

Information sheet for environmental audits and preliminary risk screen assessments (PRSAs)



Publication 2009 June 2021

Victoria's audit system

An environmental audit system has operated in Victoria since 1989. The *Environment Protection Act 2017* (the Act) provides for the appointment of environmental auditors. It also provides for Environment Protection Authority (EPA or the Authority) to have a system of preliminary risk screen assessments (PRSAs) and environmental audits. These are used in the planning, approval, regulation and management of activities, and in protection of human health and the environment.

Under the Act, the functions of an environmental auditor include to:

- conduct PRSAs and environmental audits
- prepare and issue PRSA statements and reports, and environmental audit statements and reports.

The purpose of a PRSA is to:

- assess the likelihood of the presence of contaminated land
- determine if an environmental audit is required
- recommend a scope for the environmental audit if an environmental audit is required.

The purpose of an environmental audit is to:

- assess the nature and extent of the risk of harm to human health or the environment from contaminated land, waste, pollution, or any activity
- recommend measures to manage the risk of harm to human health or the environment from contaminated land, waste, pollution, or any activity
- make recommendations to manage any contaminated land, waste, pollution or activity.

Upon completion, all PRSAs and environmental audits require preparation of either a PRSA statement, accompanied by a PRSA report, or an environmental audit statement, accompanied by an environmental audit report.

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Information sheet for environmental audits and preliminary risk screen assessments (PRSAs)

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- Part A, the PRSA or environmental audit report
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Report executive summaries, findings and recommendations should be read and relied upon only in the context of the whole document, including any appendices and the PRSA statement or environmental audit statement.

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ENVIRONMENTAL AUDIT REPORT

**GLEN HELEN LODGE
8495 NAMATJIRA DRIVE
MOUNT ZEIL, NT**

Environmental Audit ID: NTEPA2021/0004-270 "


**Prepared for
Ngurratjuta/Pmara Ntjarra
Aboriginal Corporation**

Date: November 2023



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Approved by	30 November 2023  Steven Jon Kirsanovs Environmental Auditor (Contaminated Land) appointed under the Victorian accreditation scheme (Environment Protection Act 2017)	

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EXECUTIVE SUMMARY

This is an environmental audit report for the site at Glen Helen Lodge (8495 Namatjira Drive, Mount Zeil) which has been completed by Mr. Steven Kirsanovs of Kirsa Environmental (the Auditor). The Auditor is an NT EPA approved person within the class of persons suitable to undertake Environmental Audits in the Northern Territory¹. The audit has been performed in accordance with the relevant provisions of Part 6 of the *Waste Management and Pollution Control Act 1998*, and (as far as applicable to the Northern Territory) with the relevant provisions of the *Environment Protection Act 2017* of Victoria (Mr. Kirsanovs is appointed as an environmental auditor in that jurisdiction). The audit details and outcomes are summarised in the following tables.

Table 1: Summary of Audit Report information

Auditor	Steven Kirsanovs
Auditor account number	EXT001154
Date EPA notified of audit	30/08/2021
Environmental audit reference	NTEPA2021/0004-270
Name of person requesting audit	Cameron Miller, CEO Ngurratjuta/Pmara Ntjarra Aboriginal Corporation PO Box 8573 Alice Springs NT 0871 Phone 08 8951 1911 reception@ngur.com.au
Relationship of person requesting audit to site	Authorised representative of former Site owner
Name of site owner	Beston Parks Land Co Pty Ltd (ACN 111 783 423) (trading as / known as) Discovery Parks who acquired the site in August 2021.
Date of auditor engagement	30/08/2021
Completion date of the audit	30/11/2023
Reason for audit	Requirement of Notice issued under S48(1) of the Waste Management and Pollution Control Act (dated 26 August 2021)
Environmental segments	Air, land, water
Planning permit number or requirement detail if applicable	-
EPA Region	Not applicable
Municipality	MacDonnell Regional Council
Dominant - lot on plan	NT Portion 830 from Plan A 000315 (CUFT Volume 849 Folio 156)
Additional - lot on plan(s)	-
Site/premises name	Glen Helen Lodge
Building/complex sub-unit/lot No.	-
Street/Lot – Lower No.	8495
Street/Lot – Upper No.	-
Street Name	Namatjira
Street type (for example road, court)	Drive

¹ Steven Kirsanovs is an approved person accredited under the South Australian, Victorian and Western Australian Auditor schemes.

Street suffix (for example, North, South)	-
Suburb	Mount Zeil
Postcode	0872
GIS Coordinate of Site centroid	E.g., GDA94 – Latitude/Longitude in decimal degrees
Latitude (GDA94)	-23.68516 S
Longitude (GDA94)	132.67346 E
Site area (in square metres)	71,800m ² (area of Portion 830, noting the actual investigation area is only a small part of this land parcel)
Plan of site/premises/location showing the audit site boundary attached	Included in Appendix A and the annexures to the Audit Statement
Members and categories of support team utilised	-
Further works or requirements	Groundwater Quality Management Plan (GQMP) to be implemented as per Audit Statement recommendations.
Nature and extent of continuing risk	<p>Risk of harm or detriment to land, surface water and groundwater</p> <ul style="list-style-type: none"> ○ Land. The information reviewed indicates there has been some degree of harm arising from the activities to the land in the immediate vicinity of the former tanks and bowsers. As noted above, the impacts are relatively localised in the immediate vicinity of the former tanks and bowsers, and are also limited to soils at a depth below approximately 1.5m. ○ Groundwater. The information reviewed suggests there is unlikely the activities have resulted in any harm to groundwater, although as noted above this will need to be confirmed via some further monitoring. ○ Surface water. The information reviewed suggests there is unlikely the activities have resulted in any harm to surface water in the Finke River.
Outcome of environmental audit report	<p>The objectives of the audit have been achieved, including assessing the nature and extent of contaminated land, waste, pollution or any activity nature and extent of contamination. This includes impacts at the audit site and also any impacts in adjacent land affected by the audit site.</p> <p>I conclude that the site is suitable for ongoing commercial and recreational open space as currently developed.</p> <p>No further clean up is required for air, land or water at the site, subject to the audit statement recommendations.</p> <p>Recommended have been provided as outlined in the section above to manage:-</p> <ul style="list-style-type: none"> ○ Risks of harm to human health and the environment; and ○ Ccontaminated land, waste, pollution or activity <p>Land use suitability has been confirmed for the proposed for ongoing use (see below).</p>
Land use suitability	Suitable for the ongoing use as proposed subject to compliance with recommendations in the Audit Statement

