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Detailed Site Investigation

Hepburn Shire Council

Glenlyon Recreation Reserve
Suttons Lane, Glenlyon VIC 3461

Project No. 20204153.001A

Revised Report Date: 21 January 2021

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Prepared for:

Daniel Owe-Young
Hepburn Shire Council
PO Box 21
Daylesford VIC 3460

Prepared by:

Kleinfelder Australia Pty Ltd

Level 1, 95 Coventry Street
South Melbourne, VIC 3205
Phone: 03 9907 6000
Fax: 03 9907 6090

ABN: 23 146 082 500

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		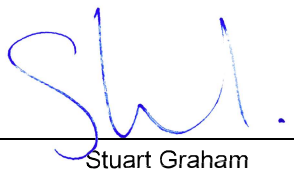
Lucy Ferrier	Jeremy McDonnell	Stuart Graham

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EXECUTIVE SUMMARY

Kleinfelder Australia Pty Ltd (Kleinfelder) was engaged by Hepburn Shire Council (Council) to undertake a detailed site investigation (DSI) at the Glenlyon Recreation Reserve, located at Suttons Lane, Glenlyon, Victoria (the Site). Activities undertaken at the Site include:

- Equestrian (pony club, dressage, cross-country and a former racecourse).
- Sports events (e.g., cricket).
- Dog walking.
- Picnicking and barbecuing, including a children's playground.
- Camping.
- Public events.
- Clay target shooting.

The DSI works were conducted to address the clean-up notice (CUN) issued to the Site by the Environment Protection Authority Victoria (EPAV). The EPAV issued the CUN following the receipt of a preliminary soil investigation (PSI) report that detailed lead and polycyclic aromatic hydrocarbon (PAH) compound concentrations that were assessed as representing a potential human recreational health risk, based on the screening concentrations in the National Environment Protection (Assessment of Site Contamination) Amendment Measure (NEPM; http://www.nepc.gov.au/). Following community inquiries, the PSI was requested by Council based on the understanding that clay target shooting activities at other ranges in Victoria are known to cause environmental contamination.

The Kleinfelder DSI involved a limited historical and physical setting review and field investigation works, which included the installation of four groundwater monitoring wells, soil sampling from 120 soil bores and groundwater, surface water and sediment sampling. The primary DSI objective was to delineate the previously identified contamination, including the potential migration to groundwater and within the Site's stormwater network. The secondary objective was to expand the investigation to include assessment of soil in other areas of the Site, which included the barbecue area, children's playground, camping area, pony club areas and neighbouring properties to the north, east and west of the Site, and to assess the soil quality for potential off-Site disposal from proposed future works near the pavilion and eastern and south-eastern fence lines.

All works, including laboratory testing were conducted in accordance with the relevant EAPV and national guidelines.

In addressing the previously reported contamination at the Site, Kleinfelder collected soil samples from 52 hand auger locations within the racecourse area. The hand auger locations were selected based on the previously reported contamination and the spatial distribution designed to delineate the previously reported NEPM screening criteria exceedances for lead and PAH compounds. With respect to the racecourse investigation the following conclusions are made:

- The previous PSI used a portable x-ray fluorescence (pXRF) detector to measure metal concentrations in soil and subsequently identified that lead concentrations within a broad area exceeded the concentrations protective of human health in a recreational setting.
- Kleinfelder reviewed the pXRF data and concluded it is not appropriate for comparison to the NEPM because, unlike laboratory determined metal concentrations, the pXRF measured concentrations are not based on metal bioavailability, and therefore over-estimate the potential health and ecological risks.
- The previous PSI reported concentrations of lead at two surface soil sample locations exceeding the NEPM health investigation level (HIL C) applicable to public open space/recreation (i.e. 600 mg/kg). Concentrations of lead were reported below the NEPM HIL C in all soil samples analysed during this DSI.
- Concentrations of PAH compounds (as benzo(a)pyrene – BaP TEQ) exceeded the NEPM HIL C (i.e. 3 mg/kg) in two near surface soil samples during this DSI and at ten sample locations during the previous PSI.
- The previous PSI documented the presence of stockpiles located in the northwest corner of the Site. No visible stockpiles, however, were observed during this investigation.
- Groundwater and surface water at the Site have not been affected by the lead or PAH compound contamination in the soil, suggesting that the contaminants are not:
    - Being transported within the Site stormwater system.
    - Migrating though the soil profile and contaminating groundwater within the surface aquifer.
- The findings of the delineation investigation confirmed the lead and PAH contamination are restricted to the racecourse area, with no exceedances reported in other areas of the Site where soil sampling was completed. In addition, no exceedances of lead and PAH were reported at the off-Site soil sample locations.
- Based on the findings of the investigations completed at the Site, the lead and PAH compound contamination are considered likely to associated with clay target shooting activities.

- Based on the findings of this report, Kleinfelder recommends the production of a management plan and human health risk assessment to address the PAH compound contamination in the racecourse area.

Contents

TABLES (IN TEXT)

FIGURES (IN TEXT)

FIGURES

TABLES

APPENDICES

ABBREVIATIONS

ACL	Added Contaminant Limit
ALS	Australian Laboratory Services
ANZECC	Australian and New Zealand Environment and Conservation Council
ARMCANZ	Agriculture and Resources Management Council of Australia and New Zealand
BTEXN	Benzene, Toluene, Ethylbenzene, Total Xylenes and Naphthalene
CEC	Cation-Exchange Capacity
COC	Chain Of Custody
COPC	Contaminants Of Potential Concern
CSM	Conceptual Site Model
EPA	Environment Protection Authority
DSI	Detailed Site Assessment
EILs	Ecological Investigation Levels
ESLs	Ecological Screening Levels
Eurofins	Eurofins Environment Testing Australia
F1	TRH C_6-C_{10} minus BTEX
F2	TRH >C_{10}-C_{16} minus Naphthalene
GME	Groundwater Monitoring Event
HIL	Health Investigation Levels
HSL	Health Screening Levels
Kleinfelder	Kleinfelder Australia Pty Ltd
km	Kilometre
LOR	Limit Of Reporting
m	Metre
mAHD	Metres Above Australian Height Datum
mbgl	Meters Below Ground Level
mBTOC	Meters Below Top Of Casing
mg/L	Milligrams Per Litre
mg/m^3	Milligrams per cubic metres
N/A	Not Applicable
NATA	National Association of Testing Authorities
NEPM	National Environment Protection Measure
NHMRC	National Health and Medical Research Council
NL	Not Limiting
OCP	Organochlorine Pesticides

PID	Photoionisation Detector
PAHs	Polycyclic Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls
ppm	Parts Per Million
QA	Quality Assurance
QC	Quality Control
RAP	Remediation Action Plan
RPD	Relative Percent Difference
SAQP	Sampling and Analysis Quality Plan
SEPP	State Environmental Protection Policy
TDS	Total Dissolved Solids
TOC	Top of PVC Casing
TPH	Total Petroleum Hydrocarbons
TRH	Total Recoverable Hydrocarbons
µg/L	Micrograms Per Litre
VOC	Volatile Organic Compound

1. INTRODUCTION

Kleinfelder Australia Pty Ltd (Kleinfelder) was engaged by Hepburn Shire Council (Council) to undertake a detailed site investigation (DSI) for the Glenlyon Recreation Reserve, located at Suttons Lane, Glenlyon, Victoria (the Site). The Site location is attached as **Figure 1** (attached).

The DSI was completed to meet the requirements of Section 3.2 of EPA Victoria Clean Up Notice (CUN) 90010886, which requires:

> *"…an environmental site assessment (ESA) carried out in accordance with National Environment Protection Measure (Assessment of Site Contamination) 1999 (as varied from time to time) of the level and extent of contamination in soil and groundwater on and from the premises".*

1.1 OBJECTIVE

The objective of these works was to meet the CUN 90010886 Section 3.2 requirements (provided as **Appendix A**).

In order to complete the objective, the principal goal of the works was to delineate the lead and PAH hotspots identified in the 2019 Beveridge and Williams report[1].

1.2 WORKS COMPLETED

The works completed by Kleinfelder included the following:

- Completed a desktop review comprising the site history, use and setting.
- Review of the previous preliminary site investigation (PSI) undertaken at the Site (Beveridge Williams, 2019).
- Review available information from other Victorian sites where clay target and/or field shooting occurs, including management/remediation implemented to mitigate risk.
- Advanced 104 soil bores from locations across the racecourse, camping ground, barbeque area, pavilion area, children's playground, fence lines and mounting block and horse yards.

[1] Beveridge Williams, 2019. Preliminary soil contamination assessment. Glenlyon Reserve, Suttons Lane, Glenlyon.

- Converted four soil bores into groundwater monitoring wells (MW01 to MW04). Each monitoring well's location and elevation were surveyed by a licenced surveyor.
- Collected sediment and stormwater samples at two points of discharge to the Loddon River.
- Collected additional water samples from the Glenlyon Mineral Springs Pump and the Glenlyon Community Dam.
- Gauged the four groundwater monitoring wells and collected groundwater samples.
- Collected off-Site soil samples from neighbouring properties to the north, east and west of the Site.
- Submitted the collected samples for contaminants of potential concern (COPC) to laboratories that have National Association of Testing Authorities accreditation to measure the COPC concentrations in the submitted media.
- Compiled this DSI report including a summary of the desktop review and the previous PSI completed at the Site in 2019, detailed the findings of the field assessment completed by Kleinfelder, review of Tier 1 screening against established guideline values, the preparation of a revised conceptual site model (CSM) and source-path-receptor linkages for the Site, and a summary of the conclusions and recommendations.

2. SITE BACKGROUND INFORMATION

2.1 LOCATION AND SITE DESCRIPTION

The Site is located at Suttons Lane, Glenlyon, Victoria, and is approximately 22 hectares in area, which is used for recreational purposes. The Site comprises a horse racing track, sports oval, which includes a synthetic cricket pitch (the Des Leonard Oval), camping ground, barbecue area, children's playground, pony club and equestrian mounting block, and open space used for equestrian events and clay target shooting.

Two watercourses are present in the southern area of the Site, including the Loddon River running along the southwestern boundary, and an unnamed tributary running through the camping area near the southern reserve boundary. The reserve interior also contains an internal surface water drainage network, including two soaks, with the one near the western boundary discharging to the Loddon River.

Site features are presented on the site plan in **Figure 2** (attached).

Table 2.1 below outlines the details of the Site.

Table 2.1: Site Details

Item	Description
Site Address	Suttons Lane, Glenlyon, Victoria
Land Titles	5~48\PP5324 A copy of the land title reports is contained in **Appendix B**.
Site Zoning	Public Park and Recreation (PPRZ) A copy of the land zoning report is provided in **Appendix B**.
Former Site Use	Recreational
Current Site Use	
Proposed Site Use	

2.2 SURROUNDING LAND USE

The surrounding land use is summarised in **Table 2.2** below.

Table 2.2: Surrounding Land Use

Direction	Description
North	Agricultural land
East	Agricultural land
West	Public conservation areas and residential properties
South	Public conservation areas, residential properties and the Glenlyon Community Dam and Park

2.3 SITE INSPECTION

A Site inspection was completed on 2 April 2020. The inspection noted the following:

- The Site was accessed via Suttons Lane located to the south.
- The Site was predominantly flat and at a lower elevation than the surrounding land surfaces.
- The centre of the Site was occupied by a predominantly flat grassed area containing:
  - A horse exercise/training track. During the inspection, the track was used for dog walking.
  - An equestrian dressage enclosure and mounting yard were in the south east.
  - An equestrian cross-country course was located around the grassed reserve and the elevated area to the north.
  - A cricket oval was located within the eastern portion.
- Loddon River was located along the southern boundary of the Site.
- Five buildings in the south portion of the Site between the grassed reserve and Loddon River including one toilet block, three club houses and one storage shed.
- A camping ground, which was unoccupied, was present in the south east portion of the Site.
- A barbeque area and children's playground in the south west portion of the Site.

2.4 SITE USES

Information provided by Hepburn Shire Council and information obtained from the PSI completed by Beveridge Williams in 2019 indicated that the Site is used for the following recreational activities:

- Clay target shooting.
- Equestrian activities including dressage, racing/training circuit, cross country and horse trial events.
- Sporting events (e.g. cricket).
- Public use as a park (e.g. dog walking).
- Camping.
- Open space for public events.

2.5 SITE SETTING

2.5.1 Topography

Based on Google Earth imagery (accessed 16 April 2020) the Site elevation ranges between 535 and 555 m above the Australian Height Datum (mAHD). The Site surface slopes from the northern boundary towards the middle (i.e. the drainage area), by approximately 20 m, and the surface elevation increases between the drainage area and the southern boundary of the Site by approximately 5 m.

2.5.2 Geology

Geological information obtained from the Geological Society of Victoria online Earth Resources database indicates that the geology in the Site area is underlain mostly by silt, gravel and sand alluvium in the flat areas with Castlemaine Group sandstones and siltstones in the elevated areas. The alluvium was deposited within the Loddon River flood plain and is predominantly derived from Castlemaine Group rocks. Newer Volcanic Group basalts, which overlie the Castlemaine Group are present across the northern and western Site boundaries (Geological Survey of Victoria (https://gsv.vic.gov.au/sd_weave)).

