Preliminary Soil Contamination Assessment

Glenlyon Reserve, Suttons Lane, Glenlyon

Client

Hepburn Shire Council

Issued

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Revision Table

REV	DESCRIPTION	DATE	AUTHORISED
0	Preliminary Soil Contamination Assessment: Glenlyon Reserve, Suttons Lane, Glenlyon	25/11/2019	AH

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APPENDIX

1. INTRODUCTION

At the request of Hepburn Shire Council, Beveridge Williams & Co P/L (Beveridge Williams) conducted a Preliminary Soil Contamination Assessment of Glenlyon Reserve, Suttons Lane, Glenlyon (referred to as "the site" in this report).

The purpose of the Preliminary Soil Contamination Assessment was to identify if the site contained any significant soil contamination (from current or historic use of the site for shooting club activities) that may pose an adverse risk to potential future users of the site and to provide guidance for potential redevelopment options.

This report presents information from desktop resources, results of soil sampling and testing programs, evaluation of the chemical testing results with respect to relevant criteria and conclusions and recommendations with regard to soil and suitability of the site for the continued recreational uses.

2. SITE DETAILS

Site details are presented in Table 2-1.

Table 2-1: Summary of Site Details

ITEM		SITE DETAILS	REFER TO
Site Address		Glenlyon Reserve, Suttons Lane, Glenlyon	Figure 1
Approx. Site Assessment Area (ha)		15.3	
Zoning		Public Park And Recreation Zone (PPRZ)	Appendix A
Municipality		Hepburn Shire Council	
Current Use		Recreation	Appendix B
Historic Site Use		Recreation	
Surrounding land uses	North	Residential/grazing	
	East	Grazing	
	South	Residential/grazing	
	West	Residential	

3. DESKTOP REVIEW

The following sources of historical information were reviewed:

- Aerial photographs held by the Nearmap and Google Earth
- Geology plans
- Hydrogeology plans
- Topography plans
- Shooting club activity information

3.1. Aerial Photographs

A review of recent aerial photographs from 2005, 2010, 2012, 2016 and 2018 was undertaken prior to attending the site. A summary of the observations is provided below.

Site conditions comprised a race/training track, smaller structures for equestrian events, a sports/cricket oval and equestrian dressage field through the central and east portions of the site. The site boundaries were treed, and several club houses/storage sheds were present south of the training track.

The site has remained in the current layout with minimal change to the site over the last 15 years comprising the addition of some sheds in the south portion of the site and areas of filling in the central portion of the site south of the sports oval.

3.2. Geology

The majority of the site is underlain by Quaternary age alluvials comprising gravel, sand, silt: variably sorted and rounded; generally unconsolidated; includes deposits of low terraces; alluvial floodplain deposits.

The site boundaries to the north and west are listed as being underlain by:

- Ordovician aged Castlemaine Group comprising sandstone, mudstone, black shale and minor granule quartz conglomerate: mostly thick-bedded sandstone, coarse- to fine-grained, often graded, diffusely stratified to cross laminated, moderately to well sorted; sparsely fossiliferous with graptolites and phyllocarids; deep marine turbidites and hemipelagic sediments. Soil types were confirmed by soil conditions encountered onsite; and
- Neogene Age Newer Volcanic Group comprising olivine tholeiite, quartz tholeiite, basanite, basaltic icelandite, hawaiite, mugearite, minor scoria and ash, fluvial sediments: tholeiitic to alkaline; includes sheet flows and valley flows and intercalated gravel, sand, clay.

3.3. Topography

The site generally slopes down from a local high of approximately 560 mAHD into the central portion and to the south/south west. Low points on the site are along the south west site boundary (approximately 530 m AHD).

A plan showing the regional topography is presented in Figure 2.

3.4. Surface Water and Drainage

3.4.1. Onsite Surface Waters

Drainage channels were observed originating in the centre and heading offsite to the south west towards Loddon River.

Majority of the drainage channels were dry, indicating they contained flows in heavier rainfalls.

Based on topography, it is considered that surface water will drain into the central portion of the site from the west, north and north east portion of the site before draining to the south and south west and discharging into Loddon River.

3.4.2. Hydrogeology

A search of the Visualising Victoria's Groundwater[1] database indicates the groundwater conditions at the site are inferred to be typically less than 5 m below ground level with an area along the south west boundary inferred to be between 10 to 20 m below ground level with TDS concentrations between 1,000 to 3,500 mg/L (Segment B).

Table 3-1: Protected Beneficial Uses of Groundwater

		SEGMENTS (MG/L TDS)						
BENEFICIAL USES		**A1 (0 - 600)**	**A2 (601-1,200)**	**B (1,201 - 3,100)**	**C (3,101 – 5,400)**	**D (5,401 – 7,100)**	**E (7,101 – 10,000)**	**F (>10,000)**
Water dependent ecosystems and species		√	√	√	√	√	√	√
Potable water supply	desirable	√						
	acceptable		√					
Potable mineral water supply		√	√	√	√			
Agriculture and irrigation	irrigation	√	√	√				
	stock watering	√	√	√	√	√	√	
Industrial and commercial		√	√	√	√	√		
Water-based recreation (primary contact recreation)		√	√	√	√	√	√	√
Traditional Owner cultural values		√	√	√	√	√	√	√
Cultural and spiritual values		√	√	√	√	√	√	√
Buildings and structures		√	√	√	√	√	√	√
Geothermal properties		√	√	√	√	√	√	√

Note: Table 3-1 is a reproduction of is a reproduction of 'Table 2 – Beneficial Uses for Groundwater' from the State Environment Protection Policy (Waters, October 2018). The shading denotes the beneficial uses to be protected for the site based on the reported TDS values.