Has groundwater cleanup been undertaken as far as reasonably practicable?	Yes	
Does groundwater contamination remain at the site and is the site the source?	The Site is a source of petroleum hydrocarbon impacts within soils. One round of groundwater monitoring has been undertaken following adequate development of the installed groundwater monitoring wells and does not indicate groundwater petroleum hydrocarbon impacts. As stated within the audit report, additional groundwater monitoring is proposed under a groundwater management plan to confirm the results obtained to date.	
If groundwater contamination remains, does it extend off-site?	No.	
Is a GQRUZ recommended?	Not applicable.	
If applicable, please indicate which of the following are threatened environmental values of groundwater	For example, site-sourced and regional pollution.	
	Water dependent ecosystems and species	No*
	Potable water supply (desirable)	Lead (considered likely to be anomalous and will need to be checked via further monitoring)
	Potable water supply (acceptable)	Lead (considered likely to be anomalous and will need to be checked via further monitoring)
	Potable mineral water supply	NA
	Agriculture and irrigation (irrigation)	NA
	Agriculture and irrigation (stock watering)	No
	Industrial and commercial use	No
	Water-based recreation (primary contact recreation)	No
	Traditional Owner cultural values	NA
	Buildings and structures	No
	Geothermal properties	NA
Is ongoing groundwater monitoring required?	Yes	
Is ongoing vapour/gas monitoring required	No	
Are vapour/gas mitigation measures required	No	
List any other ongoing management requirements if applicable	No other measures from those listed previously in this summary.	

*threatened on-site only – not threatened off-site at point of nearest surface water receptor

Table 2: Physical Site information

Current EPA permission/s and related permission ID if applicable	Not applicable.
Historical land use	Traditional owners / custodians – Western Arrarnta people Post European history includes pastoral use and since then a tourism / accommodation lodge with fuel station.
Current land use	Accommodation / tourism facility
Proposed land use	Accommodation / tourism facility
Current land use zoning	No Zone
Proposed land use zoning	No Zone
Surrounding land use – north (if applicable)	The Site is surrounded by the Tjoritja / West MacDonnell National Park. The land portions within the National Park surrounding the site are Aboriginal Land (scheduled under ALRA) owned by the Tyurretye aboriginal land trust.
Surrounding land use – south (if applicable)	
Surrounding land use – east (if applicable)	
Surrounding land use – west (if applicable)	
Has EPA been notified about the site under Section 40 of the Environment Protection Act 2017? ²	Not applicable
Nearest surface water receptor – name	Finke River.
Nearest surface water receptor – direction	south.
Nearest surface water receptor – distance (m)	120m.
Likely point of groundwater discharge	Finke River The Finke River wraps around the western and southern boundary of the site, flowing from north to south, and the Glen Helen Gorge is approximately 450m southeast of where the fuel tanks were formerly located. The Finke River is an ephemeral watercourse which flows for short periods following significant rainfall events, with waterholes adjacent to the site where surface water remains for some time after river flows cease. The Glen Helen Gorge, located downstream from the site, is a permanent waterhole.
Site aquifer formation	Florina Formation: Fractured and karstic limestone, locally cavernous (per NT aquifer map – Appendix J of LES, 8 December 2021).
Groundwater flow direction	South / southwest
Groundwater TDS range (mg/L)	1,220-3,201mg/L (per nearby groundwater bores information in Table 1 of 8 December 2021).
Groundwater Segment	B
Are there multiple aquifers impacted by pollution at the site	No.

² Section 40 refers to a duty to notify EPA of notifiable contamination. Further information in relation to this can be found in EPA Publication 2008: Notifiable contamination guideline: Duty to notify of contaminated land.