2.5.3 Hydrology

Two watercourses are located in the southern area of the Site:

- The Loddon River, which partially defines the southwestern Site boundary.
- An unnamed tributary that passes through the camping area near the southern Site boundary.

The reserve interior contains an internal surface water drainage network, including two "soaks", with the one near the western boundary discharging to the Loddon River (**Figure 2** attached). The Glenlyon Community Dam is located approximately 150 m to the south of the Site boundary (**Figure 8** attached).

2.5.4 Hydrogeology

The DELWP groundwater resource report indicates there are three aquifers in the Site area (**Table 2.3** below).

Table 2.3: Groundwater Resource Report Summary

Aquifer	Depth Below Ground Level (mbgl)	Salinity (mg/L)
Quaternary, alluvial (sand, gravel, clay, silt)	0 to 6	501 – 1,000
Upper Tertiary/Quaternary basalt	6 to 7	1,001 – 3,500
Palaeozoic Bedrock, sandstone/siltstone	7 to 207	501 – 1,000

Shugg[2] indicates there are two mineral water bores are located on the Site (the recreation reserve rotunda hand pump and the Glenlyon 4 Spout (Jet) bore in the reserve car park), and multiple mineral springs (groundwater discharge areas) are known in the Glenlyon area.

Alluvial aquifer groundwater recharge in the reserve is likely through direct infiltration, with subsequent leakage to the regional Castlemaine Group (bedrock) aquifer.

There are 116 registered bores within 2 km of the Site (**Table 2.4** below).

[2] Shugg, A., 2004. Sustainable Management of Central Victorian Mineral Waters. PhD Thesis, Royal Melbourne Institute of Technology.

Table 2.4: Groundwater Resource Report Summary

Bore Use	Number	Depth Range (mbgl)	TDS mg/L
Domestic and Stock	100	7.6 to 101	75 to 1,500
Mineral Water	4	33 to 85Θ	94 to 10,000
Irrigation	3	39 to 65	-
Industrial	2	40 and 60	-
Investigation	1	260Θ	4,500
Unknown	1	34	-

Notes - Θ the Jet bore is located at the Site

A copy of the groundwater database search results is provided as **Appendix C**.

2.5.5 Mean Rainfall

The Lauriston Reservoir located 12.5 km north east of the Site has a mean annual rainfall of 772 mm/yr (1948 to 2020), with the mean monthly rainfall highest in Aug (92 mm) and the lowest in March (37 mm).

Climate statistics for Creswick (35 km south west) indicate mean daily evaporation (1973 to 1985) varied from 0.9 in July and 6.7 in January. The number of rainy days >10 mm (1949 to 2020) varied from 0.5 in Feb to 2.3 in Aug and Oct, indicating that overland flow and infiltration to groundwater are most likely to occur in the winter months.

2.6 HISTORICAL SITE DETAILS

The limited historical review indicates that there have not been substantial changes in the reserve layout since 1946 (**Figure 2.1** below). Some minor changes included the removal of a small structure, the racecourse surface has likely been up-graded and the pony club infrastructure (including dressage arena installed. Surface drainage is also likely to have been upgraded. It is notable however, that the “drainage soak” identified on **Figure 2.2** below is also present on **Figure 2.1** below, implying that this area has been receiving the reserve surface water run-off for an extended time period. It is understood that clay target shooting commenced at the Site during the 1980s and was conducted until at least 2019. It is noted that historically clay targets (i.e. pigeons) are made of limestone and bitumen mixture.

The bitumen makes up approximately 30% of the targets and may contain between 0.5 and 5% polycyclic aromatic hydrocarbon (PAH) compounds[3]. Shotgun pellets are contained within shotgun wads and are made up of lead.

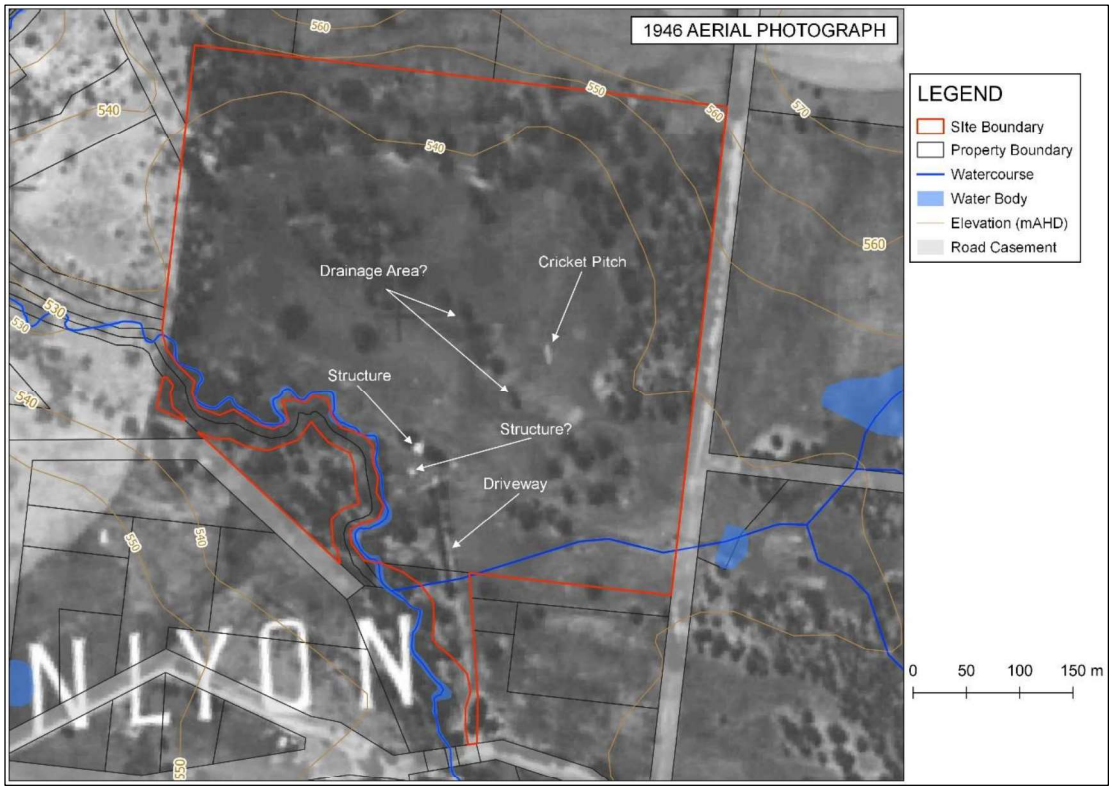

Figure 2.1: 1946 aerial photograph of the Glenlyon Recreation Reserve

[3] Environment Canterbury, 2006. Potential for contamination from clay target debris at shooting sites: Review of literature on occurrence of site contamination from clay targets. Report No. U06/81

Figure 2.2: 2016 aerial photograph of the Glenlyon Recreation Reserve

2.6.1 Review of Previous Investigation

A PSI was previously completed at the Site by Beveridge Williams in 2019. The PSI included a limited aerial photograph history review which indicated that the Site had remained in the current layout with minimal change over the previous 15 years comprising the shed construction in the southern Site area and levelling (soil filling) in the central area south of the sports oval.

Based on the site history and the site inspection, the COPC identified were:

- Metals, PAH, organochlorine pesticides (OCP), total petroleum hydrocarbons (TPH)/ total recoverable hydrocarbons (TRH) and polychlorinated biphenyls (PCB) from historical uncontrolled soil importation.
- Metals and PAH from clay target shooting.

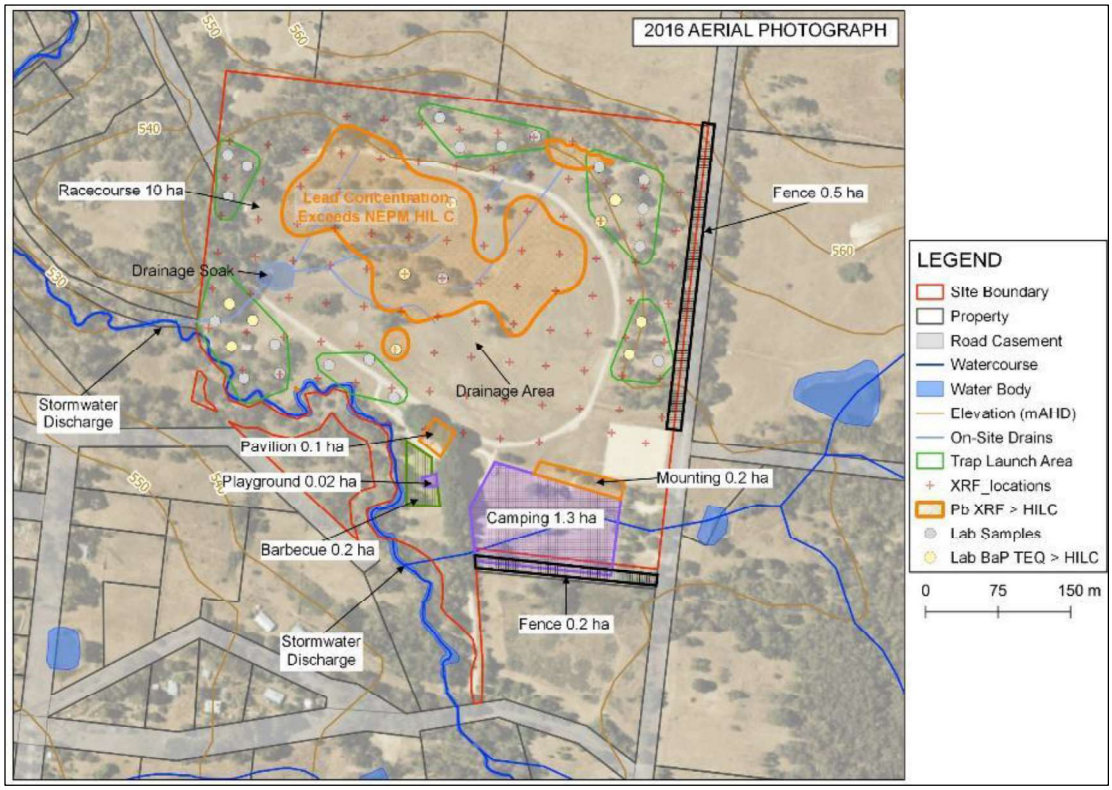

Figure 2.3: Preliminary pXRF and laboratory data for Glenlyon Recreation Reserve soil samples

The PSI also included the use of a portable x-ray fluorescence (pXRF) detector, which identified lead concentrations that exceeded the NEPM HIL C (600 mg/kg) in 22% of samples (total analyses = 104), with 65% of samples having concentrations below 300 mg/kg (the HIL A screening level for a sensitive use). The pXRF investigation revealed a large lead concentration hot-spot in the racecourse's centre (**Figure 2.3** above). Laboratory analysis of 30 samples confirmed the elevated lead concentrations, with seven samples (four within the pXRF defined hotspot) reported to have lead concentrations above 300 mg/kg (23% of the analyses) and two above 600 mg/kg (7%), both located within the pXRF identified hot-spot.

While the pXRF is an invaluable screening technology, comparison between the laboratory and pXRF data for the seven reserve soil samples with corresponding laboratory and pXRF data indicates that the pXRF tends to overestimate the lead concentration (**Figure 2.4** below).

The correlation shown on the adjacent **Figure 2.4** is not a result of pXRF inaccuracy but rather the different methods employed to measure the metal concentrations. The laboratory metal concentrations are measured from an aqua regia "leach" on a 2-gram soil aliquot, which provides the approximate bioavailable metal concentrations and is directly comparable to the NEPM screening criteria. An aqua regia digestion does not completely dissolve the soil, which would provide *total metal* concentrations, but rather dissolves the metals adsorbed to soil and organic matter particles. Pure lead is only very slightly soluble in aqua-regia. In contrast, the pXRF measures the lead concentration in a small area (approximately 5 mm) of the sample via x-rays that penetrates the adsorbed material and soil particles to measure a total (not adsorbed) metal concentration, which is not comparable to the NEPM screening criteria.

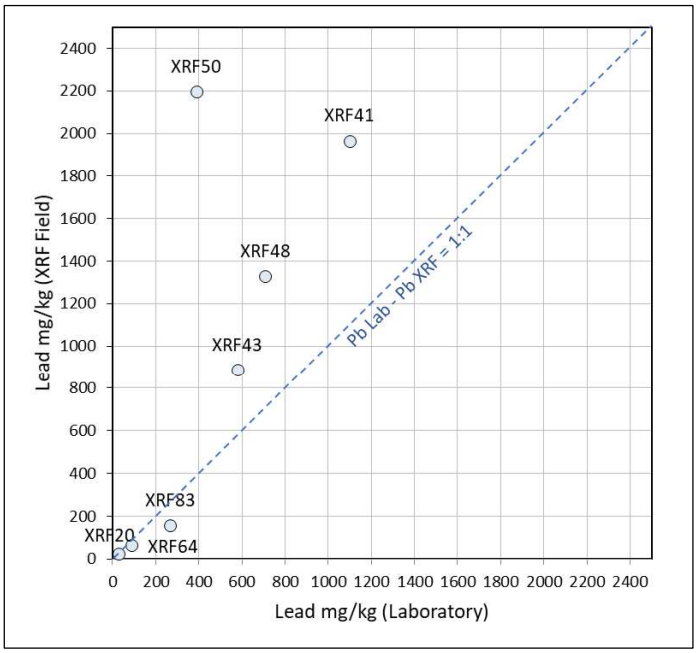

Figure 2.4: Comparison between laboratory and pXRF derived lead concentrations for Glenlyon Recreation Reserve soil samples.

