite of MF4, MF5 & MF6			
Lab Number:		2994809.7	2994809.8			
Polycyclic Aromatic Hydrocarbons Screening in Soil*						
Total of Reported PAHs in Soil	mg/kg dry wt	< 0.3	< 0.3	-	-	-
1-Methylnaphthalene	mg/kg dry wt	< 0.011	< 0.011	-	-	-
2-Methylnaphthalene	mg/kg dry wt	< 0.011	< 0.011	-	-	-
Acenaphthylene	mg/kg dry wt	< 0.011	< 0.011	-	-	-
Acenaphthene	mg/kg dry wt	< 0.011	< 0.011	-	-	-
Anthracene	mg/kg dry wt	< 0.011	< 0.011	-	-	-
Benzo[a]anthracene	mg/kg dry wt	< 0.011	< 0.011	-	-	-
Benzo[a]pyrene (BAP)	mg/kg dry wt	< 0.011	< 0.011	-	-	-
Benzo[a]pyrene Potency Equivalency Factor (PEF) NES*	mg/kg dry wt	< 0.03	< 0.03	-	-	-
Benzo[a]pyrene Toxic Equivalence (TEF)*	mg/kg dry wt	< 0.03	< 0.03	-	-	-
Benzo[b]fluoranthene + Benzo[j] fluoranthene	mg/kg dry wt	< 0.011	< 0.011	-	-	-
Benzo[e]pyrene	mg/kg dry wt	< 0.011	< 0.011	-	-	-
Benzo[g,h,i]perylene	mg/kg dry wt	< 0.011	< 0.011	-	-	-
Benzo[k]fluoranthene	mg/kg dry wt	< 0.011	< 0.011	-	-	-
Chrysene	mg/kg dry wt	< 0.011	< 0.011	-	-	-
Dibenzo[a,h]anthracene	mg/kg dry wt	< 0.011	< 0.011	-	-	-
Fluoranthene	mg/kg dry wt	< 0.011	< 0.011	-	-	-
Fluorene	mg/kg dry wt	< 0.011	< 0.011	-	-	-
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	< 0.011	< 0.011	-	-	-
Naphthalene	mg/kg dry wt	< 0.06	< 0.06	-	-	-
Perylene	mg/kg dry wt	< 0.011	< 0.011	-	-	-
Phenanthrene	mg/kg dry wt	< 0.011	< 0.011	-	-	-
Pyrene	mg/kg dry wt	< 0.011	< 0.011	-	-	-

Summary of Methods

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

Sample Type: Soil			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
Environmental Solids Sample Drying*	Air dried at 35°C Used for sample preparation. May contain a residual moisture content of 2-5%.	-	7-8
Total of Reported PAHs in Soil	Sonication extraction, GC-MS analysis. In-house based on US EPA 8270.	0.03 mg/kg dry wt	7-8
Heavy Metals, Screen Level	Dried sample, < 2mm fraction. Nitric/Hydrochloric acid digestion US EPA 200.2. Complies with NES Regulations. ICP-MS screen level, interference removal by Kinetic Energy Discrimination if required.	0.10 - 4 mg/kg dry wt	7-8
Organochlorine Pesticides Screening in Soil	Sonication extraction, GC-ECD analysis. Tested on as received sample. In-house based on US EPA 8081.	0.010 - 0.06 mg/kg dry wt	7-8
Polycyclic Aromatic Hydrocarbons Screening in Soil*	Sonication extraction, GC-MS analysis. Tested on as received sample. In-house based on US EPA 8270.	0.002 - 0.05 mg/kg dry wt	7-8
Dry Matter (Env)	Dried at 103°C for 4-22hr (removes 3-5% more water than air dry) , gravimetry. (Free water removed before analysis, non-soil objects such as sticks, leaves, grass and stones also removed). US EPA 3550.	0.10 g/100g as rcvd	7-8
Benzo[a]pyrene Potency Equivalency Factor (PEF) NES*	BaP Potency Equivalence calculated from; Benzo(a)anthracene x 0.1 + Benzo(b)fluoranthene x 0.1 + Benzo(j)fluoranthene x 0.1 + Benzo(k)fluoranthene x 0.1 + Benzo(a)pyrene x 1.0 + Chrysene x 0.01 + Dibenzo(a,h)anthracene x 1.0 + Fluoranthene x 0.01 + Indeno(1,2,3-c,d)pyrene x 0.1. Ministry for the Environment. 2011. Methodology for Deriving Standards for Contaminants in Soil to Protect Human Health. Wellington: Ministry for the Environment.	0.002 mg/kg dry wt	7-8

Sample Type: Soil			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
Benzo[a]pyrene Toxic Equivalence (TEF)*	Benzo[a]pyrene Toxic Equivalence (TEF) calculated from; Benzo[a]pyrene x 1.0 + Benzo(a)anthracene x 0.1 + Benzo(b) fluoranthene x 0.1 + Benzo(k)fluoranthene x 0.1 + Chrysene x 0.01 + Dibenzo(a,h)anthracene x 1.0 + Indeno(1,2,3-c,d)pyrene x 0.1. Guidelines for assessing and managing contaminated gasworks sites in New Zealand (GMG) (MfE, 1997).	0.002 mg/kg dry wt	7-8

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

Testing was completed between 25-May-2022 and 26-May-2022. For completion dates of individual analyses please contact the laboratory.

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

Ara Heron BSc (Tech)
Client Services Manager - Environmental