3.4.3. Groundwater Flow Direction and Recharge

Groundwater flow is anticipated to be in line with the local topography, with the general groundwater flow direction to the south west. Groundwater is then expected to flow south/south west along Loddon River and other drainage.

[1] http://www.vvg.org.au/ - (online) accessed October 2019

3.5. Site Inspection

A site inspection was carried out on 30 October 2019 during which the following observations were made:

- The site was accessed via Suttons Lane located to the south of the site
- The site was predominantly flat with slopes rising around the reserve area to the north, east and west boundaries of the site
- The centre of the site was occupied by a predominantly flat grassed reserve containing:
    - A horse exercise/training track, the track was also observed to be used for public uses including dog walking
    - An equestrian dressage enclosure in the south east portion
    - A cricket oval in the east portion
- A waterway (Loddon River) was located along the south boundary of the site with an observed flow in a westerly direction
- An equestrian cross country/show jumping course was observed located around the grassed reserve and portions of the sloped areas to the north
- The site contained 5 buildings in the south portion between the grassed reserve and Loddon River including:
    - One toilet block
    - Three club houses; and
    - A storage shed which was observed to house the clay target launcher and other supplies
- Clay target fragments were observed in surface soils across the majority of the site north of the Loddon River and used ammunition shells were noted through the central reserve area and the north/north east sloped areas of the site. No separate shotgun fragments were visible at the surface
- Shallow drainage channels were observed east of the cricket field running in a north-south direction

Current site conditions and marked shooting areas are shown on Figure 3. Site photographs taken during the site inspection are provided in Appendix C.

3.6. Potential for Contamination

Based on the historical sources of information the site has historically been used for public recreation and shooting. Beveridge Williams considers the risk of widespread contamination of the site as moderate to high.

Based on the information provided by the site history and site inspection, the following activities and potential contaminants have been listed in Table 3-4.

Table 3-2: Potential Contamination Sources

Source / Site Activities	Onsite / Offsite	Location	Contaminants
Imported fill material	Onsite	Entire site	Heavy metals, polycyclic aromatic hydrocarbons (PAH), organochlorine pesticides (OCP), total petroleum hydrocarbons (TPH) and Polychlorinated biphenyls (PCB)
Past shooting club activities (Clay Target)	Onsite	Entire site	Heavy metals and PAH

Beveridge Williams considers the main potential sources of site contamination to be from the shooting activities which have occurred across the site and areas of limited site filling.

4. Conceptual Site Model

4.1. Site Uses

4.1.1. Shooting Activities

Information regarding the shooting activities was provided by the Daylesford chapter of the Victorian Sporting Clays Association based at the Glenlyon Recreation Reserve. Based on the information provided it was confirmed that:

- Shooting activities are restricted to clay targets only
- Clary targets are launched from six different areas (shown on Figure 4-1 below)

Figure 4-1: Shooting and clay target launching areas

- All targets and shooting is directed into the centre of the Glenlyon Reserve
- Mobile traps are distributed throughout the central portion of the site to capture target fragments
- The west portion of the site occupied by the cricket oval and dressage field are listed as a zero-debris area

4.1.2. Other Site Activities

Based on information provided by Hepburn Shire Council, other site activities include the following:

- Equestrian Activities including dressage, racing/training circuit and cross country/event horse trials
- Public uses as a park land (e.g. walking, dog park, public events etc)
- Sporting events (cricket)

4.2. Source Assessment

Based on the information around the shooting activities carried out at the site (shotgun clay target shooting operated across six areas around the perimeter of the site) and typical ranges of impacts based on these activities, an estimated area of impact has been identified (see Figure 4-2 and Figure 4-3 below).

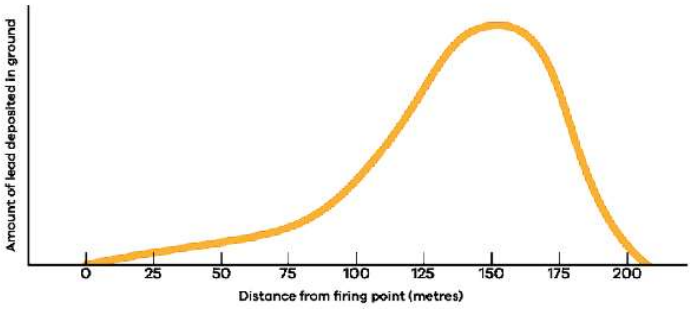

Figure 4-2: Lead contamination at a skeet or trap range based on distance from the firing point[2]

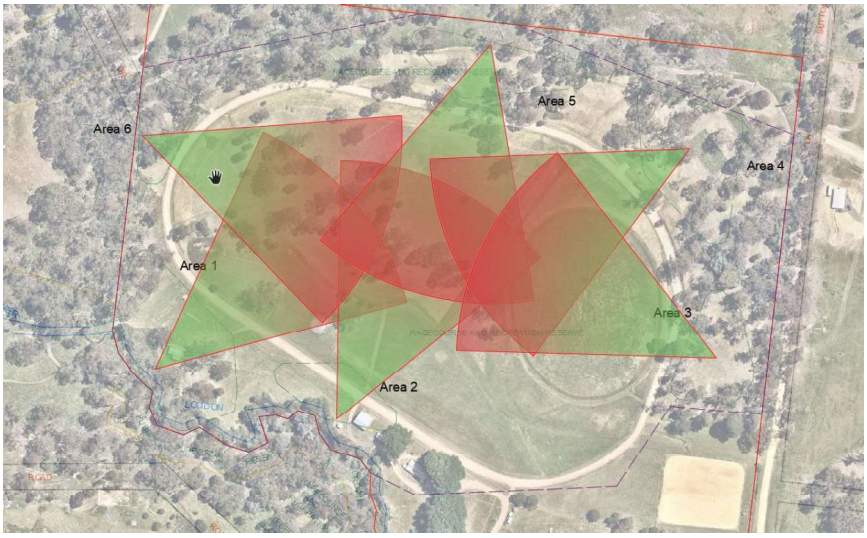

Figure 4-3: Estimated areas of impact within indicated firing direction and range