Beveridge Williams collected 30 surface soil samples for laboratory analysis, with 26 collected from locations outside the pXRF lead hotspot.

The reserve soil sample laboratory data showed that PAH compounds were identified in and near the trap shooting clay-pigeon launching areas, and in some cases exceeded the NEPM health investigation level applicable to an open space (HIL C). Elevated PAH concentrations were also identified in areas away from the launching areas (**Figure 2.3** above), implying that PAH compounds are potentially widespread within the reserve.

Based on the PSI findings Beveridge Williams considered that lead and PAH impacts at the Site from clay target shooting activities may pose a potential risk to Site users. The following recommendations were made in the report:

- *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 from ongoing target shooting 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.*

Based on the findings of the PSI, a CUN 90010886 was issued for the Site.

2.7 OTHER VICTORIAN SHOOTING RANGES

2.7.1 Wangaratta Clay Target Club

Lead and PAH contamination was identified at the Wangaratta Clay Target Club in 2016, resulting in a CUN being issued by the EPA.

Information obtained from the EPA Victoria website (accessed 6 May 2020) indicates that lead contaminated soil was excavated and removed from the site resulting in the reduction of human health and environmental risks. A site management plan was implemented outlining access restrictions and dust monitoring requirements.

As a result of the findings, the club moved from petroleum pitch (i.e., PAH source) based targets to eco-friendly targets.

2.7.2 Former Winchelsea Clay Target Shooting Club

Lead and PAH contamination were identified at the former Winchelsea Clay Target Shooting Club. As a result, in late 2013, the reserve was fenced off and the community warned of the potential effects of contamination and the requirement for remediation. The remediation technique involved coarse sieving of the soil and on-site encapsulation of the fine soil fraction. Following more detailed investigations that revealed the extent of the contamination, the club was unable to resume shooting activities.

2.8 SAMPLING AND ANALYSIS QUALITY PLAN

2.8.1 Contaminants of Potential Concern

Based on the desktop review, including the current and previous uses of the Site, the contaminants of potential concern (COPC) are listed in **Table 2.5** below.

Table 2.5: Contaminants of Potential Concern

Source	COPC
Historical uncontrolled importation of fill	Metals, PAH, TPH/TRH, OCP, PCB
Shooting activities	PAH and lead

2.8.2 Data Qaulity Objectives

Schedule B2 of the NEPM describes the data quality objectives (DQO) process and its importance in contaminated site assessment programs.

The NEPM DQO process is a seven-step iterative planning approach. The first six steps of the process include qualitative and quantitative statements that define the purpose of the site assessment to be undertaken and the type, quantity and quality of data needed to inform decisions relating to the assessment of site contamination. In the seventh step, the sampling, analysis and quality plan (SAQP) is developed to generate data to meet the DQOs. The SAQP documents the criteria that a sample design should satisfy, including when, where and how to collect samples or measurements, acceptance (performance) criteria and the samples or measurements that should be collected.

The DQOs developed for this assessment are provided in **Table 2.6** below.

Table 2.6: Data Quality Objectives

Step	Description	Outcome
1	State the problem	The SAQP intends to assess the impacts of current and historical site operations on the receiving elements of the environment. The problems identified at the Site include: • Past Site use has resulted in the contamination of soil with PAH compounds and lead. • Untested soil has potential been imported to the Site. • Based on the past uses there is a potential for surface water and groundwater to be contaminated at the Site.

Step	Description	Outcome
2	Identify the decisions/goal of the investigation	The data obtained from the field monitoring and laboratory analysis will be used to make decisions regarding the impacts of current and historical Site operations on soil, sediment, surface water and groundwater. The decisions may include the requirement for further investigation and/or management or determine that the risks are low and acceptable. Detailed site characterisation is required to: • Delineate lead and PAH impacts in soils previously identified at the Site. • Assess metals and PAH impacts in sediment and surface water at the stormwater discharge locations both on and offsite. • Assess if the contaminants identified in soil have impacted the underlying groundwater. • Assess whether the lead and PAH impacts represent a potential risk to on- and off-Site human health or ecological receptors of the surrounding area. • Establish the soil contamination status in the areas of the camping ground, along the proposed fence lines, at the mounting block and horse yards, children's playground, barbeque area, and pavilion.
3	Identify the inputs to the decision	The following information is required to make the above listed decisions: • Site layout. • Groundwater flow direction. • Topographic profile. • Surface water drainage channels. • Concentrations and spatial distribution of key analytes in sampled media. • Potential receptors and complete source-pathway-receptor linkages. • Quality assurance and quality control (QA/QC) data.
4	Define the study boundaries/ constraints on data	The vertical boundary of the investigation area extends from the ground surface to the upper aquifer beneath the Site. The lateral extent of the investigation area extends approximately to the Site boundaries to the north, east and west, and the surface water receiving body to the south. The timeframe (temporal boundary) for this investigation's scope of work is primarily defined by the deadline stipulated in the CUN (i.e., 27 May 2020).
5	Develop the analytical approach (or decision rule)	The degree of impact by metals, PAH and other potential contaminants of concern will be assessed with reference to the applicable assessment criteria. The decision rule is considered to be: • If concentrations of key analytes in soil on-Site are observed and/or exceed the soil investigation and screening criteria, then further risk assessment, remediation and/or management may be required. The soil assessment criteria will be based on the NEPM. • If concentrations of key analytes in surface water and groundwater on- or off-Site are observed and/or exceed the surface water and groundwater assessment criteria, then further risk assessment, remediation and/or management may be required. The surface

Step	Description	Outcome
		water and groundwater assessment criteria will be based on the 2018 State Environment Protection Policy (SEPP) Waters. • No further action may be required in the event that analyte concentrations are below adopted site criteria and/or are not detected confirms a low and acceptable risk for the Site. • Waste categorisation of surplus soils that may be generated as part of future construction works at the reserve will also be compared against the Environment Protection (Industrial Waste Resource) Regulations 2009. Publication IWRG621 – June 2009 will be used to determine soil management or disposal options
6	Specify limits on decision errors	Acceptable limits on decision errors and the manner of addressing possible decision errors, have been developed based on the data quality indicators (DQIs) of sensitivity, precision, accuracy, representativeness, comparability and completeness. The tolerable limits on decision errors for data that Kleinfelder considers acceptable are: • Probability that 95% of data satisfied the DQIs, therefore the limit on the decision error was 5% that a conclusive statement may be incorrect. • In applying statistical analysis of a data set (where appropriate). • A robust QA/QC program will be implemented to ensure an appropriate analytical program and sampling density is adopted and representative sampling undertaken. The possible consequences of making a decision error are the need for further investigation, remediation and/or management. However, the controls above minimise the potential of making decision errors.
7	Optimise the design for obtaining data	This DSI has been designed based on the information and data obtained during previous PSI and iterative development of the CSM. The resource-effective sampling and analysis methodology has been designed to achieve Steps 1-6 of the DQOs.

2.8.3 Data Quality Indicators

DQIs refer to quality control criteria established for various aspects of data gathering, sampling, or analysis activity. In defining DQIs specifically for the assessment, the level of uncertainty associated with each measurement is defined. The DQIs adopted for field techniques and laboratory analysis include:

- Completeness: a measure of the amount of useable data (expressed as %) from a data collection activity.
- Comparability: a qualitative parameter expressing the confidence with which one data set can be compared with another.

- Representativeness: the confidence (expressed qualitatively) that data are representative of each media present on the site.
- Precision: a quantitative measure of the variability (or reproducibility) of data.
- Accuracy (bias): a quantitative measure of the closeness of reported data to the true value.

A summary of the DQIs developed for this assessment are provided in **Table 2.7** below.

Table 2.7: DQIs for Field Techniques

DQI	Field	Laboratory	Acceptability Limits
Completeness	• All critical locations sampled • All samples collected • Standard operating procedures (SOPs) appropriate • Experienced sampler • Documentation correct	• All samples submitted for analysis and the concentrations of all COPC analytes determined according to the laboratory SOPs • Appropriate methods to analyse samples • Appropriate reporting limits • Sample documentation complete • Sample holding times complied with	As per NEPM Less than nominated criteria
Comparability	• Sample SOPs used on each occasion • Experienced sampler • Climatic conditions	• Same analytical methods used • Same laboratories, which are National Association of Testing Authorities (NATA) accredited • Same units as the criteria	As per NEPM Less than nominated criteria
Representativeness	• SOPs developed in accordance with national and state sampling guidelines	• Ensuring the sample preparation and measurement of the analyte within the sample does not affect analytes measured during the analytical routine	Relative percent difference (RPD) of 30 to 50%
Precision	• Collection of blind and split duplicate samples in accordance with required state and national requirements	Analysis of: • Intra-laboratory duplicate samples (1 in 20 primary samples) • Inter-laboratory duplicate samples (1 in 20 primary samples) • Laboratory duplicate samples • Laboratory prepared trip blank / trip spike (1 sampling round)	RPD of 30 to 50%

DQI	Field	Laboratory	Acceptability Limits
Accuracy	• SOPs appropriate • Collection of rinsate blanks	Analysis of: • Method blanks • Matrix spikes • Matrix spike duplicates • Surrogate spikes • Laboratory control samples • Laboratory prepared spikes • Reagent blanks • Reference materials	RPD of 30 to 50%

3. SITE ASSESSMENT CRITERIA

To assess the relative level and significance of any contaminants reported in soil, sediment, groundwater and surface water at the Site, reference is made to established environmental and/or human health-based investigation levels. These investigation levels are dependant mainly upon the ongoing use of the Site as a recreation reserve and the associated environmental and human health risk, either on-site or off-site, in both the long and short term.

3.1 SOIL ASSESSMENT CRITERIA

The State Environment Protection Policy (Prevention and Management of Contamination of Land) (Land SEPP) sets out the regulatory framework for the prevention and management of contaminated land within the State of Victoria. The intent of this framework is to maintain and maximise to the extent practicable the quality of the land environment in Victoria, in order to protect its existing and potential beneficial uses.

The Land SEPP identifies a range of land use categories and a range of protected beneficial uses for each of these categories. The EPA considers that land (soil) is polluted where current and/or future protected beneficial uses for the relevant land use categories are precluded. Beneficial uses of land are considered to be precluded when relevant soil quality objectives set out in the Land SEPP for those beneficial uses have been exceeded.

The Land SEPP states that the following beneficial uses that must be protected for a recreation/open space land use:

- Maintenance of ecosystems (modified and highly modified).
- Human health.
- Buildings and structures.
- Aesthetics.

Soil quality investigation levels that were adopted as part of this DSI for each of these protected beneficial uses are discussed in the following sections.

3.1.1 Adopted Soil Criteria

In accordance with the Land SEPP, soil quality investigation levels for the identified protected beneficial uses were primarily sourced from the NEPM, and more specifically those provided in Schedule B1 of the NEPM, ‘Guideline on the investigation levels for soil and groundwater’.

The NEPM states, “Investigation and screening levels are not clean-up or response levels nor are they desirable soil quality criteria. Investigation and screening levels are intended for assessing existing contamination and to trigger consideration of an appropriate site-specific risk-based approach or appropriate risk management options when they are exceeded”.

3.1.1.1 Protection of Modified and Highly Modified Ecosystems

Schedule B1 of the NEPM provides a range of investigation levels for the protection of ecosystems, referred to as ecological investigation levels (EILs) and ecological screening levels (ESLs) and are applicable for assessment of risk to terrestrial ecosystems. The following should be noted:

- A limited range of EILs are provided. EILs depend on specific soil properties and land use scenarios.
- A limited range of ESLs have been developed for organic substances including selected petroleum hydrocarbon compounds and TRH fractions and are applicable for assessing risk to terrestrial ecosystems. ESLs broadly apply to coarse- and fine-grained soils and various land uses.
- The EILs/ESLs generally apply to the top 2 m of soil.

EILs/ESLs values are provided for three exposure settings based on land use. These are:

- Areas of ecological significance.
- Urban residential and public open space.
- Commercial and industrial.

EILs have been used to assess onsite environmental impacts, by direct comparison with soil concentrations found at each sampling location. As the purpose of this DSI was to assess the Site for the ongoing land use scenario as a recreation reserve, soil concentrations were compared against public open space EILs/ESLs. Further, given the silty soil conditions encountered at the Site, ESLs relating to coarse grained soil were considered to be appropriate.

The NEPM allows for site specific EILs to be derived for chromium (III), copper, lead, nickel and zinc based on the sum of the ambient background concentration and added contaminant limit (ACL).

Site specific EILs were calculated based on aged ambient background concentrations (ABC) and are outlined in the following table.

Table 3.1: Site Specific EILs

Analyte	Site Specific EIL (mg/kg)
Chromium	190
Copper	60
Lead	1,100
Nickel	170
Zinc	310

3.1.1.2 Protection of Human Health

Schedule B1 of the NEPM provides a range of investigation levels for the protection of human health, referred to as health investigation levels (HILs) and health screening levels (HSLs).