Perched groundwater depth – upper [metres below ground level (mbgl)]	-
Perched groundwater depth – lower (mbgl)	-
Regional groundwater depth – upper (mbgl)	5.2
Regional groundwater depth – lower (mbgl)	6.1
Number of bores within 2km	2
Closest extractive use (distance in m)	The current groundwater bore used to supply water to the Glen Helen Lodge is bore RN016944, adjacent to Namatjira Drive, about 1,140m northeast of the fuel systems.
Zone of groundwater plume influence (m from site boundary)	Not applicable
Year groundwater last monitored	2023

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ENVIRONMENTAL AUDIT STATEMENT

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- Appendix A Current and Historical Certificates of Title
- Appendix B Section 48 Notice
- Appendix C Glen Helen Groundwater Investigation 1991-1995 (Water Resources Branch of the Power and Water Authority, 1996)
- Appendix D Alice Springs Region Glen Helen Resort Potable Water Pipeline Feasibility Review (NT Department of Infrastructure, 2016)
- Appendix E Glen Helen Resort High-Level Environmental Due Diligence Inspection (LES, 2020)
- Appendix F Alice Springs Town Council Soil Classification Analysis for General Fill Disposal Report (LES, September 2021)
- Appendix G Glen Helen Lodge Discovery Parks Fuel Contamination from Underground Petroleum Storage System: Investigation and Remediation Report (LES, 2022)
- Appendix H Glen Helen Discovery Park Groundwater Monitoring Event – May 2023 Sampling and Analysis Quality Plan (Tierra Environment Pty Ltd, 2023)
- Appendix I Groundwater Monitoring Event May 2023 (Tierra Environment Pty Ltd, 2023)
- Appendix J Fuel Contamination from Underground Petroleum Storage System: A Progress Update Report, November 2023 (LES, 2023).
- Appendix K Audit Communications / Reviews

LIST OF ABBREVIATIONS / TERMS

ADWG	Australian Drinking Water Guidelines
ANZECC	Australian and New Zealand Environment and Conservation Council
ANZG	Australian and New Zealand Guidelines for Fresh and Marine Water Quality
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
ASC NEPM	National Environment Protection (Assessment of Site Contamination) Measure
BPEM	Best practice environmental management
BTEX	Benzene, toluene, ethylbenzene and xylene compounds
CRC CARE	Co-Operative Research Centre for Contamination and Remediation of the Environment
CSM	Conceptual site model
CUSFARP	Clean Up so Far as Reasonably Practicable
DNAPL	Dense non-aqueous phase liquid
DSI	Detailed Site Investigation
EAS	Environmental Audit Statement
EC	Electrical conductivity
EPA	NT Environment Protection Authority
EIL	Ecological investigation Level
EP Regs	Environment Protection Regulations 2021 (Vic)
ERS	Environmental Reference Standard
ESA	Environmental site assessment
ESL	Ecological screening level
EV	Environmental Value
GQMP	Groundwater Quality Management Plan
HIL	Health investigation level
HSL	Health screening level
LNAPL	Light non-aqueous phase liquid
NAPL	Non-aqueous phase liquid
NEPC	National Environment Protection Council
NEPM	National Environment Protection Measure
NHMRC	National Health and Medical Research Council
OCP	Organochlorine pesticide
OPP	Organophosphate pesticide
PAH	Polycyclic aromatic hydrocarbon
PID	Photoionisation detector
PSI	Preliminary Site Investigation
SWL	Standing water level
TDS	Total dissolved solids
TPH / TRH	Total petroleum hydrocarbons / Total recoverable hydrocarbons
US EPA	United States Environment Protection Agency
UST	Underground storage tank
VOC	Volatile organic compound
WHO	World Health Organization

1. INTRODUCTION

1.1 Background

This is an environmental audit report for a portion of the Glen Helen Lodge property (“the audit site”) which has been completed by Mr. Steven Kirsanovs of Kirsa Environmental (“the Auditor”), in his capacity as a qualified person as defined in Sections 67 to 69 of the *Waste Management and Pollution Control Act 1998* to provide environmental audit services in relation to contaminated sites issues in the Northern Territory.

The audit was originally commissioned by the Ngurratjuta/Pmara Ntjarra Aboriginal Corporation, as the former owners of the audit site, to satisfy conditions of a notice to carry out an environmental audit program issued by the Northern Territory Environment Protection Authority (NT EPA) pursuant to Section 48(1) of the *Waste Management and Pollution Control Act 1998*.

The audit has been performed in accordance with Section 47 of the *Waste Management and Pollution Control Act 1998*, and (as far as applicable to the Northern Territory) with the relevant provisions of the *Environment Protection Act 2017* of Victoria (Mr. Kirsanovs is appointed as an environmental auditor in that jurisdiction). The audit provides an independent review of the information relating to the assessments, remediation and validation works completed and specifically to address the requirements for the audit as specified in the s48 Notice as noted below:-

- a. determine the type, amount and distribution and mobility of contaminants and wastes present in the environment resulting from the activities;
- b. determine the risk of any possible harm or detriment to the land, surface water and groundwater environments as a result of identified contamination;
- c. where a risk of any possible harm or detriment to a segment of the environment has been determined in requirement b above, recommend any further assessment, risk analysis (human health or ecological) or remedial measures necessary to reduce the risk to an acceptable level; and
- d. include an indicative implementation timetable for any recommended clean-up and/or management works referred to in requirement c

It is noted the s48 Notice specifically relates to impacts associated with underground petroleum products storage and dispensing in a specific area of the property, and that is what has been considered as “the activities” referred to in item above. Various other potentially contaminating activities have been identified at the Glen Helen Lodge site such as above ground fuel storage / dispensing in other parts of the site, landfilling and wastewater / effluent treatment and disposal but these are specifically excluded from this audit as they were not required to be considered as part of the s48 Notice.

The relevant legislation, guidelines and standards current at the time of the audit are summarised in Section 8 of this audit report, and the outcomes of the audit are summarised in a Statement of Environmental Audit which is included in the audit report attachments.