4.3. Pathways

4.3.1. Direct

The following direct pathways exist to site users at the site:

- Projectiles/debris landing on parkland, conservation land or a sporting oval
- Public access to reserve area with exposed projectiles/debris
- Projectiles/debris landing on or around community buildings

4.3.2. Indirect

4.3.2.1. Water

- Stormwater runoff and movement of projectiles and debris
- Leachable lead and/or polycyclic aromatic hydrocarbon (PAH) contaminants leaching into surface water runoff and discharge into Loddon River
- Contamination migration downstream
- Potential increased lead concentrations in fish and other flora and fauna
- Leaching of contaminants into groundwater.

[2] EPA Publication 1710 - Guide for managing contamination at shooting ranges

4.3.2.2. *Wind*

- Soil dust – Soil can become contaminated by lead. This can happen in two ways:
  - Small lead fragments can become scattered throughout soil
  - Lead can corrode and chemically attach to soil particles
- Lead dust – Small amounts of lead dust can be released after firing. This dust is heavier than soil dust and therefore is not likely to travel as far. However, it could potentially expose nearby people such as shooters and visitors to a shooting range.

4.3.3. Contaminant Pathway Conceptual Model

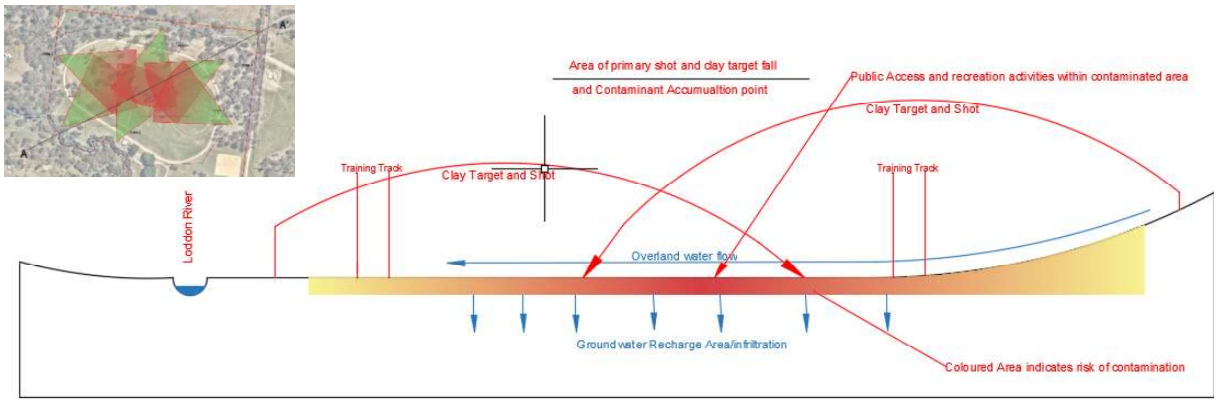

Figure 4-4: Preliminary Contaminant Pathways

Based on the site activities the primary pathways Beveridge Williams considers that there is potential for both direct and indirect exposure pathways present at the site. As such additional control measures are likely to be required at the site to provide protection to site users and nearby receptors (Refer to Section 4.4).

4.4. EPA Recommended Management Measures

In line with EPA Publication 1710 "Guide for managing contamination at shooting ranges" the following management measures would be recommended in order to address the exposure risks from contamination resulting from the shooting activities at the site:

Table 4-1: Preferred Management Measures based on Pathway[3]

PATHWAY	CONTROLLING ACCESS	ALTERNATIVE AMMUNITION/ CLAY TARGETS	VEGETATION	WATER MANAGEMENT	SHOTGUN RANGE DESIGN	STOP BUT DESIGN	BULLLET TRAPS	EMPS	LEAD RECOVERY
Direct	1	1	-	-	2	-	-	2	2
Water	-	1	1	1	1	1	1	2	2
Wind	-	1	1	1	2	-	-	2	-

[3] Management Measures based on Pathway as derived from Table 5 in EPA Publication 1710 "Guide for managing contamination at shooting ranges".

Preferences are shown in terms of:

1 = Preferred management measure to address exposure pathway

2 = Secondary management measure which should be carried out in conjunction with 1.

5. SOIL CONTAMINATION ASSESSMENT

5.1. Assessment Guidelines and Criteria

The Victorian State Environmental Protection Policy (SEPP), Prevention and Management of Contaminated Land (June 2002, updated September 2013) lists the beneficial uses for each segment of land to be protected.