The following should be noted:

- HILs have been developed for a broad range of metals and organic substances. The HILs are applicable for assessing human health risk via all relevant pathways of exposure. The HILs are generic to all soil types and apply generally to a depth of 3 m below the surface.
- HSLs have been developed for selected petroleum compounds and fractions and are applicable to assessing human health risk via the inhalation and direct contact pathways. The HSLs depend on specific soil physicochemical properties, land use scenarios, and the characteristics of building structures. They apply to different soil types, and depths below surface to >4 m.

Values for HILs/HSLs are provided for four exposure settings based on land use. These are:

- A – Residential with garden/accessible soil (home grown produce <10% fruit and vegetable intake, (no poultry), also includes children's day care centres, preschools and primary schools;
- B – Residential with minimal opportunities for soil access includes dwellings with fully and permanently paved yard space such as high-rise buildings and flats;
- C – Public open space such as parks, playgrounds, playing fields (e.g. ovals), secondary schools and footpaths. It does not include undeveloped public open space (such as urban bushland and reserves) which should be subject to a site-specific assessment where appropriate; and
- D – Commercial/industrial such as shops, offices, factories and industrial sites.

A Tier 1 assessment is a risk-based analysis comparing reported concentrations of analytes with investigation and screening levels for various land uses to determine the need for further assessment or development of an appropriate management strategy.

Where assessment criteria are not provided in the NEPM, the following criteria were included from Cooperative Research Centre for Contamination Assessment and Remediation of the Environment (CRC CARE) Technical Report No. 10:

- CRC CARE Soil HSLs A, B, C & D for direct contact in residential, urban residential/public open space and commercial/industrial settings; and
- CRC CARE Soil HSL for direct contact (maintenance worker).

As the purpose of this DSI was to assess the Site for the ongoing land use scenario as a recreation reserve, HIL/HSL C has been adopted. HIL/HSL A was adopted for the children's playground area. For the purposes of assessing potential risks to the off-Site properties, HIL/HSL A was adopted.

3.1.1.3 Buildings and Structures

The Land SEPP states, "*Contamination must not cause the land to be corrosive to or adversely affect the integrity of structures or building materials*". The potential for the condition of soils at the Site to adversely impact upon buildings includes:

- Ingress of contaminants into subterranean service lines (such as ingress into water supply pipelines).
- Corrosion of concrete or steel foundations, basements or service utilities.

Exposure classifications for steel and concrete piles are provided in:

- Standards Australia, 2005. Piling – design and installation. AS 2159-2009.

3.1.1.4 Aesthetics

The Land SEPP states that "*Contamination must not cause the land to be offensive to the senses of human beings*". This beneficial use was assessed qualitatively based on observations recorded during the field and is considered to be protected through application of investigation levels relating to more conservative beneficial uses.

3.2 GROUNDWATER ASSESSMENT CRITERIA

The SEPP (Waters) 2018 (SEPP), outlines the requirements for the protection of water (surface water and groundwater) in Victoria. The SEPP requires certain beneficial uses of groundwater to be protected. These beneficial uses are based on the classification of groundwater into segments with the segments being determined by groundwater quality based on the measured TDS. The segments are defined in **Table 3.2** below.

Table 3.2: Groundwater Segments for TDS Ranges

Segment	A1	A2	B	C	D	E	F
TDS Range (mg/L)	0-600	601-1,200	1,201-3,100	3,101-5,400	5,401-7,100	7,101-10,000	>10,001

Based on the measured TDS during this GME (550 mg/L to 2,200 mg/L) and the expected range of 1,000-3,500 mg/L, Groundwater Segment A1 has been conservatiely adopted for this assessment (**Table 3.3**).

3.2.1 Beneficial Uses of Groundwater

The significance of groundwater contamination in Victoria is assessed in terms of the beneficial use of the groundwater. The beneficial uses to be protected under legislation for each groundwater segment as defined in the SEPP are shown in grey in **Table 3.3** below.

Table 3.3: Beneficial Uses of Groundwater Segments

Beneficial Uses	Segments (mg/L TDS)						
	A1	A2	B	C	D	E	F
Water dependent ecosystems and species	✓	✓	✓	✓	✓	✓	✓
Potable water supply (desirable)	✓						
Potable water supply (acceptable)		✓					
Potable mineral water supply	✓	✓	✓	✓			
Agriculture and irrigation (irrigation)	✓	✓	✓				
Agriculture and irrigation (stock watering)	✓	✓	✓	✓	✓	✓	
Industrial and commercial	✓	✓	✓	✓	✓		
Water-based recreation (primary contact recreation)	✓	✓	✓	✓	✓	✓	✓

Beneficial Uses	Segments (mg/L TDS)						
	A1	A2	B	C	D	E	F
Traditional Owner cultural values	✓	✓	✓	✓	✓	✓	✓
Cultural and spiritual values	✓	✓	✓	✓	✓	✓	✓
Buildings and structures	✓	✓	✓	✓	✓	✓	✓
Geothermal properties	✓	✓	✓	✓	✓	✓	✓

Notes:
✓ Beneficial uses requiring protection for a nominated segment.
Indicates segment relevant to the site, based on TDS.

The beneficial uses of Site groundwater and the relevant screening criteria are explained in the following subsections.

3.2.1.1 Water Dependent Ecosystems and Species

In accordance with the Waters SEPP, the guidelines used to protect the water dependent ecosystems and species (WDES) beneficial use is the Australian and New Zealand Environment and Conservation Council (ANZECC)[4]. The Site is located within the SEPP Central Foothills and Coastal Plains Segment, which are considered to be slightly to moderately modified freshwater ecosystems.

Any groundwater discharging to a surface water body in the area is assessed against the ANZECC 95% protection limits relating to freshwater ecosystems.

3.2.1.2 Potable Water Supply (Desireable)

The screening criteria for this beneficial use are from National Health and Medical Research Council (NHMRC[5]). Australian drinking water guidelines.

3.2.1.3 Potable Mineral Water Supply

Guideline values sourced from the NHMRC guidelines. It is noted that the Groundwater Resources of Victoria map sheet (DME 1992) and VVG database indicate that the Glenlyon region is with a mineral springs area.

[4] Australian and New Zealand Environment and Conservation Council and the Agriculture and Resource Management Council of Australia and New Zealand, 2000. Australian and New Zealand guidelines for fresh and marine water quality.
[5] National Health and Medical Research Council, 2011. Australian drinking water guidelines 6. Version 3.5. Updated August 2018.

3.2.1.4 Agriculture and Irrigation (Irrigation)

Irrigation screening criteria are from ANZECC – Water quality for irrigation.

3.2.1.5 Agriculture and Irrigation (Stock Watering)

Stock watering screening criteria are from ANZECC – Livestock drinking water.

3.2.1.6 Industrial and Commercial

Specific guidelines for industrial water use cannot be established, as the ANZECC guidelines '*provide no specific guidance, because industrial water requirements are so varied (both within and between industries) and sources of water for industry have other coincidental environmental values that tend to drive management of the resource*' (pg.1-4). On this basis, the beneficial use for industrial water use at the Site is considered to be protected by consideration of other protected beneficial uses.

3.2.1.7 Water-based Recreation (Primary Contact Recreation)

Water-based recreation criteria are from NHMRC, 2008[6]. Guidelines for managing risks in recreation water.

In accordance with this publication, drinking water guidelines have been multiplied by a factor of 10 for non-volatile compounds, taking into consideration a consumption of 100-200 millilitres per day due to recreational water exposure.

3.2.1.8 Traditional Owner Cultural Values

Traditional owner cultural values relates to the protection of water for cultural needs and ensure traditional owner cultural practices can continue. Values may include traditional aquiculture, fishing, harvesting, and cultivation of freshwater foods, fish, grasses, medicines and filtration of water holes. Conservatively, ANZECC WDES and NHMRC (2008) guidelines have been adopted as the investigation levels relevant for the protection of this beneficial use.

3.2.1.9 Cultural and Spiritual Values

Water quality is suitable for cultural, spiritual and ceremonial practices including baptisms, water-based festivals and cultural celebrations. Conservatively, NHMRC (2008) guidelines will be adopted as the investigation levels relevant for the protection of this beneficial use.

[6] National Health and Medical Research Council, 2008. Guidelines for managing risks in recreational water.

3.2.1.10 Buildings and Structures

Exposure classifications for steel and concrete piles outline in AS 2159[7] are typically adopted for the protection of the beneficial use (i.e. pH, chloride and sulfate).

3.2.1.11 Geothermal Properties

The intent of this benefical use under the Water SEPP is to ensure groundwater quality will not affect the natural thermal capacity of the groundwater (e.g. temperature). The target aquifer of this investigation is not considered suitable for geothermal utilisaiton and the beneficial use is not further considered.

3.3 SURFACE WATER ASSESSMENT CRITERIA

As outlined within the Waters SEPP, Site surface waters are within the Central Foothills and Coastal Plains Segment which is considered a slightly to moderately modified freshwater ecosystem.

The beneficial uses of inland waters relevant to the site are explained in the following subsections.

3.3.1.1 Water dependent ecosystems and species

The guidelines used to protect this beneficial use is the Australian and New Zealand Governments "Water Quality Management Framework". As outlined within the SEPP, discharge of groundwater to surface waters in the vicinity of the Site falls under the Central Foothills and Coastal Plains segment. As outlined within the SEPP, the Central Foothills and Coastal Plains segment is considered a slightly to moderately modified freshwater ecosystem. As such, ANZEC 95% WDES protection limits relating to fresh water have been adopted.

3.3.1.2 Agriculture and Irrigation

Irrigation screening criteria are from:

- ANZECC – Water quality for irrigation.
- ANZECC – Livestock drinking water.

[7] Standards Australia, 2009. Piling – Design and installation. AS 2159

3.3.1.3 Human consumption of aquatic foods

Guideline values sourced from the NHMRC have been adopted for the protection of this potential beneficial use.

3.3.1.4 Industrial and Commercial

Specific guidelines for industrial water use cannot be established, as the ANZECC guidelines *'provide no specific guidance, because industrial water requirements are so varied (both within and between industries) and sources of water for industry have other coincidental environmental values that tend to drive management of the resource'* (p.1-4). On this basis, the beneficial use for industrial water use at the Site is considered to be protected by consideration of other protected beneficial uses.

3.3.1.5 Water-based recreation

Water-based recreation criteria are from NHMRC, 2008[8]. Guidelines for managing risks in recreation water.

In accordance with this publication, drinking water guidelines have been multiplied by a factor of 10 for non-volatile compounds, taking into consideration a consumption of 100-200 millilitres per day due to recreational water exposure.

3.3.1.6 Traditional Owner Cultural Values

Traditional owner cultural values relates to the protection of water for cultural needs and ensure traditional owner cultural practices can continue.

Values may include traditional aquiculture, fishing, harvesting, and cultivation of freshwater foods, fish, grasses, medicines and filtration of water holes. Conservatively, ANZECC WDES and NHMRC 2008 guidelines are be adopted as the investigation levels relevant for the protection of this beneficial use.

3.3.1.7 Cultural and Spiritual Values

Water quality is suitable for cultural, spiritual and ceremonial practices including baptisms, water-based festivals and cultural celebrations. Conservatively, NHMRC 2008 guidelines are be adopted as the investigation levels relevant for the protection of this beneficial use.

[8] National Health and Medical Research Council, 2008. Guidelines for managing risks in recreational water.

4. FIELD ACTIVITIES

4.1 SUMMARY OF FIELD ACTIVITIES

Field activities that were undertaken as part of the completed scope of works are summarised in **Table 4.1** below.

Table 4.1: Field Activities

Activity/Date	Description
Site induction 2 April 2020	Kleinfelder field staff and subcontractors were inducted into Council's occupational health and safety (OH&S) management system by a Council member prior to the commencement of field works.
Subsurface clearance 2 – 3 April 2020	Prior to the commencement of ground disturbing activities, subsurface clearance of drilling and sampling locations was completed by a utility location contractor to identify the presence and location of underground services that may affect the planned sample locations.
Soil boring and well installation 2 – 3 April	Four monitoring wells were installed onsite in accordance with: • Kleinfelder Standard Operating Procedure (SOP) #14 • National Uniform Drillers Licencing Committee (NUDLC) minimum construction requirements for water bores in Australia (2012). The drilling and well construction included: • A combination of hand auger and mechanical drilling using 150 mm solid auger to the target depth. • Installation of Class 18 uPVC 50 mm 0.45 µm slotted screen and blank casing. • Installation of a filter pack comprising clean graded sands within the annular space between the borehole and the well casing and extending from the base of the screened interval to approximately 0.5 m above the top of the slotted casing. • Installation of a one meter thick bentonite seal, comprising granular or pelleted bentonite above the filter pack and finished to the surface with a cement grout to prevent water seepage downward along the well casing or borehole. • Completion of each monitoring well with a ground flush mounted lockable steel gatic cover. The borehole logs including the details of the groundwater monitoring well construction are provided in **Appendix D**. The locations of the groundwater monitoring wells are presented on **Figure 6** and the Victorian Water Registry bore construction licence is attached in **Appendix E**.
Well development 3 April 2020	Following well installation, the four wells were developed by removing at least four well volumes of water using a steel bailer to remove fines and promote hydraulic connection with the aquifer. Well development logs are provided in **Appendix F**.