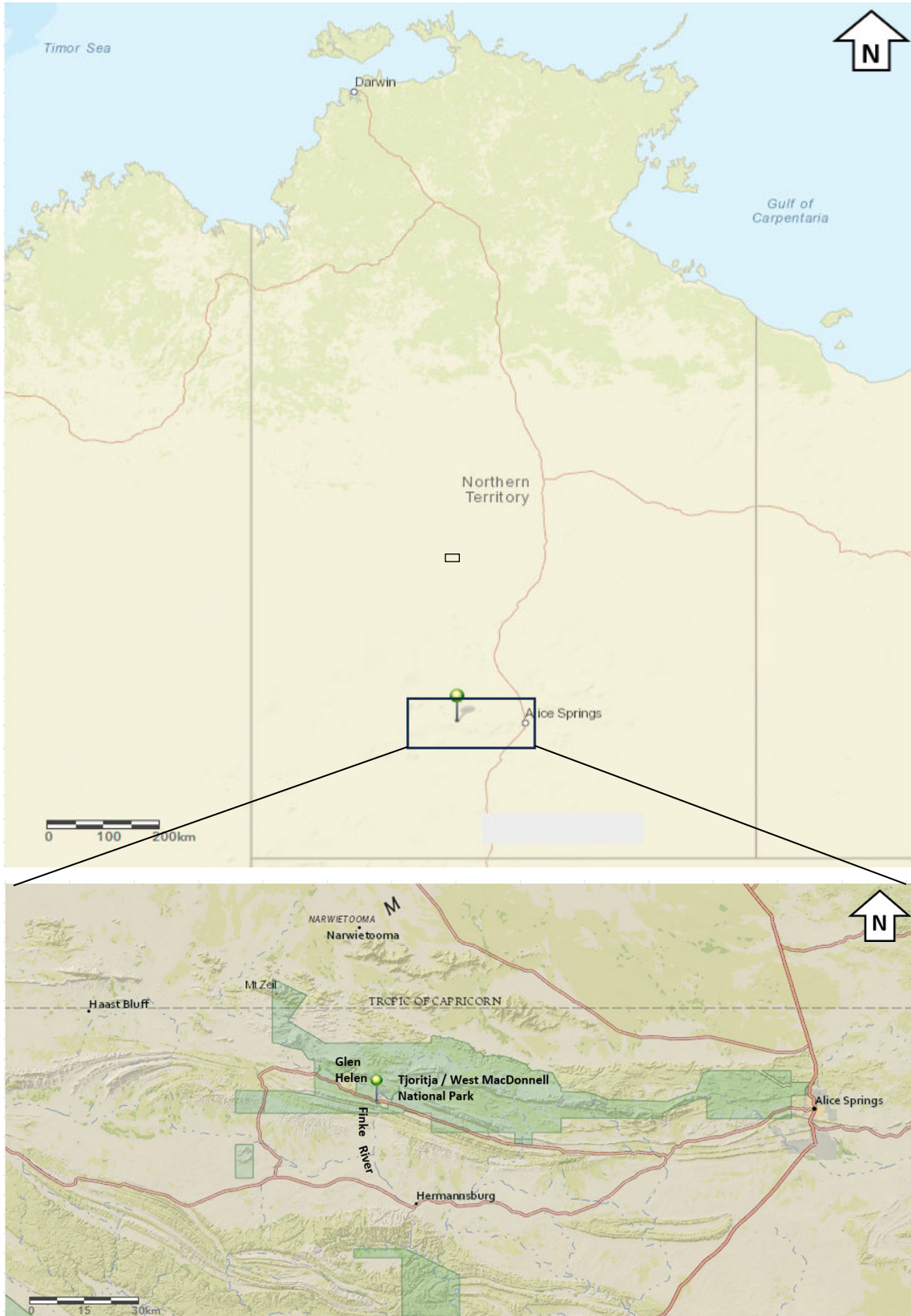


Figure 1. Site Location
(Source :- ESRI)

1.2 Site Address, Property ID and Zoning

The audit site is located in the West McDonnell Ranges, within the Tjoritja / West MacDonnell National Park, approximately 130km west of Alice Springs. The legal description of the property is CUFT Volume 849 Folio 156, NT POR 830. The land is freehold, and the currently listed owner is Beston Parks Land Co Pty Ltd (ACN 111 783 423). No zoning applies to the property. A copy of the current title is attached in Appendix A.

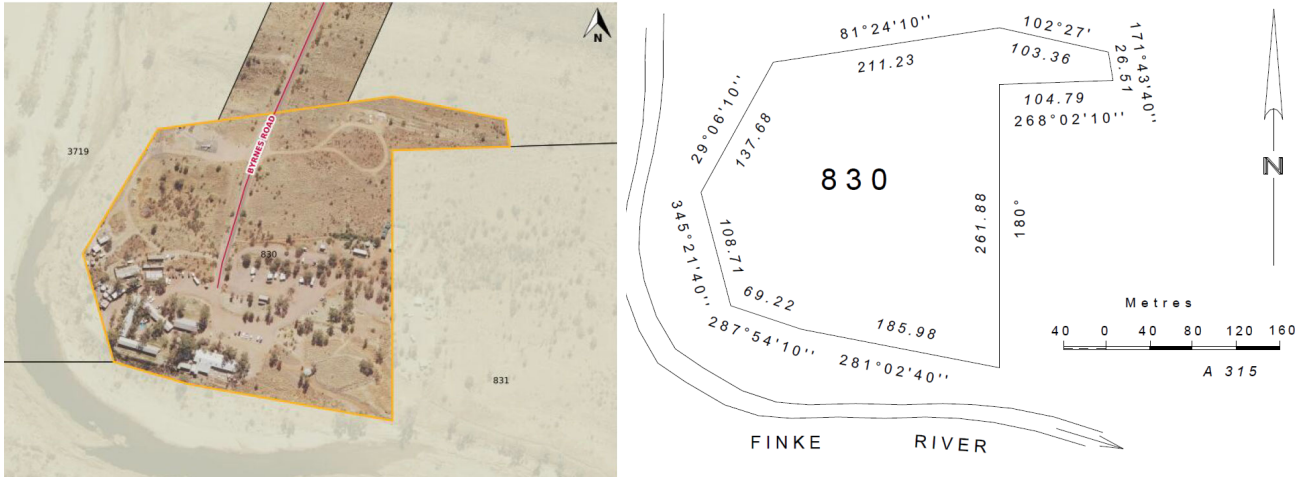


Figure 2. Property Boundary
(Source: NT Govt, plans included in CT Vol 849 Fol 156)