Table 5-1: Protected Beneficial Uses of Land

BENEFICIAL USE		LAND USE						
				SENSITIVE USE				
		PARKS AND RESERVES	AGRICULTURAL	HIGH DENSITY	OTHER	RECREATION / OPEN SPACE	COMMERCIAL	INDUSTRIAL
Maintenance of ecosystems	Natural Ecosystems	√						
	Modified Ecosystems	√	√		√	√		
	Highly Modified Ecosystems		√	√	√	√	√	√
Human Health		√	√	√	√	√	√	√
Buildings and Structures		√	√	√	√	√	√	√
Aesthetics		√		√	√	√	√	
Production of food, flora and fibre		√	√		√			

Note: Table 4-1 is a reproduction of 'Table 1 – Protected Beneficial Uses of Land' from the State Environment Protection Policy (Prevention and Management of Contamination of Land), June 2002. The shading denotes the beneficial uses to be protected for the proposed site use.

- **Maintenance of modified and highly modified ecosystems** – National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013 (No.1) (NEPM (Amendment 2013)) - Ecological Investigation Levels (EIL). EPA Fill criteria (EPA Industrial Waste Resource Guidelines (IWRG) Publication No. 621 published by the Environment Protection Authority of Victoria, which lists the maximum concentrations of contaminants allowed in soil to be disposed of as Clean Fill, Category C and Category B Contaminated Soil) has been referenced also
- **Human health** – NEPM (Amendment 2013) Human Health Investigation Levels (HIL) for public open space (such as parks, playing fields, secondary schools and footpaths, HIL C) and CRC Care 2011 Direct Contact HSL C have been referenced
- **Buildings and structures** – Contamination must not cause the land to be corrosive to or adversely affect the integrity of structures or building materials
- **Aesthetics** – Contamination must not cause the land to be offensive to the senses of human beings

5.2. NEPM (Amendment 2013) Ecological Investigation Levels Criteria Derivation

The NEPM (Amendment 2013) states that 'the EIL [criteria] takes into account the biological availability of the element in different soils and separate naturally occurring concentrations of a contaminant and the added contaminant in deriving EILs which are based on the 'added risk approach'. This approach assumes that the availability of the ambient background concentration (ABC, the soil concentration in a specified locality that is the

sum of the naturally occurring background and the contaminant levels that have been introduced from diffuse or non-point sources by general anthropogenic activity not attributed to industrial, commercial, or agricultural activities) of a contaminant is zero or sufficiently close that it makes no practical difference. More importantly, it assumes that the background 'has resulted in the biodiversity of ecosystems or serves to fulfil the needs for micronutrients for the organisms in the environment'. Therefore, the approach views only the effect of added contaminants to the environment as adverse (for further information refer to Section 2.4, Schedule B5b). Thus, rather than having a single numerical limit for a contaminant, different soils will have different limits. The EIL derivation methodology generates, wherever possible, soil-specific EILs'.

Based on the site history and current site uses, Beveridge Williams considers that any contamination identified on the site is unlikely to have been added within the last 2 years indicating that contamination would be "aged" (as defined by NEPM (2013 Amendment)). Therefore Beveridge Williams has adopted the "aged" values listed in Appendix A of NEPM 2013 Amendment Schedule B5a "Guide on Ecological Risk Assessment" for urban residential/public open space for reporting purposes.

5.3. Field Methodology

5.3.1. Soil Samples

Due to the preliminary nature of the investigation works Beveridge Williams has undertaken all fieldworks generally accordance with Australian Standard (AS) 4482.1-2005 by Beveridge Williams Environmental Professionals who logged the soil samples generally in accordance with AS 1726-1993 and obtained disturbed soil samples at surface.

The equipment used to recover the required soil samples was cleaned between each sample prior to each sample being taken in accordance with the following procedures:

- All adhered soil and/or other matter was removed by means of scrubbing and flushing with clean water
- The hand sampling equipment was then scrubbed in a phosphate free detergent solution before being rinsed copiously in clean water
- Disposable rubber nitrile gloves worn by the Environmental Professional were replaced prior to the recovery of each sample.

The soil samples were placed into acid-rinsed and solvent-washed screw top glass jars supplied by the analysing laboratory. The jars were tightly closed and kept on ice in a portable cooler until delivery to the laboratory under chain of custody procedures.

Each soil sample was assessed both visually and by odour for evidence of contamination with a ranking on a scale of 0 - 3 as follows:

0 No odour or visual evidence of contamination

1 Slight visual evidence of contamination and/or slight odour

2 Visual evidence of contamination and/or odour

3 Obvious visual evidence of contamination and/or strong odour.

A calibrated photoionization detector (PID) was used to screen for the presence of volatile organic compounds (VOCs) in all samples collected. During sampling an extra sample was collected and placed in a properly sealed snap lock plastic bag. The volume of soil used for obtaining PID readings was kept generally uniform for all samples tested. After approximately 15 minutes the plastic bag was pierced with the probe to obtain a PID reading.

All sample locations have been determined and recorded using a hand-held GPS unit (error tolerance +/- 3 m) or determined using measurements from fixed structures/features on site.

All chemical testing was undertaken by the following NATA registered analytical laboratories:

- Primary testing laboratory - Ecowise Australia Pty Ltd (ALS Water Resources Group, ALSWRG)
- Secondary testing laboratory (for QA/QC purposes) - Eurofins Services Pty Ltd (Eurofins).

5.3.2. Field Methodology – X-Ray Fluorescence (XRF)

In order to provide adequate site coverage to determine the risk of lead impacts and distribution across the site, a Beveridge Williams Environmental Professional undertook a field screening across the site on an approximate grid

using a calibrated X-ray fluorescence (XRF) device. Grid location spacing was carried out generally accordance with Australian Standard (AS) 4482.1-2005 and the soils screened were logged generally in accordance with AS 1726-1993.

Each location was screened using an XRF device for heavy metals. Lead concentration readings were recorded along with location and soil conditions such as colour and inclusions (lead shot, used casings and/or clay target fragments) if encountered.