Activity/Date	Description
Soil boring 6 – 9 April 2020 and 5 January 2021	The following soil bores were advanced to depths between 0.3 mbgl and 1.0 mbgl into natural soil using a hand auger: • 52 targeted locations in the racecourse (samples OG01 – OG52 and OG53). • 12 gridded locations in the camping ground (CG01 – CG12). • 11 targeted locations in the barbeque/shelter area (BS01 – BS11). • 10 targeted locations in the pavilion area (PV01 - PV10). • 5 targeted locations in the children's playground (PG01 – PG05). • 5 unbiased locations along the proposed fence lines (FB01 – FB05). • 5 targeted locations in the mounting yard and horse yards (MY01 – MY05). • 1 targeted location on the southern Site boundary (OG52). • 14 accessible off-Site locations within the neighbouring properties to the north, east and west of the Site (SB01 – SB14). Following soil sampling/logging was completed, the boreholes were backfilled using the soil cuttings. Bore logs are provided as **Appendix D**. Soil sample locations are presented on **Figure 3**.
Soil sampling and logging 2 April 2020, 6 – 9 April 2020 and 5 January 2021	**Monitoring Wells** During drilling and installation of groundwater wells, retrieved soil cores were logged by the Kleinfelder field supervisor. Soil logging was performed in general accordance with AS1726. The Kleinfelder field supervisor performed field screening of the retrieved soil core using a photoionisation detector (PID) fitted with a 10.6 electron volt (eV) ionising lamp. Soil samples from each location were collected at 0.1 mbgl, 0.5 – 0.7 mbgl, 1.0 mbgl and then at metre intervals to the target depth. Sampling was conducted by collecting soils via hand/solid auger and transferring the sample into laboratory supplied jars via nitrile gloved hands. To prevent cross-contamination all samples were handled using a new pair of disposal nitrile gloves.
	Soil Bores Soil from soil bores was logged in accordance with AS1726. The Kleinfelder field supervisor performed field screening of the retrieved soil core using a PID fitted with a 10.6 eV ionising lamp. Sampling was conducted by collecting soils via hand auger and transferring the sample into laboratory supplied jars via nitrile gloved hands. To prevent cross-contamination all samples were handled using a new pair of disposal nitrile gloves. Soil samples were collected at two depths from each location (surface to 0.1 mbgl and within natural soil). The Site geological profile is summarised in **Table 4.2** below. The surface to 0.1 m sampling procedure was as follows: • Vegetation, including where possible rootles were removed from the surface and upper most soil layer • The hand auger was advanced to 0.1 mbgl • An aliquot for VOC testing was transferred to a zip-lock plastic bag • All remaining soil was transferred to the laboratory supplied soil jar
Well gauging, purging and sampling	Monitoring wells were gauged using an oil/water interface probe prior to purging/sampling and the standing water level relative to top of casing (TOC) was recorded.

Activity/Date	Description
8 April 2020	Sampling was conducted using the low-flow method and in accordance with the Kleinfelder SOP. Purging took place until field parameters stabilised in accordance with EPA Victoria Publication 669. During sampling, the depth to water was monitored. Field measurements were recorded during, and at the completion of purging (immediately prior to sample collection). Samples were transferred into laboratory supplied containers via nitrile gloved hands (replaced at each location to prevent cross-contamination). Groundwater samples were filtered in the field (0.45µm filter) for dissolved metals analysis. The groundwater sampling field sheets are provided in **Appendix G**.
	New disposable low flow bladders, tubing and filters were used for each location. Duplicate and split duplicate (triplicate) samples were taken at a rate of one duplicate per day. Rinsate blanks were from a piece of non-dedicated field equipment being used at a rate of one per day.
Sediment sampling 9 April 2020	Sediment samples were collected at two points of discharge to the Loddon River (SD01 and SD02). Sampling was conducted by collecting sediment via hand auger and transferring the sample into laboratory supplied jars via nitrile gloved hands. Sediment sampling sheets are provided in **Appendix H**. Sediment sampling locations are presented on **Figure 8**.
Surface water sampling 9 April 2020	Stormwater samples were collected at two points of discharge to the Loddon River (SW01 and SW02). One surface water sample was collected from the Glenlyon Community Dam (DAM). Sampling was conducted by collecting water directly into laboratory supplied containers via telescoping grab sampler. Surface water samples were filtered (0.45µm filter) in the lab for dissolved metals analysis. Surface water sampling logs are provided in **Appendix H**. Surface water sampling locations are presented on **Figure 8**.
Mineral springs sampling 9 April 2020	One sample was collected from the Glenlyon Mineral Springs Pump (MS01). Sampling was conducted by pouring water from the pump directly into laboratory supplied containers. Surface water sampling logs are provided in **Appendix H**. Mineral springs sampling location is presented on **Figure 8**.
Laboratory analysis – soil	A total of 250 soil samples were collected and submitted to Eurofins. Of these, 106 on-Site samples were analysed for the COPC (metals and PAH), and 14 off-Site samples analysed for lead and PAH. Select soil samples were also analysed for: • Particle size (% clay and <63 and >63 µm) • NEPM Soil Classification (% Fe, cation exchange capacity (CEC), pH, total organic carbon (TOC), % clay). • NEPM HIL Screen (TRH, BTEX, PAH, phenol, pentachlorophenol, 2-methylphenol (o-cresol), 3&4-methylphenol (m+p-cresol), OCPs, acid herbicides, atrazine, chlorpyrifos, bifenthrin, polychlorinated biphenyls (PCBs), metals (As, Be, B, Cd, Co, Cr, Cu, Pb, Hg, Mn, Ni, Se, Zn), Cr^{6+}, free cyanide). • EPA Victoria IWRG Suite (TRH, PAH, phenols, OCP, PCB, BTEX, metals (As, Cd, Cr, Cu, Pb, Hg, Mo, Ni, Se, Ag, Sn, Zn), CN, total fluoride), for soil disposal assessment. • Nitrates and phosphates.

Activity/Date	Description
	Quality control (QC) samples in the form of nine duplicates, four equipment rinsates and two trip blanks were collected and submitted to Eurofins for quality control purposes. Nine triplicate samples were submitted to ALS for quality control purposes. Laboratory reports are provided in **Appendix I** and tabulated results are attached in **Tables 1** to **13**.
Laboratory analysis – groundwater	A total of five groundwater samples (MW01 to MW04 and MS01) were submitted to Eurofins for analysis. All groundwater samples were analysed for metals, nutrients, cations, anions, PAH and TDS. QC samples in the form of one duplicate, one rinsate and one trip blank were collected and submitted to Eurofins for quality control purposes. One triplicate sample was submitted to ALS for quality control purposes. Laboratory reports are provided in **Appendix I** and tabulated results are attached in **Tables 15** to **21**.
Laboratory analysis – surface water	A total of three primary surface water samples were submitted to Eurofins for analysis. All samples were analysed for anions, cations, TDS and metals. In addition, SW01 and SW02 were analysed for TSS and PAH. QC samples in the form of one trip blank were collected and submitted to Eurofins for analysis. Laboratory reports are provided in **Appendix I** and tabulated results are attached in **Tables 22** to **25**.
Decontamination procedure	All reusable sampling equipment was decontaminated between each sample location by: • Washing thoroughly in a bucket with Decon 90. • Rinsing thoroughly in a second bucket using potable water. • Rinsing thoroughly with deionised water.
Equipment calibration	Well maintained and calibrated field sampling and monitoring equipment was used. Equipment calibration certificates are provided in **Appendix J**.
Sample preservation during sampling and transit	Soil samples were stored on ice while on Site and during transit to the laboratory. Samples were transported in laboratory supplied glass jars under COC documentation.
Waste Management – soil	Soil cuttings from drilling of MW01 to MW04 were stored on Site in three secure 205 L steel drums and disposed off-Site at a suitably licensed facility. A copy of the waste transport certificates are provided in **Appendix K**.
Waste Management – water	Well development water and purged groundwater was stored on Site in one secure 205 L steel wastewater drum and disposed off-Site at a suitably licensed facility. A copy of the waste transport certificates are provided in **Appendix K**.
Well surveying	A licenced surveying company surveyed the location of the four newly installed groundwater wells relative to the Geocentric Datum of Australia (GDA; 1994 and 2020). The top of each bore casing elevation was surveyed relative to the Australian Height Datum (AHD) with an accuracy of +/- 0.001m. The survey report is attached in **Appendix L**.

5. RESULTS

5.1 SOIL

5.1.1 Field Observations

No olfactory evidence of contamination was observed during soil sampling. Soils were screened using a PID and readings ranged between 0.0 parts per million (ppm) to a maximum reading of 1.9 ppm (MW02_0.7), which are not considered indicative of volatile organic compound presence.

No staining was observed during soil sampling. Visible clay target fragments were identified on the surface soils predominantly in the north and north-western portions of the racecourse. The presence of clay target fragments cannot be excluded across the other areas of the Site.

The previous PSI documented the presence of stockpiles located in the northwest corner of the Site. No visible stockpiles, however, were observed during this investigation.

5.1.2 Site Geological Profile

The geological profile encountered during drilling consisted of topsoil overlying gravelly silts and clayey silts. A summary of the subsurface profile is shown in **Table 5.1** below.

Table 5.1: Site Geological Profile

Depth Range (mbgl)	Unit Description
0.0 to 0.5	Fill: Brown, dry, silt, soft.
0.5 to 0.7	Gravelly silt/clayey silt, brown/grey, dry, low plasticity, soft.
0.7 to 2.0	Clayey silt, brown/grey, dry, low plasticity, soft.
2.0 to 10.0	Clayey silt, brown/grey, dry to wet, low to medium plasticity, soft to firm.

Bore logs are attached in **Appendix D**.

5.1.3 Soil Analytical Results

A summary of soil analytical results is presented in **Table 5.2** below.

Table 5.2: Summary of Soil Analytical Results

Analyte	No of Samples Analysed	Concentration Range (mg/kg)	Samples Exceeding Criteria
BTEXN			
Benzene	6	<0.1	None
Toluene	6	<0.1	None
Ethylbenzene	6	<0.1	None
Total Xylenes	6	<0.3	None
Naphthalene	6	<0.5	None
TRH			
TRH C_6-C_{10}	6	<20	None
F1 (TRH C_6-C_{10} minus BTEX)	6	<20	None
TRH >C_{10}-C_{16}	6	<50	None
F2 (TRH >C_{10}-C_{16} minus Naphthalene)	6	<50	None
TRH >C_{16}-C_{34}	6	<100 to 130	None
TRH >C_{34}-C_{40}	6	<100	None
Metals			
Arsenic	104	<2.0 to 180	**MW01_0.1 and PV03_0.1 (EIL – public open space)**
Cadmium	104	<0.4	None
Chromium	104	6.8 to 170	None
Copper	104	<5.0 to 44	None
Lead	120	6.3 to 470	None
Nickel	104	<5.0 to 100	None
Zinc	104	9.6 to 130	None
PAH			
Naphthalene	120	<0.5	None
Benzo(a)pyrene (BaP)	120	<0.5 to 13	None
BaP TEQ	120	<0.5 to 20	**OG26_0.1, OG42_0.1 (HIL C – recreational)**
Total PAH	120	<0.5 to 139	None
PCBs			
Total PCBs	6	<0.1	None

Notes
BTEXN = Benzene, toluene, ethylbenzene, xylenes, naphthalene

Concentrations of BTEXN and TRH were reported below the laboratory limit of reporting (LOR) in all six soil samples analysed.

Concentrations of arsenic exceeded the adopted EIL for public open space (100 mg/kg) at two soil sample locations, which included within the racecourse (MW01_0.1 – 180 mg/kg) and the pavilion (PV03_0.1 – 180 mg/kg). The concentrations were less than the adopted NEPM HIL C (300 mg/kg) in all samples analysed.

Concentrations of other metals analysed were reported below the laboratory LOR or below the adopted assessment criteria in all soil samples analysed.

Concentrations of BaP TEQ exceeded the HIL C – recreational criteria (4 mg/kg) in two soil samples (4.2 mg/kg and 20 mg/kg).

In addition, select soil samples were also analysed for PCB compounds pesticides, phenolic compounds and volatile organic compounds (VOCs) in which concentrations were all reported below the laboratory LOR.

Soil analytical results are presented in **Tables 1** to **8** and a plan showing the concentrations of the COPC (i.e. lead and PAH) are depicted on **Figures 4** and **5**.

5.1.4 Categorisation for Soil Disposal

Comparison was made to EPAV IWRG621 to provide information on the likely waste categorisation of surplus soils that may be generated as part of future construction works at the Site. Based on the concentrations reported, the soil was generally categorised as EPAV IWRG Fill Material for off-Site disposal. It was noted that slightly elevated concentrations of arsenic were reported at the soil sample locations targeting the pavilion (79 and 180 mg/kg) and a slightly elevated concentration of fluoride was reported at one of the sample locations at the proposed fence line (510 mg/kg). Further soil analysis may be required to classify soils prior to off-Site disposal in accordance with EPAV IWRG702.

The soil categorisation table is attached as **Table 14**.