1.3 Site Layout and Condition

NT Portion 830 is an irregular shaped block with an area of approximately 71,800m². The property has been recently acquired by new owners and it is currently being upgraded to continue operations as part of the Discovery Parks group of tourist accommodation and facilities. The tourist accommodation facilities have been closed since mid 2022. The following description of the layout and features of the Glen Helen Lodge was provided by Low Ecological based on an inspection completed in 2020³:-

- The tourist accommodation facilities are located in the southwest of the property, with the Finke River adjacent to the western and southern boundaries.
- Pub and guest / staff accommodation area.
- Utilities / maintenance / storage area including wastewater treatment system, diesel generators with above ground diesel storage (4,000L capacity), and water supply tanks and pump. It was reported a new wastewater treatment plant was installed in 2018 with the effluent irrigation field located to the north of the main lodge and buildings.
- Landfill area. Described as an 'informal landfill' in the report, with 'wastes from renovation / building works etc', and tyres. It was also reported that since mid 2020 after an agreement with Ormiston Landfill had lapsed, general refuse / garbage from the lodge had been disposed in a pit in this area and burnt.

³ Glen Helen Resort High-Level Environmental Due Diligence Inspection (Low Ecological Services, November 2020)

- Helicopter pad and refueling area. It was noted that refueling was completed via drums wheeled out to the helicopter, with no permanent fuel storage.
- Campground area, toilets / amenities blocks, with fuel tanks and bowser for vehicle refueling.
- Groundwater supply bore area. The bore is located approximately 1,100m to the northeast of the lodge. It was reported power for the bore is supplied by a diesel-powered generator with the diesel stored in an above ground tank of approximately 80L capacity.

The area of interest for this audit program is the former fuel storage and bowser area which was located near the other lodge buildings and car parking areas. Fuel storage was noted to include two operational fuel tanks (1 x diesel approximately 5,000L capacity and 1 x petrol / opal product tank approximately 12,000L capacity). There was also suspected to be another possible redundant underground fuel tank present based on an additional vent pipe adjacent to the unleaded fuel bowser. Ultimately there were three USTs (underground storage tanks) identified in that location, which were removed during 2021 / 2022 with further details provided later.

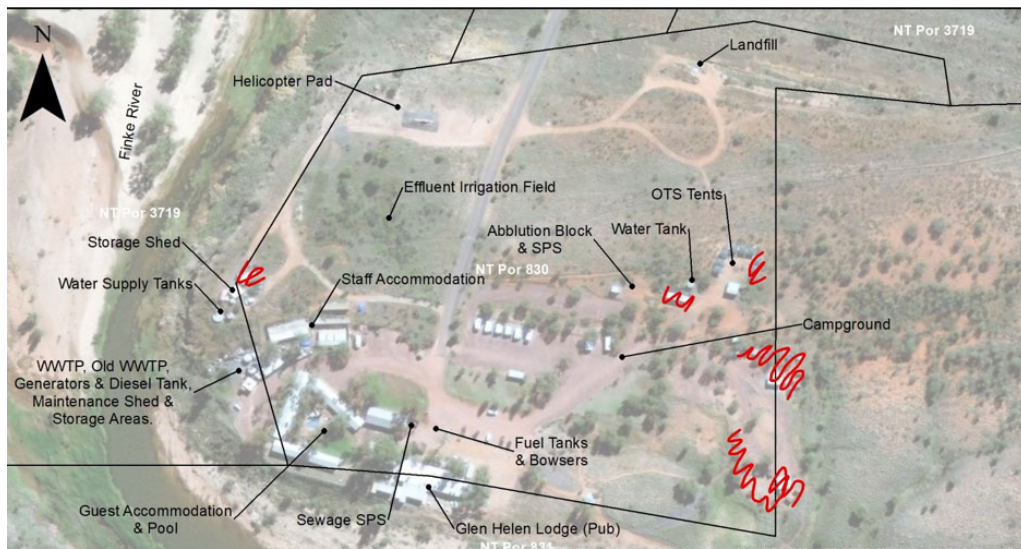


Figure 3. Site Layout (Low Ecological, 2021)



Figure 4. Fuel bowser area looking SW – Finke River and escarpment behind (Source:- Low Ecological)

1.4 Proposed Future Use

At the time of this audit report, the accommodation facilities at Glen Helen are closed. It is understood that Discovery Parks intend to continue operating the property for short stay accommodation with powered and unpowered camping areas for caravans, tents and onsite cabins. A recent plan of the accommodation park is provided on the following page.