During site screening areas of increased concentration readings within the anticipated shot and debris fall were marked and verification laboratory samples collected.

5.4. Soil Investigation

5.4.1. Surface Samples (21 June 2019)

A total of 30 surface samples (191030-SS01 to 191030-SS30) were collected by hand on an approximate grid across the six firing areas and within the debris drop zone at points with an elevated lead concentration identified during XRF screening (central portion – refer to Section 5.4.2). The surface samples were taken from 0.0 to 0.1 m depth. Eight test pits (TP01 to TP08) were conducted through stockpiles in the north west corner of the site to assess the risk associated with the stockpiled fill (in the north west corner) and historical site activities.

5.4.2. X-Ray Fluorescence (21 October 2019)

A screening program of surface soils was undertaken at 104 additional locations (191029-XRF01 to 191029-XRF104) was undertaken using a calibrated handheld XRF device. XRF screening was undertaken on an approximate grid across the entire reserve area to further investigate the potential lead distribution across the site as a result of the clay target shooting activities. Each location was cleared of groundcover vegetation and XRF screening was completed on exposed soils.

5.4.3. Soil Observations

Disturbed soils were identified across the site comprising brown sandy silt/silt. Clay target fragments were observed through the majority of the surface soils along with used ammunition shells at surface.

Logs of the surface samples are presented in Appendix D. Surface sample and XRF locations are shown on Figure 4.

5.4.4. Contamination Ranking and PID Readings

No odours or visible signs of contamination were noted in any of the samples or surface soils at the site.

Table 5-2: Soil Sample Contamination Rankings

CONTAMINATION RANKING	SAMPLE	REASON
0	All Beveridge Williams samples	No odour or visual evidence of contamination

All soil samples were screened in the field with a photoionisation detector (PID). The PID response recorded for all samples were generally 0.0 ppm, with a maximum reading of 0.3 ppm.

Each VOC result is expressed as a VOC isobutylene equivalent concentration (in ppm). Different compounds give different responses relative to isobutylene

5.5. Soil Chemical Testing Program

The chemical testing program for individual samples is detailed in Table 4-9.

Table 5-3: Soil Sample Chemical Testing Program

SAMPLE NUMBERS	TESTING PROGRAM
191030-SS03, 191030-SS09, 191030-SS11, 191030-SS15, 191030-SS22, 191030-SS28	EPA 621 Screen[4]
191030-SS01, 191030-SS02, 191030-SS04, 191030-SS05, 191030-SS06, 191030-SS07, 191030-SS08, 191030-SS10, 191030-SS12, 191030-SS13, 191030-SS14, 191030-SS16, 191030-SS17, 191030-SS18, 191030-SS19, 191030-SS20, 191030-SS21, 191030-SS23, 191030-SS24, 191030-SS25, 191030-SS26, 191030-SS27, 191030-SS29, 191030-SS30	Heavy metals[5], PAH
191030-SS04, 191030-SS10, 191030-SS13, 191030-SS18, 191030-SS23, 191030-SS26	TRH
191030-SS04, 191030-SS10, 191030-SS13, 191030-SS18, 191030-SS23, 191030-SS26	pH
191030-SS28	ASLP[6] heavy metals
191030-SS15	ASLP PAH
191029-XRF01 to 191029-XRF104	XRF heavy metals field analysis

5.6. Soil Chemical Testing Results

Elevated concentrations of heavy metals (Arsenic, Cadmium, Chromium (III+VI), Copper, Lead, Nickel and Zinc), PAH (Carcinogenic PAHs (as BaP TEQ) PAHs (sum of total)) and TPH C10 - C36 (sum of total) were reported at the site. A summary of the exceeding samples is provided in Table 5-4 an Table 5-5.

Chemical testing summary tables are provided in Appendix E. NATA Laboratory Certificates of Analysis and XRF output tables have been provided in Appendix F.

[4] An EPA 621 screen consists of the following analytes: total metals (Sb, As, Ba, Be, B, Cd, Cr (III+VI), Cr (VI), Co, Cu, Pb, Mn, Hg, Mo, Se, Ag, Sn, V, Zn), total cyanide, total fluoride, speciated phenols (halogenated plus non-halogenated), MAH, PAH, TPH, PCB, CHC and OCP

[5] Heavy metals: Al, Sb, As, Ba, Be, B, Cd, Cr (III+VI), Co, Cu, Fe, Pb, Mn, Hg, Mo, Ni, Se, Ag, Sr, Tl, Th, Sn, Ti, U, V, Zn

[6] Australian Standard Leaching Procedure

Table 5-4: Soil Chemical Testing Results Exceedances of Ecological and Human Health criteria