5.2 GROUNDWATER

5.2.1 Site Hydrogeology

The standing water level and water table elevation in each well is summarised in **Table 5.3** below.

Table 5.3: Groundwater Table Elevations

Well ID	Well Depth (mbgl)[1]	Screened Interval (mTOC)[2]	Standing Water Level (mBTOC)[2]	Water Table Elevation (mAHD)[3]
MW01	7.04	2.5 to 7.0	5.961	524.128
MW02	5.05	2.0 to 5.0	0.703	531.288
MW03	5.04	2.0 to 5.0	2.137	531.955
MW04	4.97	2.0 to 5.0	3.203	529.364

Notes:
[1] mbgl = Metres below ground level
[2] mBTOC = Metres below top of casing
[3] mAHD (metres above Australian Height Datum)

Groundwater gauging indicated depth to groundwater ranged from 524.128 mAHD in MW01 to 531.955 mAHD in MW03. The groundwater elevations and contours are presented in **Figure 7**. Based on the water table elevation contours the potential groundwater flow is in a westerly direction toward, or parallel with the Loddon River.

5.2.2 Groundwater Analytical Results

Groundwater analytical results are presented in **Tables 15** to **17**. A summary of the groundwater analytical results is presented in **Table 5.4** below.

Table 5.4: Summary of Groundwater Analytical Results

Analyte	No of Samples Analysed	Concentration Range (mg/L)	Samples Exceeding Beneficial Use Criteria
Anions and Cations			
Sulfate	5	26 to 140	None
Nutrients			
Ammonia as N	5	<0.01 to 0.42	None
Nitrate as N	5	<0.02 to 0.36	None
Inorganics			
TDS	5	550 to 2,200	None

Analyte	No of Samples Analysed	Concentration Range (mg/L)	Samples Exceeding Beneficial Use Criteria
Dissolved Metals			
Arsenic	5	<0.001-0.001	None
Cadmium	5	<0.0002	None
Chromium	5	<0.001-0.01	None
Copper	5	<0.001-0.015	**MW01, MW02, MW03, MW04 (WDES)**
Lead	5	<0.001	None
Nickel	5	<0.001-0.160	**MW01, MW02, MW03, MW04 (WDES)** **MW02, MW03, MW04 (drinking water)**
Zinc	5	<0.005-0.13	**MW01, MW02, MW03, MW04 (WDES)**
PAH			
Benzo(a)pyrene	4	<0.00001	None
Total PAH	4	<0.00001	None

Notes:
"*" denotes duplicate/triplicate adopted

Concentrations of anions, cations and nutrients were reported below the adopted assessment criteria in all four groundwater samples analysed. Concentrations of TDS were reported below the adopted assessment criteria in all four groundwater samples.

Concentrations of dissolved metals arsenic, cadmium, chromium and lead were reported either below the laboratory LOR and/or adopted assessment criteria in all four groundwater samples. Concentrations of copper, nickel and zinc exceeded the water dependent ecosystems and species criteria in all four groundwater samples. Concentrations of nickel in groundwater sampled from groundwater monitoring wells MW02, MW03 and MW04 exceeded the drinking water criterion.

Concentrations of PAHs were reported below the laboratory LOR in all four groundwater samples.

5.3 SURFACE WATER

5.3.1 Surface Water Analytical Results

Surface water analytical results are presented in **Tables 22** to **24**. A summary of surface water analytical results is presented in **Table 5.5** below.

Table 5.5: Summary of Surface Water Analytical Results

Analyte	No of Samples Analysed	Concentration Range (mg/L)	Samples Exceeding Beneficial Use Criteria
Anions and Cations			
Sulfate	3	<5.0	None
Nutrients			
Ammonia as N	3	<0.01 to 0.19	None
Nitrate as N	3	<0.02	None
Inorganics			
TDS	3	150 to 230	None
TSS	2	12 to 15	N/A
Dissolved Metals			
Arsenic	3	<0.001	None
Cadmium	3	<0.0002	None
Chromium	3	<0.001	None
Copper	3	<0.001	None
Lead	3	<0.001	None
Nickel	3	<0.001	None
Zinc	3	<0.005	None
PAH			
Benzo[a]pyrene	2	< 0.00001	None
Total PAH	2	<0.00001	None

Notes:
"N/A" denotes no criteria

Concentrations of anions and cations were reported below the adopted assessment criteria (where available) in all three samples analysed. Concentrations of nutrients were reported below the adopted assessment criteria (where available) in all four samples analysed. Concentrations of TDS were reported below the adopted assessment criteria in all four samples.

Concentrations of metals were reported below the laboratory LOR in all four samples.

Concentrations of PAHs were reported below the laboratory LOR in both samples analysed (SW01 and SW02).

6. ASSESSMENT OF IMPACT ON BENEFICIAL USES

6.1 LAND

An assessment of the impact of COPCs in soil on beneficial uses of land is provided in **Table 6.1** below.

Table 6.1: Protected Beneficial Use Assessment - Land

Beneficial Use	Details	Beneficial Use Precluded (Yes/No)
Maintenance of Ecosystems (modified and highly modified)	Concentrations of contaminants were less than the adopted ecological investigation and screening levels (EILs and ESLs – public open space), with the exception of concentrations of arsenic reported in two of the 104 soil samples. The beneficial use is not precluded as the concentrations reported were not considered to pose an ecological risk to the current vegetation on-Site.	No
Human Health	Concentrations of the following contaminants were reported in the soil exceeding the adopted health investigation level (NEPM HIL C): • Lead at two sample locations during the previous PSI. • BaP TEQ at two sample locations during this DSI and ten sample locations during the previous PSI. Given the largely unsealed surface at the Site, it is possible that the Site users may be in contact with the impacted soils during Site activities.	Yes
Buildings and Structures	Based on Soil Conditions B in AS 2159, pH in soil is Mild Exposure Classification.	No
Aesthetics	There were no odours or staining observed during soil sampling, with only minor clay target fragments observed on the surface of the Site	No

6.2 GROUNDWATER

An assessment of the impact of COPCs in groundwater on beneficial uses both on and off-Site is provided in **Table 6.2** below.

Table 6.2: Protected Beneficial Use Assessment – Groundwater

Beneficial Use (SEPP Segment A1)	Details	Beneficial Use Precluded (Yes/No)
Water dependent ecosystems and species	On-Site: Possibility for groundwater to discharge to the creek and at the Site surface. The beneficial use is not considered to be precluded as the reported exceedances are considered to be consistent with background concentrations.	No
	Off-Site: The beneficial use is not considered to be precluded as the reported exceedances are considered to be consistent with background concentrations.	No
Potable water supply (desirable)	On-Site: Concentrations of contaminants reported in the surface (i.e. alluvial) aquifer exceeded the applicable criteria. However, the groundwater extracted On-Site for drinking water purposes is screened within the deeper aquifer and the concentrations reported at this sample location (i.e. MS01) were less than the applicable criteria indicating that this is not being impacted by the shallow groundwater.	No
	Off-Site: 24 registered groundwater bores are located within a 500 m radius of the Site. The bores are located in areas that have higher elevations than the Site and are not impacted by the shallow groundwater sampled from wells installed within the racecourse (i.e. MW01-MW04).	No
Agriculture and irrigation (stock watering)	On-Site: The beneficial use is unlikely to be realised on-Site given the current recreational use.	No
	Off-Site: Concentrations were reported below the criteria.	No
Water-based recreation (primary contact recreation)	On-Site: Not relevant as groundwater does not discharge at Site surface and the beneficial use is not considered to be precluded.	No
	Off-Site: Concentrations were reported below the criteria	No
Traditional Owner cultural values	On-Site: Possibility for groundwater to discharge to the creek and at the Site surface, however, the concentrations were reported below the adopted criteria.	No
	Off-Site: Relevant, given the Loddon River flows on the western boundary of the Site, however, the concentrations were reported below the adopted criteria.	No
Cultural and spiritual values	On-Site: Possibility for groundwater to discharge to the creek and at the Site surface, however, the concentrations were reported below the adopted criteria.	No
	Off-Site: Relevant, given the Loddon River flows on the western boundary of the Site, however, the concentrations were reported below the adopted criteria.	No
Buildings and structures	On-Site: The buildings and structures beneficial use was not precluded on the basis of pH, sulfate and chloride concentrations (below adopted screening criteria) and non-aggressive exposure classification based on Soil Conditions B in AS 2159 reported in groundwater from on-Site wells.	No

Beneficial Use (SEPP Segment A1)	Details	Beneficial Use Precluded (Yes/No)
	Off-Site: The buildings and structures beneficial use was not precluded on the basis of pH, sulfate and chloride concentrations (below adopted screening criteria) and non-aggressive exposure classification based on Soil Conditions B in AS 2159 reported in groundwater from On-Site wells.	No

6.3 SUFACE WATER

An assessment of the impact of COPCs in surface water on beneficial uses off-Site is provided in **Table 6.3** below.

Table 6.3: Protected Beneficial Use of Water (Central Foothills and Coastal Plains)

Beneficial Use (Central Foothills and Coastal Plains)	Details	Beneficial Use Precluded (Yes/No)
Water dependent ecosystems and species	Concentrations were reported below the laboratory LOR or screening criteria.	No
Agriculture and irrigation		
Human consumption of aquatic foods		
Water-based recreation		
Traditional owners' cultural values		
Cultural and spiritual values		

7. QUALITY ASSURANCE / QUALITY CONTROL

Soil, sediment, groundwater and surface water samples were collected in the field by Kleinfelder personnel in laboratory supplied containers, placed on ice, and transferred to the analytical laboratory using appropriate sample preservation methods and COC documentation in accordance with AS4182 and NEPM requirements.

The NATA certifies both laboratories, Eurofins and ALS for the analytical testing employed. As part of their internal quality assurance, these laboratories conduct regular audits and verify their recoveries through the use of reagent blanks, analysis of surrogate spikes and laboratory control samples and duplicates.

7.1 LABORATORY QA/QC PROGRAM

A review of the internal laboratory quality assurance/quality control (QA/QC) program presented as part of their final NATA Reports indicates that no method blank, duplicate, laboratory control, matrix spike, surrogate recovery, analysis holding time and/or quality control sample frequency outliers occurred, with the exception of the following:

Eurofins Report 713494-S

- Matrix spike recovery was outside of the recommended acceptance criteria for nickel, lead, 1.1.1-trichloroethene.
- Duplicate relative percent difference (RPD) criteria did not pass Eurofins QC acceptance criteria for arsenic, chromium, copper, nickel and zinc.

Eurofins Report 713582-S

- Matrix spike recovery was outside of the recommended acceptance criteria for 1.1.1-trichloroethene.

ALS Report EM2006217

- Duplicate RPDs exceed limit of reporting (LOR) based limits for PAH.

ALS Report EM2006205

- Matrix spike recovery not determined because the background concentration was greater than or equal to 4 x spike level for total nitrogen and total phosphorus.

- Quality control frequency not within specification for laboratory duplicate for PAH/phenols.

The above outliers are associated with the internal laboratory QC program and are not considered to impact on the integrity of the analytical results.

7.2 LABORATORY LIMITS OF REPORTING

LORs reported for soil and groundwater samples were deemed to be sufficiently low to enable comparison of contaminant concentrations with adopted assessment criteria.

7.3 HOLDING TIME COMPLIANCE

All samples were received at the laboratory, extracted and analysed within the respective holding times, with the exception of the secondary groundwater sample QC02_08042020 for TDS (one day overdue) and nitrite (six days overdue).

These holding time exceedances are not considered to impact on the integrity of the primary analysis results.

7.4 RELATIVE PERCENT DIFFERENCE

Kleinfelder adopts a relative percent difference (RPD) acceptance criterion of up to 50% in accordance with the AS 4482.1 which is considered appropriate for this assessment. The RPD was calculated for duplicate and triplicate field samples as shown below.

$$RPD = \frac{(Co - Cs)}{\left(\frac{Co + Cs}{2}\right)} x100$$

where: Co = concentration of the original sample
Cs = concentration of the duplicate sample

The following duplicate and triplicate RPD results were above the 50% acceptance criterion for soil and groundwater QC samples.

7.4.1 Soil

- Arsenic – OG36_0.6 (5.1 mg/kg), QC02 (10 mg/kg) – adopt QC02.
- Arsenic – PG01_0.1 (5.7 mg/kg), QC24 (10 mg/kg) – adopt QC24.