Figure 5. Layout of accomodation and related buildings (Discovery Parks, 2022)

2. AUDIT APPROACH AND METHODOLOGY

2.1 Audit Objectives and Scope

The objectives for this particular audit were to address the requirements for the audit as specified in the s48 Notice:-

- a. determine the type, amount and distribution and mobility of contaminants and wastes present in the environment resulting from the activities;
- b. determine the risk of any possible harm or detriment to the land, surface water and groundwater environments as a result of identified contamination;
- c. where a risk of any possible harm or detriment to a segment of the environment has been determined in requirement b above, recommend any further assessment, risk analysis (human health or ecological) or remedial measures necessary to reduce the risk to an acceptable level; and
- d. include an indicative implementation timetable for any recommended clean-up and/or management works referred to in requirement c.

The s48 Notice specifically relates to impacts associated with underground petroleum products storage and dispensing in a specific area of the property, and the audit has been completed assuming that these are “the activities” referred to in item a. above.

The audit scope was developed with regard to Victoria EPA Publication 2041⁴ but has been tailored to be consistent with the NT legislative framework in particular Section 47 of the *Waste Management and Pollution Control Act 1998* and the requirements of the s48 Notice.

Table 3. Audit scope

Scope Item	Details	Comments / Rationale
Is this an audit for a site or an activity?	This is an audit of an activity. The activity is the historical storage and dispensing of petroleum products near the tourist accommodation facilities at Glen Helen Lodge.	This audit is for an activity rather than a site to be consistent with the s48 Notice. The details are as noted throughout this audit report.
Use or proposed use for which the site is being audited	Land use (site):- Historical and proposed ongoing use is for tourist accommodation and associated facilities. Land use (adjacent land):- Glen Helen Lodge is on freehold land within the boundaries of the Tjoritja / West MacDonnell National Park.	Land uses under the NT planning framework broadly align with the definitions and categories in the ASC NEPM. The onsite land use/s are considered to be within the categories of 'commercial' and 'recreation / open space' Because the site is located within a national park this also warrants consideration in the context of possible impacts on that land. This has been considered by reference to the Tjoritja / West MacDonnell National Park Joint Management Plan amongst the other guidelines and standards considered for this audit.
Segments of the environment to be	Land Air Water (surface water) Water (groundwater)	The s48 Notice specifies that the audit must consider risk of any possible harm or detriment to the land, surface water and groundwater environments. These all fall within the definition of 'land' under the <i>Waste Management and Pollution Control</i>

⁴ Guidelines for conducting environmental audits. Vic EPA Publication 2041, February 2022.

Scope Item	Details	Comments / Rationale
assessed in the environmental audit.		<i>Act 1998</i> . Environmental values, indicators and objectives for these segments are outlined later in this audit report.
Standards and reference documents to be considered	<p>NT Guidance / references:- Tjoritja / West MacDonnell National Park Joint Management Plan (NT Parks & Wildlife commission, NT government, March 2018) NT EPA, Northern Territory Contaminated Land Guideline, June 2017.</p> <p>National guidance / references:- National Environment Protection (Assessment of Site Contamination) Measure (NEPC 1999, as amended 2013) (“the ASC NEPM”) Australian Government 2018, <i>Charter: National Water Quality Management Strategy</i>, Department of Agriculture and Water Resources, Canberra, March. CC BY 3.0 The Australian drinking water guidelines The Australian and New Zealand Guidelines for Fresh and Marine Water Quality The Guidelines for managing risks in recreational water</p> <p>Victorian guidance / references:- Environment Reference Standard 2021 (“the ERS”) Environmental auditor guidelines for appointment and conduct (EPA publication 865) Environmental auditor guidelines – Provision of environmental audit statements and reports for environmental audits and preliminary risk screen assessments (EPA publication 2022) Guidelines for conducting environmental audits (EPA publication 2041) Guideline on clean up and management of contaminated groundwater (EPA publication 2001) Assessing and controlling contaminated land risks: a proposed guide to meeting the duty to manage for those in management or control of land (EPA publication 1977) Contaminated land: understanding section 35 of the Environment Protection Act (EPA publication 1940)</p>	<p>As far as possible the audit has been conducted with regard to NT guidance, supplemented with other relevant national and state guidance particularly from Victoria which is where the auditor holds accreditation that is recognised by the NT EPA.</p> <p>The NT EPA Contaminated Land Guidance is the primary reference for contaminated land assessment, remediation and management in the NT. The was other national guidance considered to supplement the NT guidance.</p> <p>The Tjoritja / West MacDonnell National Park Joint Management Plan was developed by the Traditional Owners and Parks and Wildlife commission of the NT, with support, assistance and advice from the Central Land Council and other stakeholders including tourism industry representatives. Quoting directly from this Plan – “<i>The Plan defines our shared vision, objectives and strategies to deliver effective joint management, care for culture and country and support exciting, memorable and safe visitor experiences.</i>” This Plan is therefore considered to represent the latest available views of the Traditional Owners and other relevant stakeholder with regard to the management of the national park.</p> <p>This audit also had regard for various other sources of guidance and references as per the guidance in EPA Victoria Publication 2041⁵ as listed here. The ERS is a reference standard that provides a framework to identify environmental values that the Victorian community want to achieve and maintain, and also specifies indicators and objectives for assessing impacts on these values. The audit has been conducted with regard to the various other EPA Victoria guidelines relevant to environmental auditing as listed here.</p>
Exclusions from the environmental audit and rationale for these	None of the elements of the environment specified in the s48 Notice were excluded from this audit.	No further comments
Assumptions made or limitations on the environmental audit	None	No further comments
Supporting documentation	Supporting documents considered for this audit have been listed in section 2.4 of this audit report.	No further comments

⁵ Guidelines for conducting environmental audits. Victoria EPA Publication 2041, February 2022.