ANALYTE	NEPM (AMENDMENT 2013)			
	EIL/ESL CRITERIA	X IL A/B CRITERIA	HIL C/HSL C CRITERIA	HIL D/HSL D CRITERIA
Arsenic	191030-SS17, 191030-SS24, 191030-SS27, 191030-XRF31, 191030-XRF52	191030-SS27	None	None
Cadmium	None	191030-XRF29	None	None
Chromium (III+VI)	191030-SS19, 191030-SS20, 191030-SS23, 191030-SS29, 191030-XRF05, 191030-XRF34, 191030-XRF37, 191030-XRF49, 191030-XRF53, 191030-XRF56, 191030-XRF57, 191030-XRF62, 191030-XRF66, 191030-XRF67, 191030-XRF73, 191030-XRF76, 191030-XRF96, 191030-XRF99	None	None	None
Copper	191030-XRF53	None	None	None
Lead	191030-SS11, 191030-SS23, 191030-SS26, 191030-SS27, 191030-SS30 191030-XRF01, 191030-XRF02, 191030-XRF03, 191030-XRF05, 191030-XRF07, 191030-XRF08, 191030-XRF15, 191030-XRF16, 191030-XRF22, 191030-XRF21, 191030-XRF23, 191030-XRF24, 191030-XRF26, 191030-XRF30, 191030-XRF31, 191030-XRF32, 191030-XRF33, 191030-XRF34, 191030-XRF39, 191030-XRF40, 191030-XRF41, 191030-XRF42, 191030-XRF43, 191030-XRF48, 191030-XRF49, 191030-XRF50, 191030-XRF51, 191030-XRF57, 191030-XRF59, 191030-XRF66, 191030-XRF67, 191030-XRF68, 191030-XRF69, 191030-XRF70, 191030-XRF73, 191030-XRF76, 191030-XRF77, 191030-XRF78, 191030-XRF86	191030-SS11, 191030-SS23, 191030-SS26, 191030-SS27, 191030-SS28, 191030-SS29, 191030-SS30, 191030-XRF02, 191030-XRF03, 191030-XRF05, 191030-XRF07, 191030-XRF15, 191030-XRF16, 191030-XRF22, 191030-XRF21, 191030-XRF23, 191030-XRF24, 191030-XRF30, 191030-XRF31, 191030-XRF32, 191030-XRF33, 191030-XRF34, 191030-XRF39, 191030-XRF40, 191030-XRF41, 191030-XRF42, 191030-XRF43, 191030-XRF48, 191030-XRF49, 191030-XRF50, 191030-XRF51, 191030-XRF57, 191030-XRF59, 191030-XRF66, 191030-XRF67, 191030-XRF68, 191030-XRF69, 191030-XRF70, 191030-XRF73, 191030-XRF76, 191030-XRF77, 191030-XRF86	191030-SS28, 191030-SS29 191030-XRF15, 191030-XRF16, 191030-XRF22, 191030-XRF24, 191030-XRF30, 191030-XRF31, 191030-XRF40, 191030-XRF41, 191030-XRF43, 191030-XRF50, 191030-XRF59, 191030-XRF66, 191030-XRF67, 191030-XRF68, 191030-XRF69, 191030-XRF73, 191030-XRF76, 191030-XRF77	191030-XRF31, 191030-XRF41, 191030-XRF50, 191030-XRF73, 191030-XRF76

ANALYTE	NEPM (AMENDMENT 2013)			
	EIL/ESL CRITERIA	X IL A/B CRITERIA	HIL C/HSL C CRITERIA	HIL D/HSL D CRITERIA
Nickel	191030-SS01, 191030-SS02, 191030-SS03, 191030-SS04, 191030-SS05, 191030-SS06, 191030-SS07, 191030-SS08, 191030-SS09, 191030-SS10, 191030-SS13, 191030-SS14, 191030-SS15, 191030-SS16, 191030-SS17, 191030-SS19, 191030-SS20, 191030-SS22, 191030-SS23, 191030-SS26, 191030-SS27, 191030-SS29 191030-XRF03, 191030-XRF05, 191030-XRF09, 191030-XRF11, 191030-XRF16, 191030-XRF22, 191030-XRF23, 191030-XRF30, 191030-XRF31, 191030-XRF34, 191030-XRF36, 191030-XRF39, 191030-XRF40, 191030-XRF42, 191030-XRF43, 191030-XRF48, 191030-XRF49, 191030-XRF51, 191030-XRF52, 191030-XRF53, 191030-XRF55, 191030-XRF56, 191030-XRF57, 191030-XRF58, 191030-XRF60, 191030-XRF61, 191030-XRF63, 191030-XRF65, 191030-XRF66, 191030-XRF67, 191030-XRF68, 191030-XRF69, 191030-XRF71, 191030-XRF72, 191030-XRF73, 191030-XRF74, 191030-XRF75, 191030-XRF76, 191030-XRF77, 191030-XRF78, 191030-XRF79, 191030-XRF80, 191030-XRF82, 191030-XRF83, 191030-XRF84, 191030-XRF86, 191030-XRF87, 191030-XRF96, 191030-XRF97, 191030-XRF102	None	None	None

ANALYTE	NEPM (AMENDMENT 2013)			
	EIL/ESL CRITERIA	X IL A/B CRITERIA	HIL C/HSL C CRITERIA	HIL D/HSL D CRITERIA
Zinc	191030-SS01, 191030-SS02, 191030-SS03, 191030-SS04, 191030-SS05, 191030-SS06, 191030-SS07, 191030-SS08, 191030-SS09, 191030-SS10, 191030-SS13, 191030-SS14, 191030-SS17, 191030-SS19, 191030-SS20, 191030-SS22, 191030-SS23, 191030-SS26, 191030-SS27, 191030-SS29 191030-XRF01, 191030-XRF02, 191030-XRF03, 191030-XRF04, 191030-XRF05, 191030-XRF06, 191030-XRF07, 191030-XRF09, 191030-XRF11, 191030-XRF12, 191030-XRF15, 191030-XRF16, 191030-XRF18, 191030-XRF19, 191030-XRF20, 191030-XRF21, 191030-XRF23, 191030-XRF24, 191030-XRF26, 191030-XRF27, 191030-XRF28, 191030-XRF29, 191030-XRF30, 191030-XRF31, 191030-XRF32, 191030-XRF33, 191030-XRF34, 191030-XRF35, 191030-XRF36, 191030-XRF37, 191030-XRF38, 191030-XRF39, 191030-XRF42, 191030-XRF43, 191030-XRF46, 191030-XRF48, 191030-XRF49, 191030-XRF51, 191030-XRF52, 191030-XRF53, 191030-XRF54, 191030-XRF55, 191030-XRF56, 191030-XRF59, 191030-XRF60, 191030-XRF61, 191030-XRF63, 191030-XRF64, 191030-XRF66, 191030-XRF67, 191030-XRF68, 191030-XRF69, 191030-XRF70, 191030-XRF71, 191030-XRF72, 191030-XRF73, 191030-XRF74, 191030-XRF75, 191030-XRF76, 191030-XRF77, 191030-XRF78, 191030-XRF79, 191030-XRF80, 191030-XRF81, 191030-XRF82, 191030-XRF86, 191030-XRF87, 191030-XRF93, 191030-XRF95, 191030-XRF96, 191030-XRF97, 191030-XRF99, 191030-XRF101, 191030-XRF102	None	None	None