- Arsenic – OG53_0.1 (12 mg/kg), QC25 (4.5 mg/kg), QC26 (6.0 mg/kg) – retain OG53_0.1.
- Arsenic – SD01 (7.8 mg/kg), QC27 (3.6 mg/kg), QC28 (35 mg/kg) – adopt QC28.
- Chromium – PG01_0.1 (35 mg/kg), QC23 (62 mg/kg) – adopt QC23.
- Copper – SD01 (10 mg/kg), QC27 (<5.0 mg/kg) – retain SD01.
- Lead – OG04_0.1 (130 mg/kg), QC04 (56 mg/kg) – retain OG04_0.1.
- Lead – OG26_0.1 (42 mg/kg), QC08 (98 mg/kg) – adopt QC08.
- Lead – OG53_0.1 (81 mg/kg), QC25 (21 mg/kg), QC26 (24 mg/kg) – retain OG53_0.1.
- Zinc – CG02_0.5 (42 mg/kg), QC18 (24 mg/kg) – retain CG02_0.5.
- Acenaphthene – OG26_0.1 (<0.5 mg/kg), QC08 (1.0 mg/kg) – adopt QC08.
- Phenanthrene – OG26_0.1 (<0.5 mg/kg), QC08 (7.1 mg/kg), QC09 (1.6 mg/kg) – adopt QC08.
- Anthracene – OG26_0.1 (<0.5 mg/kg), QC08 (1.4 mg/kg) – adopt QC08.
- Fluoranthene – OG04_0.1 (1.3 mg/kg), QC03 (<0.5 mg/kg), QC04 (<0.5 mg/kg) – retain OG04_0.1.
- Fluoranthene – OG26_0.1 (1.7 mg/kg), QC08 (25 mg/kg), QC09 (4.5 mg/kg) – adopt QC08.
- Pyrene – OG04_0.1 (1.3 mg/kg), QC03 (<0.5 mg/kg), QC04 (<0.5 mg/kg) – retain OG04_0.1.
- Pyrene – OG26_0.1 (1.5 mg/kg), QC08 (23 mg/kg), QC09 (4.3 mg/kg) – adopt QC08.
- Chrysene – OG26_0.1 (1.4 mg/kg), QC08 (15 mg/kg), QC09 (3.6 mg/kg) – adopt QC08.
- Benzo(a)anthracene – OG26_0.1 (0.9 mg/kg), QC08 (11 mg/kg), QC09 (3.2 mg/kg) – adopt QC08.
- Benzo(b)fluoranthene – OG26_0.1 (1.1 mg/kg), QC08 (12 mg/kg) – adopt QC08.
- Benzo(k)fluoranthene – OG04_0.1 (0.9 mg/kg), QC03 (<0.5 mg/kg), QC04 (<0.5 mg/kg) – retain OG04_0.1.
- Benzo(k)fluoranthene – OG26_0.1 (1. mg/kg), QC08 (11 mg/kg) – adopt QC08.

- Benzo(a)pyrene – OG04_0.1 (1.1 mg/kg), QC03 (<0.5 mg/kg), QC04 (<0.5 mg/kg) – retain OG04_0.1.
- Benzo(a)pyrene – OG26_0.1 (1.4 mg/kg), QC08 (13 mg/kg), QC09 (5.1 mg/kg) – adopt QC08.
- Indeno(1,2,3-c,d)pyrene – OG26_0.1 (1.0 mg/kg), QC08 (9.2 mg/kg), QC09 (2.9 mg/kg) – adopt QC08.
- Dibenz(a,h)anthracene – OG26_0.1 (0.5 mg/kg), QC08 (2.2 mg/kg), QC09 (0.9 mg/kg) – adopt QC08.
- Benzo(g,h,i)perylene – OG26_0.1 (1.1 mg/kg), QC08 (8.4 mg/kg), QC09 (3.6 mg/kg) – adopt QC08.

RPD analysis results are presented in **Tables 9** and **10**.

7.4.2 Groundwater

- Sulfate – MW02 (27 mg/L), QC02 (<1.0 mg/L) – retain MW02.
- Chloride – MW02 (110 mg/L), QC02 (42 mg/L) – retain MW02.
- Total phosphorus – MW02 (0.02 mg/L), QC02 (<0.01 mg/L) – retain MW02.
- Amononia as N – MW02 (0.2 mg/L), QC02 (0.42 mg/L) – adopt QC02.
- Total nitrogen as N – MW02 (0.06 mg/L), QC02 (0.6 mg/L) – adopt QC02.
- Copper – MW02 (0.006 mg/L), QC01 (0.011 mg/L) – adopt QC01.

RPD analysis results are presented in **Tables 18 – 20**.

7.5 RINSATE AND TRIP BLANKS

Five rinsate blanks (four during soil sampling and one during groundwater sampling) were collected from the field sampling equipment and submitted for analysis of metals and PAH to assess the effectiveness of decontamination procedures, with all analyte concentrations reported below the laboratory LOR. The results indicate no cross contamination of samples occurred from sampling equipment and a satisfactory decontamination procedure.

Three trip blanks (two during soil and surface water sampling and one during groundwater sampling) were submitted for analysis for the purpose of assessing the potential for cross-contamination of samples during transport and storage. The trip blanks analysed reported concentrations of BTEXN and TRH C_6-C_{10} below the laboratory LOR. This indicates that cross-contamination is unlikely to have occurred during transit to the laboratory.

Quality control rinsate and trip blank results are presented in **Tables 9** to **13** and **Tables 18** to **21**.

7.6 QA/QC CONCLUSIONS

Based on a review of the results for the Kleinfelder and laboratory QA/QC program adopted, the variability observed in the soil samples for the COPC were considered to be heterogeneously distributed. The overall data quality is acceptable for interpretive use. Copies of the final NATA endorsed laboratory reports, including internal QA/QC results and chain-of-custody documentation for both laboratories are attached as **Appendix I**.

8. CONCEPTUAL SITE MODEL

A CSM is a qualitative analytical tool that identifies the sub-surface sources of contamination, exposure pathways and potential receptors on-Site and in the site surroundings. A CSM also provides a discussion of the nature and extent of impacts in soil, groundwater and surface water and relevant source-pathway-receptor (SPR) linkages.

The contamination at the Site identified by Beveridge and Williams originated from the Site's use as a clay target shooting. Based on the ITRC small arms management guidance[9] four separate impact areas are likely to be present:

- Spent shotgun plastic wads (containing shot).
- Target fragments are expected to fall between 50 and 90 metres from the firing position.
- Unused targets at approximately 80 to 90 metres from the firing position
- Lead shot is expected to be deposited with the target fragments and also between 100 and 200 metres from the firing position.

The unused targets, larger target fragments and plastic wads can be removed from the environment using physical methods. The lead shot and lead shot and target fragments are unlikely to be recovered by basic physically methods and are available to leach into the surface soils and groundwater during weathering.

For a particular substance to present a risk to receptors, three components must be present:

- Source – an entity or action which releases potential contaminants into the environment;
- Pathway – a mechanism by which receptors can become exposed to potential contaminants; and
- Receptor – the human or ecological component at risk of experiencing an adverse response following exposure to a potential contaminant.

The CSM presented below is based on conditions known to exist onsite.

[9] Interstate Technology and Regulatory Council, 2005. Environmental management at operating outdoor small arms firing ranges, technical guideline.

8.1 POTENTIAL SOURCES OF CONTAMINATION

Based on the PSI and works undertaken during this investigation, the potential sources of contamination include:

- Historical uncontrolled soil importation.
- Clay target shooting activities.

8.1.1 Contaminants of Potential Concern

Based on the previous PSI and more recent works completed by Kleinfelder at the Site, the contaminants of potential concern (COPC) were considered to be associated with clay shooting activities and included the following:

- Lead.
- PAH compounds.

It is noted that the COPC associated with historical uncontrolled soil importation (including metals, TRH, OCP and PCB) were reported below the adopted human health investigation levels applicable to recreational/public open space setting (i.e. NEMP HIL C) and are therefore not considered further as part of this CSM.

8.2 POTENTIAL COPC RECEPTORS

8.2.1 On-Site

Based on an ongoing recreational and public open space use of the Site and proposed future redevelopment works, the potential on-Site receptors include:

- Recreational users (i.e., equestrian, shooting, dog walkers, camping activities).
- Visitors to the Site (e.g. spectators).
- Groundwater extraction for drinking water purposes.
- Intrusive maintenance workers.
- Construction workers.

8.2.2 Off-Site

The potential off-Site receptors include:

- Users of surrounding sites for farming/agricultural purposes.
- Extractive groundwater users.
- Aquatic ecosystems and water recreation activities at Loddon River.

8.3 POTENTIAL TRANSPORT MECHANISMS AND EXPOSURE PATHWAYS

8.3.1 Source-Pathway-Receptor Analysis

The potential primary transport mechanisms for the migration of COPCs are:

- Dermal contact.
- Dust inhalation.
- Direct and incidental ingestion.
- Discharge of contaminated groundwater/stormwater to Loddon River.

The following table outlines the source-pathway-receptor analysis.

Table 8.1: Source-Pathway-Receptor Analysis

Source	Direct/Indirect Pathway	Pathway	Receptor
Shooting activities (lead and PAH)	Direct	• Projectiles/debris landing on parkland, conservation land or sporting oval • Public access to reserve area with exposed projectiles/debris • Projectiles/debris landing on or around community buildings	• Site users by ingestion, inhalation or dermal contact
	Indirect – Water	Stormwater runoff and movement of projectiles and debris	• Loddon River • Flora and fauna
		Leachable lead and/or PAH contaminants leaching into surface water runoff and discharge into the Loddon River	• Loddon River • Flora and fauna
		Contamination migration downstream	• Residents and livestock downstream • Flora and fauna

Source	Direct/Indirect Pathway	Pathway	Receptor
		Leaching of contaminants in soil into groundwater	• Agriculture and irrigation users
	Indirect – 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 attach to soil particles	• Site users by ingestion, inhalation or dermal contact
		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.	• Site users by ingestion, inhalation or dermal contact

Qualitative assessments of the potential COPC exposure pathways for on- and off-Site receptors are provided in **Tables 8.2** and **8.3** below.

Table 8.2: Potential Exposure Pathways (On-Site)

Exposure Pathway	Likely / Possible / Unlikely	Justification
Dermal contact, incidental ingestion and inhalation of dust from impacted soils e.g. on-Site users, visitors, intrusive workers or construction workers	Possible	• Concentrations of BaP TEQ were reported in exceedance of the adopted HIL C. • Given the largely unsealed surface and shallow contamination at the Site, it is possible that the recreation users and visitors to the Site may be in contact with the impacted soils during site activities
Dermal contact or ingestion of impacted groundwater – extractive users of groundwater	Unlikely	• Elevated concentrations considered background
Dermal contact or ingestion of impacted groundwater – potential intrusive workers	Unlikely	• In the event that works are to be conducted at the Site, residual exposure risks can be managed under a Construction Environmental Management Plan (CEMP).

Table 8.3: Potential Exposure Pathways (Off-Site)

Exposure Pathway	Likely / Possible / Unlikely	Justification
Ingestion or dermal contact with impacted groundwater for extractive users of groundwater	Unlikely	• Exceeds drinking water guidelines • Elevated concentrations considered background
Impact to Loddon River aquatic ecosystems – groundwater	Unlikely	• Although elevated concentrations of metals in groundwater exceeded the adopted screening criteria for the protection of freshwater ecosystems and species, the concentrations are considered to be indicative of background aquifer conditions, hence any discharge is likely to occur to ecosystems that are preconditioned to the elevated metal concentrations
Impact to Loddon River aquatic ecosystems – surface water	Unlikely	• Concentrations in surface water were reported below the laboratory LORs and/or criteria.
Impact to water-based recreational users	Unlikely	• No exceedances of PCR criteria were reported.

9. DISCUSSION

9.1 SOIL LEAD AND PAH CONCENTRATIONS

The lead and to some degree the PAH concentrations reported in this investigation and those reported Beveridge and Williams have revealed varying spatial distribution patterns. The laboratory data from the previous PSI (Beveridge and Williams, 2019) are provided in **Appendix M**.

Surface soil samples in this investigation were collected in accordance with NEPM 1999 (as amended 2013) and AS 4482.1 methodologies. Organic material (including rootlets) was removed from the surface soil to the extent practicable prior to advancing the 75 mm hand auger to 0.1 mbgl, the auger was then withdrawn, the PID screening aliquot removed and the remaining soil added to the sample jar.

As discussed in **Section 2.7** above, the comparison of pXRF and laboratory aqua-regia leach metal concentrations cannot be made as the aqua-regia method measures the metal concentrations that are adsorbed to soil components whereas the pXRF measures total concentrations. There are also sampling scale differences between the two methods. The laboratory measures the leachable metal concentration from a 2 gram aliquot (approximately 12.5 mm^3) whereas the pXRF measures the concentration from a 2.2 x 2.2 x 0.01 mm (approximately 0.05 mm^3) area, suggesting that the laboratory "samples" more than 250 times the soil volume than the pXRF. Extrapolating from the small (sample) to the large (Site) scales is therefore more statistically problematic for the pXRF results.

The effects the sampled volume disparity between the methods was shown in **Figure 2.3** above, where the pXRF lead concentrations, while still valid overestimated the laboratory determined concentrations in approximately 60% of samples. Coincidently the pXRF underestimated the laboratory determined lead concentration in the remaining 40% of samples. In addition, the NEPM screening criteria are comparable to the laboratory aqua-regia leach concentrations not total metal concentrations which have different bioavailability. Hence the pXRF lead hotspot reported by Beveridge Williams, which is not supported by corresponding laboratory analysis, cannot be viewed as a "hotspot" but rather an area where aqua-regia leachable elevated lead concentration may be present.

Interpolated laboratory determined lead concentrations and an approximate 100 metre lead shot debris zone (from the approximate launch area centres) is shown on **Figure 9.1** below.