2.2 Audit Team

The following support team personnel assisted the Auditor in carrying out the audit:

- John White of Kirsa Environmental. Reviews of background reports and drafting of the audit report.
- Rachael Harman of Kirsa Environmental. Drafting and review of the audit report, completed site inspections / visits on behalf of the auditor.

For this particular audit there was no need for the Auditor to consult with members of his external expert support team.

2.3 Audit Works

Audit activities have comprised:-

- Discussions with the client and their consultants Low Ecological Services and Tierra Environment re the conduct of field investigations, reporting, and further works to address the requirements of the s48 Notice;
- Meeting with representatives of the NT EPA in Darwin;
- Reviewing of reports and providing comments / queries and suggestions; and
- Preparation of this environmental audit report.

Further details of the assessment, remediation and monitoring works are provided in later sections of this audit report.

2.4 Documentation Reviewed

The table below lists the reports that were reviewed for this particular environmental audit.

Table 4: List of Reports Reviewed

Report / document title	Prepared by	Date	Copy provided in audit report
Glen Helen Groundwater Investigation 1991-1995	Water Resources Branch of the Power and Water Authority	May 1996	Appendix C
Alice Springs Region Glen Helen Resort Potable Water Pipeline Feasibility Review	NT Dept of Infrastructure	March 2016	Appendix D
Glen Helen Resort High-Level Environmental Due Diligence Inspection	Low Ecological Services Pty Ltd	Nov 2020	Appendix E
Alice Springs Town Council Soil Classification Analysis for General Fill Disposal Report	Low Ecological Services Pty Ltd	28 September 2021	Appendix F

Report / document title	Prepared by	Date	Copy provided in audit report
Glen Helen Lodge Discovery Parks Fuel Contamination from Underground Petroleum Storage System: Investigation and Remediation Report (LES, 2022)	Low Ecological Services Pty Ltd	31 March 2022	Appendix G
Glen Helen Discovery Park Groundwater Monitoring Event – May 2023 Sampling and Analysis Quality Plan	Tierra Environment Pty Ltd	May 2023	Appendix H
Groundwater Monitoring Event May 2023	Tierra Environment Pty Ltd	July 2023	Appendix I
Fuel Contamination from Underground Petroleum Storage System: A Progress Update Report, April 2023. V8*	Low Ecological Services Pty Ltd	Received 23 November 2023	Appendix J
Groundwater Monitoring and Management Plan	Tierra Environment Pty Ltd	November 2023	Audit Statement Annexure 2

* There have been multiple earlier versions of this report. Earlier versions were entitled 'Glen Helen Lodge Ngurratjuta / Pmara Ntjarra Aboriginal Corporation Underground Petroleum Storage System's Fuel Contamination Detailed Site Investigation (DSI)' however the title of this – most current version – is to reflect that some remediation was undertaken at the site.

2.5 Site visits / inspections

An inspection was carried out by Rachael Harman on behalf of the auditor on 27 May 2022 to coincide with the drilling of groundwater monitoring bores. Since the audit commenced there have been no significant changes to the building configuration onsite, aside from the installation of the swimming pool and additional gravel hardstand placed within the carpark and outdoor recreational areas. Further details are provided throughout the audit report.

3. ENVIRONMENTAL SETTING

3.1 Location and Surrounding Land Uses

The audit site is located within the Tjoritja / West MacDonnell Ranges National Park about 130km west of Alice Springs. The audit site is located adjacent to the Finke River and the river is approximately 50m beyond the property boundary, and 90m south / southwest of the former fuel bowsers and underground fuel tanks. The river path runs along the western and southern boundaries of the property, and continues south through Glen Helen Gorge, approximately 800m to the southeast. The reporting by Low Ecological has noted the Finke River is an ephemeral watercourse which flows for short periods after significant rains, with waterholes persisting adjacent to the Glen Helen Lodge site after river flows cease. Glen Helen Gorge downstream is a permanent waterhole. Aside from being within the national park, the Finke River Headwater Gorges System, which includes Glen Helen Gorge, is listed on the Directory of Important Wetlands in Australia (ID: NT002) with the gorge being one of eight permanent water bodies along the Finke River system⁶.

The tourist accommodation / campsite areas at Glen Helen Lodge are on relatively flat land at an elevation of about 635m AHD. The MacDonnell Ranges are oriented approximately east-west with one of the ranges forming a large escarpment on the south side of the Finke River at Glen Helen Lodge, rising to about 800m AHD. The reporting discussed the surface drainage at Glen Helen Lodge - “the area around each of the fuel systems slopes towards the large carpark area to the east of the tanks” and “stormwater runoff flows from the carpark to the east into a vegetated lower lying area which then turns south and flows into the Finke River”. The reporting notes that Glen Helen Lodge does not extract any water from the Finke River, with its water for the site supplied by a groundwater bore – discussed in next section.