ANALYTE	NEPM (AMENDMENT 2013)			
	EIL/ESL CRITERIA	X IL A/B CRITERIA	HIL C/HSL C CRITERIA	HIL D/HSL D CRITERIA
Carcinogenic PAHs (as BaP TEQ)	No Criteria	191030-SS01, 191030-SS03, 191030-SS04, 191030-SS11, 191030-SS13, 191030-SS15, 191030-SS17, 191030-SS27, 191030-SS28, 191030-SS29	191030-SS01, 191030-SS03, 191030-SS04, 191030-SS11, 191030-SS13, 191030-SS15, 191030-SS17, 191030-SS27, 191030-SS28, 191030-SS29	191030-SS15, 191030-SS29
PAHs (sum of total)	No Criteria	191030-SS15	191030-SS15	None

Table 5-5: Soil Chemical Testing Results Exceedances - EPA Fill Classification

ANALYTE	EPA PUBLICATION 621 WASTE CATEGORISEATION UPPER LIMITS		
	FILL MATERIAL	CATEGROY C CONTAMINATED SOIL	CATEGROY B CONTAMINATED SOIL
Arsenic	191030-SS17, 191030-SS24, 191030-SS27 191030-XRF07, 191030-XRF15, 191030-XRF31, 191030-XRF34, 191030-XRF50, 191030-XRF52, 191030-XRF53, 191030-XRF59, 191030-XRF66, 191030-XRF67, 191030-XRF86	None	None
Cadmium	191030-XRF29		

ANALYTE	EPA PUBLICATION 621 WASTE CATEGORISEATION UPPER LIMITS		
	FILL MATERIAL	CATEGROY C CONTAMINATED SOIL	CATEGROY B CONTAMINATED SOIL
Lead	191030-SS11, 191030-SS23, 191030-SS26, 191030-SS27, 191030-SS28, 191030-SS29, 191030-SS30 191030-XRF02, 191030-XRF03, 191030-XRF05, 191030-XRF07, 191030-XRF15, 191030-XRF16, 191030-XRF21, 191030-XRF22, 191030-XRF23, 191030-XRF24, 191030-XRF30, 191030-XRF31, 191030-XRF32, 191030-XRF33, 191030-XRF34, 191030-XRF39, 191030-XRF40, 191030-XRF41, 191030-XRF42, 191030-XRF43, 191030-XRF48, 191030-XRF49, 191030-XRF50, 191030-XRF51, 191030-XRF57, 191030-XRF59, 191030-XRF66, 191030-XRF67, 191030-XRF68, 191030-XRF69, 191030-XRF70, 191030-XRF73, 191030-XRF76, 191030-XRF77, 191030-XRF86	191030-XRF31, 191030-XRF41, 191030-XRF50, 191030-XRF73, 191030-XRF76	None
ASLP Lead	191030-SS28	191030-SS28	191030-SS28
Silver	191030-SS10	None	None
Tin	191030-XRF73	None	None
Benzo(a)Pyrene	191030-SS01, 191030-SS03, 191030-SS04, 191030-SS11, 191030-SS13, 191030-SS15, 191030-SS17, 191030-SS20, 191030-SS27, 191030-SS28, 191030-SS29	191030-SS11, 191030-SS13, 191030-SS15, 191030-SS17, 191030-SS27, 191030-SS29	191030-SS15, 191030-SS29
Total PAH	191030-SS01, 191030-SS03, 191030-SS11, 191030-SS13, 191030-SS15, 191030-SS17, 191030-SS27, 191030-SS28, 191030-SS29	191030-SS11, 191030-SS15, 191030-SS17, 191030-SS27, 191030-SS29	191030-SS15
TPH	191030-SS15	None	None

6. QUALITY CONTROL

Secondary laboratory testing of two split samples (191030-SS01A and 191030-SS21A) were undertaken by Eurofins and two field duplicates (191030-S-D01 and 191030-S-D02) were chemically tested by ALSWRG. Of the 168 matching pairs 33 reported an RPD of greater than 50%. Due to the nature of the soils and variability in lead shot and clay target fragments, the reported RPDs are not considered to alter the recommendations in this report.

It is considered that the overall quality of the soil analyses carried out by ALSWRG is acceptable.

The chemical testing results from the original samples tested by ALSWRG are considered to be acceptable in terms of data quality. Beveridge Williams has adopted the primary reported analyte concentrations for all discussions and interpretations relating to the contamination assessment.