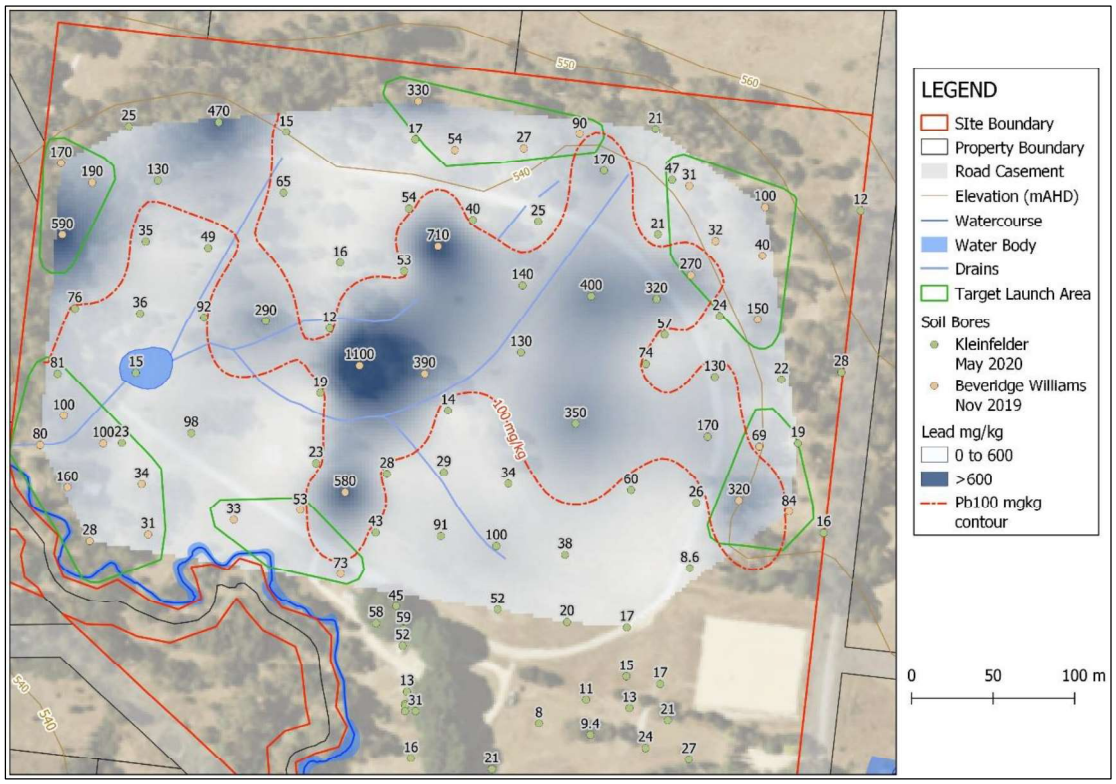

Figure 9.1: Interpolated laboratory determined lead concentrations

The previous PSI identified total PAH compounds above the laboratory LOR in 21 out of the 30 samples analysed (or 70% of samples). In contrast, total PAH compounds were only reported above the laboratory LOR in 19% of the shallow soil samples reported here (i.e., 10 out of 54). However, as shown in **Figures 9.1** and **9.2** below, the majority of Beveridge Williams samples were concentrated in the within and the target launch areas. Kleinfelder do not have information regarding where the actual trap launch equipment was located within the launch areas, however as shown on **Figure 9.2** there is a "reasonable" correlation between the elevated PAH concentrations and the approximate 50 to 90 meter fall zone, where the majority of target fragments are likely to be deposited. The 50 to 90 metres fall zone was estimated from near the centre of the launch areas.

The PAH data show that it is unlikely that the north-western launch area was using during the recurring target shooting activities. Based on the distribution observed and the sampling methodology employed, at least during this investigation, it can be concluded that the PAH distribution is likely consistent with the conceptual model PAH fall zone.

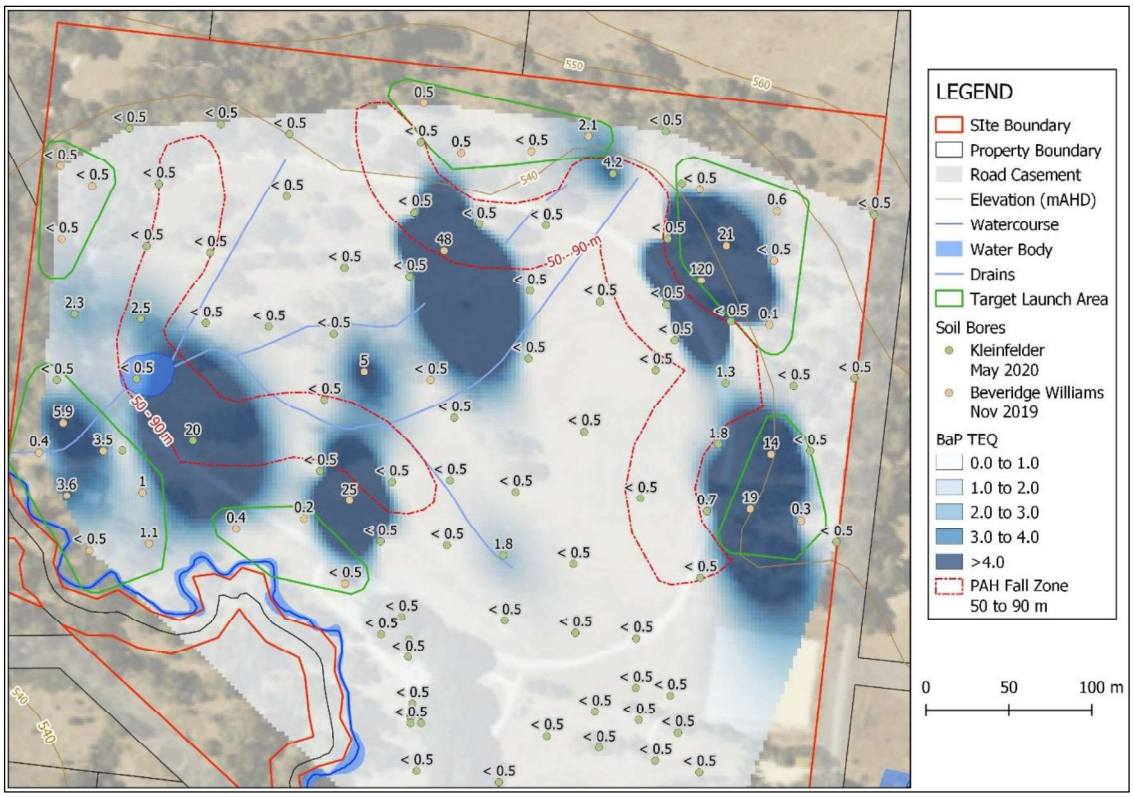

Figure 9.2: Interpolated BaP TEQ concentrations, with estimated 50 to 90 metre fall zones from indicated launch areas.

9.2 MAINTENACE OF ECOSYSTEMS

Concentrations of arsenic exceeded the adopted NEPM EIL for a public open/recreational space in two soil samples. The concentrations were less than the adopted NEPM HIL C.

Elevated concentrations of copper, nickel and zinc exceeded the WDES criteria and the drinking water criteria, however as concentrations of these metals were not elevated in soil, these are considered to be background concentrations in groundwater.

9.3 HUMAN HEALTH

Concentrations of BaP TEQ exceeded the HIL C – recreational criteria in two soil samples on the racecourse with concentrations of 4.2 mg/kg and 20 mg/kg. One sample was located in the north-east portion and one sample was located in the south-west portion of the racecourse. These exceedances pose a potential risk to Site users and management measures to address exposure risks from contamination resulting from clay target shooting should be put into place.

Concentrations of PAHs were reported below the laboratory LOR in soil samples collected outside the racecourse area, and in groundwater, surface water and sediment samples indicating that the contamination extent is restricted to surface soils within the racecourse.

The concentrations of lead and PAH reported at the 14 off-Site sample locations were all less than the adopted NEPM HIL A (for lead) and laboratory LOR (for PAH).

10. CONCLUSIONS

Kleinfelder was engaged by Hepburn Shire Council to undertake a DSI for the Glenlyon Recreation Reserve, located at Suttons Lane, Glenlyon, Victoria to fulfil the requirements of CUN 90010886, by assessing the nature, extent and magnitude of contamination to soil, groundwater and surface water.

The DSI involved a limited historical review and field works that included the installation of four groundwater monitoring wells, soil sampling from 104 soil bores, groundwater sampling, surface water and sediment sampling. With respect to the racecourse investigation the following conclusions are made:

- The previous PSI used a pXRF detector to measure metal concentrations in soil and subsequently identified that lead concentrations within a broad area exceeded the concentrations protective of human health in a recreational setting.
- Kleinfelder reviewed the pXRF data and concluded it is not appropriate for comparison to the NEPM because, unlike laboratory determined metal concentrations, the pXRF measured concentrations are not based on metal bioavailability, and therefore over-estimate the potential health and ecological risks.
- Concentrations of arsenic exceeded the adopted EIL for public open space (100 mg/kg) at two soil sample locations, which included within the racecourse (MW01_0.1 – 180 mg/kg) and the pavilion (PV03_0.1 – 180 mg/kg). The concentrations were less than the adopted NEPM HIL C (300 mg/kg) in all samples analysed.
- The previous PSI reported concentrations of lead at two surface soil sample locations exceeding the NEPM HIL C applicable to public open space/recreation (i.e. 600 mg/kg). Concentrations of lead were reported below the NEPM HIL C in all soil samples analysed during this DSI.
- Concentrations of remaining metals analysed were reported below the laboratory LOR or below the adopted assessment criteria in all soil samples analysed.
- Concentrations of BaP TEQ exceeded the NEPM HIL C in two near surface soil samples. The exceedances were confined to samples collected from the upper fill soils and were considered to be associated with historical shooting activities on-Site. It was noted that the previous PSI completed at the Site reported ten BaP TEQ exceedances at sample locations that targeted the six launching areas on-Site.

- Soil sampling conducted in the barbecue area, children's playground, equestrian and camping areas did not identify any compounds or metals that represent risks to human or ecological receptors.

- Based on the concentrations reported, the soil was generally categorised as EPAV IWRG Fill Material for off-Site disposal. It was noted that slightly elevated concentrations of arsenic were reported at the soil sample locations targeting the pavilion (79 and 180 mg/kg) and a slightly elevated concentration of fluoride was reported at one of the sample locations at the proposed fence line (510 mg/kg). Further soil analysis may be required to classify soils prior to off-Site disposal in accordance with EPAV IWRG702.

- Groundwater gauging indicated groundwater elevation ranged from 524.13 mAHD in to 531.96 mAHD and a westerly groundwater flow direction was inferred.

- Concentrations of copper, nickel and zinc exceeded the criteria for WDES in all four groundwater samples. Concentrations of nickel exceeded the Drinking Water criterion at groundwater monitoring wells MW02, MW03 and MW04. The reported concentrations were considered background and are unlikely to be derived from Site.

- Concentrations of PAHs were reported below the laboratory LOR in all four groundwater samples.

- Concentrations of total metals were reported below the laboratory LOR in all surface water samples. Concentrations of PAHs were reported below the laboratory LOR in both surface water samples analysed (SW01 and SW02).

- The findings of the delineation investigation confirmed the lead and PAH contamination are restricted to the racecourse area, with no exceedances reported in other areas of the Site where soil sampling was completed.

- Concentrations of lead and PAH were all below the applicable criteria and/or laboratory LOR at the 14 off-Site soil sample locations.

- Based on the findings of the investigations completed at the Site, the lead and PAH compound contamination are considered likely to associated with clay target shooting activities.

- Based on the findings of this report, Kleinfelder recommends the production of a management plan and human health risk assessment to address the PAH compound contamination in the racecourse area.

11. LIMITATIONS

This report has been prepared by Kleinfelder Australia Pty Ltd (Kleinfelder) and may be used only by the Client and its designated representatives or relevant statutory authorities and only for the purposes stated for this specific engagement within a reasonable time from its issuance, but in an event later than two (2) years from the date of the report.

This work was performed in a manner consistent with that level of care and skill ordinarily exercised by other members of Kleinfelder's profession practicing in the same locality, under similar conditions and at the date the services are provided. Our conclusions, opinions, and recommendations are based on a limited number of observations and data. It is possible that conditions could vary between or beyond the data evaluated. Kleinfelder makes no other representation, guarantee, or warranty, express or implied, regarding the services, communication (oral or written), report, opinion, or instrument of service provided.

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The findings and conclusions contained within this report are relevant to the conditions of the site and the state of legislation currently enacted in the relevant jurisdiction in which the site is located as at the date of this report.

Additionally, the findings and conclusions contained within this report are made following a review of certain information, reports, correspondence and data noted by methods described in this report including information supplied by the client or its assigns. Kleinfelder has designed and managed the program for this report in good faith and in a manner that seeks to confirm the information provided and test its accuracy and completeness. However, Kleinfelder does not provide guarantees or assurances regarding the accuracy, completeness and validity of information and data obtained from these sources and accepts no responsibility for errors or omissions arising from relying on data or conclusions obtained from these sources.

Any representation, statement, opinion or advice expressed or implied in this report is made on the basis that Kleinfelder, its agents and employees are not liable to any other person taking or not taking (as the case may be) action in respect of any representation, statement, opinion or advice referred to above.

12. REFERENCES

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