7. DISCUSSION

A preliminary assessment program was undertaken at the Glenlyon Reserve due to the shooting activities/public access and site observations made by Beveridge Williams. The preliminary assessment utilised a laboratory analysis and field screening using a hand-held X-Ray Fluorescence Device (XRF) to assess the site for lead and Polycyclic aromatic hydrocarbons (PAH) impacts as a result of the historic and current use of the site for clay target shooting activities.

Based on the laboratory testing results and XRF field screening elevated concentrations of heavy metals (in particular lead) and PAHs were reported above the adopted criteria across the majority of the central and north portion of the site.

7.1. Maintenance of Ecosystems

Elevated concentrations of heavy metals (Arsenic, Chromium (III+VI), Copper, Lead, Nickel, Zinc) were reported above guidelines for the protection of the environment (NEPM (Amendment 2013) EIL) in several samples.

The elevated Arsenic (up to 150 mg/kg), Chromium (up to 159 mg/kg), Copper (up to 86 mg/kg), Nickel (up to 100 mg/kg) and Zinc (up to 115 mg/kg) above NEPM EIL criteria are considered to be associated with importation of uncontrolled fill and shooting ammunition fragments. The elevated concentrations of Lead (up to 2,195 mg/kg) are considered to be associated with ammunition fragments from the shooting activities at the site.

Whilst Beveridge Williams considers the elevated concentrations of heavy metals (with the exception of lead) are unlikely to affect most vegetation types, concentrations reported may pose an adverse risk to the environment if soils are to be permanently exposed and vegetation planted within these soils or in the instance of sediment runoff from the site into nearby waterways (Loddon River).

7.2. Human Health

Based on the anticipated continuation of site activities (recreation reserve and clay target shooting) under the NEPM (Amendment 2013), public open space (grassed areas and carparks), the relative criteria (NEPM HIL C), has been adopted for the land use at the site as the primary criteria for assessing the risks to human health.

Concentrations of lead, carcinogenic PAHs (as BaP TEQ) and PAHs (sum of total) exceeded the guidelines for the protection of human health for recreation, including parks (NEPM (Amendment 2013) HIL C).

7.2.1. Lead

Elevated concentrations of lead were reported within twenty samples (refer to Table 5-4 in Section 5.6) predominantly located across the central portion of the site. Based on the reported maximum concentration (2,195 mg/kg) it is considered that the lead impacts detected at the site pose a risk to human health without undertaking a more detailed assessment and remediation works in conjunction with a soil management plan.

7.2.2. Polycyclic Aromatic Hydrocarbons (PAHs)

Elevated concentrations of PAHs (carcinogenic hydrocarbons and PAH (sum of total)) were reported within ten samples (refer to Table 5-4 in Section 5.6). The reported concentrations were predominantly located across the central and north east portions of the site in line with the increased fall due to the prevailing wind directions.

Based on the reported maximum concentration (780 mg/kg) it is considered that the PAH impacts detected at the site pose a risk to human health without undertaking a more detailed assessment and remediation works in conjunction with a soil management plan.

7.3. Buildings and Structures

Due to the preliminary nature of the investigation works comment cannot be provided around potential impacts to site buildings and structures.

7.4. Aesthetics

Fill inclusions (clay target fragments and ammunition shells) were observed in multiple sample locations across the site. The inclusions may be considered to pose an aesthetic problem if left exposed. Beveridge Williams considers the beneficial use of aesthetics to be precluded while extensive fragments remain present at surface. However, it is noted that the beneficial use of aesthetics may be protected during current and future use of the site provided adequate recovery of the inclusions is undertaken in line with a site management plan.

7.5. Offsite Soil Disposal

Chemical analysis of the soils at surface has classified the impacted soils as EPA Category B Contaminated Soils based on maximum concentrations.

However, based on preliminary ASLP testing results for lead (8.8 mg/L) soils with elevated lead concentrations are anticipated to be conservatively classified as **EPA Category A Contaminated Soils**.

8. CONCLUSIONS AND RECOMMENDATIONS

8.1. Preliminary Soil Contamination Assessment

Based on the preliminary soil chemical testing results and observations made during the site inspection, Beveridge Williams considers that the site contains lead and PAH impacts from the recreational shooting activities (clay target shooting) which may pose a potential health risk to site users.

Due to the reported concentrations (total and leachable) and the potential heal and environmental impacts, it is recommended that:

- Access and activities at the site should be limited to prevent direct exposure and additional contaminant loading where possible.
- Due to the likely continued contaminant loading due to ongoing shooting actives either:
    - strict management measures for ammunition types (non-lead containing), clay targets (PAH free) and more effective traps should be considered for short-term management
    - restrict public access to the site for activities in which direct access to the soils may occur (e.g. sporting activities, picnics etc…).
- Additional detailed assessment works including a soil and groundwater investigation must be undertaken as part of an Environmental Audit to ensure adequate protection for the environment and human health are provided in the long-term operation and management of the site.

9. LIMITATIONS

Soil and rock formations are variable. The surface sample logs indicate the approximate soil conditions only at the specific test locations. Boundaries between zones on the logs are often not distinct, but rather are transitional and have been interpreted. The precision with which subsurface conditions are indicated depends largely on the frequency and method of sampling, and the uniformity of subsurface conditions.

Chemical conditions described in this report refer only to those conditions indicated by analysis of samples obtained at the points and under the circumstances noted in the report.

These conditions may differ due to the variability of contaminant concentrations in imported fill material or in natural soil as a consequence of activities on the site or adjacent sites. Where conditions encountered at the site or the proposed development differ significantly from those anticipated in this report, it is a condition of this report that Beveridge Williams & Co Pty Ltd be notified of the changes and provided with an opportunity to review the recommendations of this report.

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