*Figure 6. Aerial photograph Glen Helen accommodation looking east
(Discovery Parks, 2022)*

⁶ Northern Territory Government, *Sites of Concentration Significance Greater MacDonnell Ranges, Publication 2009.*



Figure 7. General topography of the area
(Low Ecological, 2021)

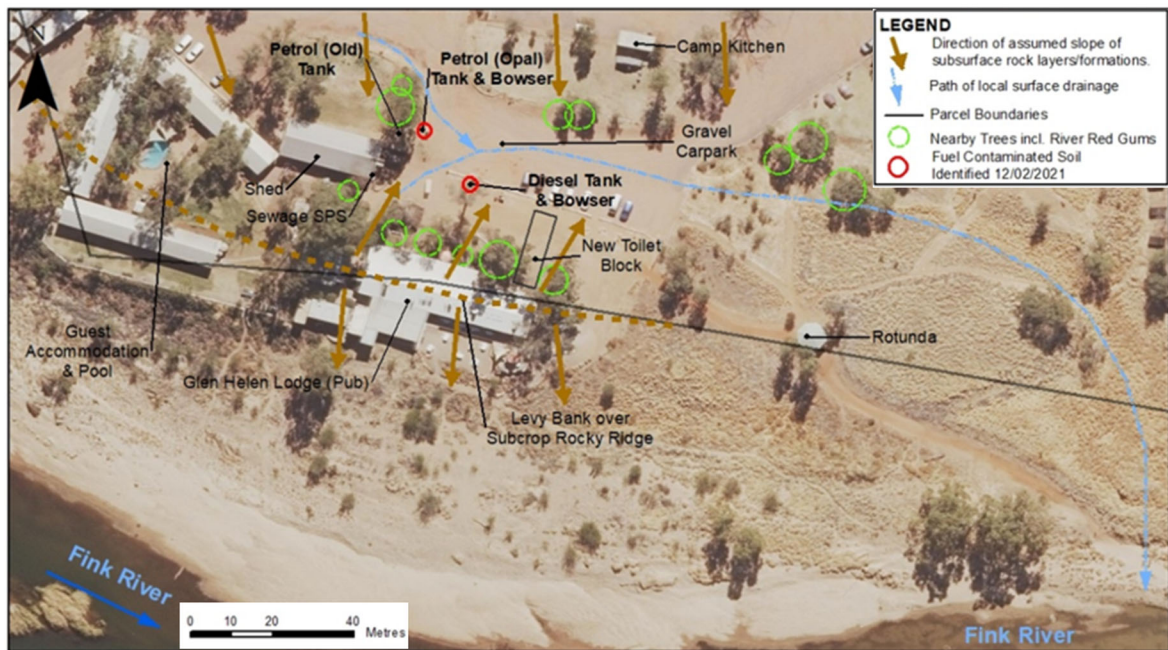


Figure 8. Site layout showing surface drainage and Finke River banks
(Low Ecological, 2021)

3.2 Geology, Hydrogeology & Groundwater Beneficial Use

The reporting by Low Ecological reviewed local geological mapping which indicates the site is within an area mapped as alluvial silt and sand associated with the Fink River, with basement rock outcropping in the area as Hugh River Shale which reportedly comprises shale, siltstone, and minor limestone. No specific reference was provided but it is presumed the mapping was 1:250,000 scale geological survey mapping.

The Auditor reviewed additional literature including Austin et al, 2017⁷ which provides more detailed interpretation of the basement rock formations in the Glen Helen area using aerometric data supplemented with some ground-based field mapping. This paper indicates the West MacDonnell ranges in the Glen Helen area are part of a complex sequence of ancient sediments which date from the Middle to late Cambrian (488-542 million years of age). The paper noted the bedding in the Glen Helen area is nearly vertical with the formations increasing in age from south to north. The paper interpreted the formation directly beneath the lodge site as a limestone / dolostone (Goyder Formation), with the escarpment to the south across the Finke River interpreted as a quartzite (Pacoota Sandstone).

Low Ecological reviewed NR online groundwater mapping which indicates groundwater in the Glen Helen area is present within an aquifer classified as 'fractured and karstic rocks (local and intermediate scale)'. They also reviewed listings of groundwater bores in the area which identified the following registered bores in the area:-

- RN016364. Located approximately 520m NW of the lodge and former fuel tank area. Listed as an observation bore. Details recorded as 34.4m deep, water struck during drilling at 19.8m depth, standing water level of 8.8m and yield of 2 litres per second (L/sec). The record also notes this bore water was not suitable for human consumption, presumably on the basis of the salinity (recorded as approx. 6,600 mg/L TDS).
- RN006146. Located approximately 880m ENE of the lodge and former fuel tank area. Listed as a disused bore. Details recorded as 61m deep, water struck during drilling at 15.2m depth, standing water level of 8.2m and yield of 1.3 L/sec. The record also notes this bore water was not suitable for human consumption, presumably on the basis of the salinity (recorded as approx. 3,100 mg/L TDS).
- RN016944. Located approximately 1,140 m NE of the lodge and former fuel tanks. Listed as the current water supply bore for Glen Helen Lodge. Details recorded as 49m deep, water struck during drilling at 38m depth, standing water level of 17.6m and yield of 1 L/sec. The record also notes this bore produced water with a TDS of 1,200 mg/L.

It is agreed based on the above information that the expectation is that groundwater at Glen Helen Lodge will likely be present as a fractured rock aquifer beneath this area, and that the depth to groundwater would be expected to be within 20m of the surface.

Groundwater / surface water interaction was not specifically addressed in the assessment reporting, however based on the information reviewed it is considered unlikely that there is any significant groundwater inflow contributing to flows in the section of the Finke River adjacent to the Glen Helen Lodge. The information does however suggest there must be at least some influence

⁷ Using stratiform magnetic anomalies to map near surface architecture insights from the Amadeus Basin. Austin, JR, Schmidt, S, & Foss, CA. Australian Journal of Earth Sciences, Vol 64, No.3 (2017).

from groundwater contributing to the permanent water in the Glen Helen Gorge further downstream.

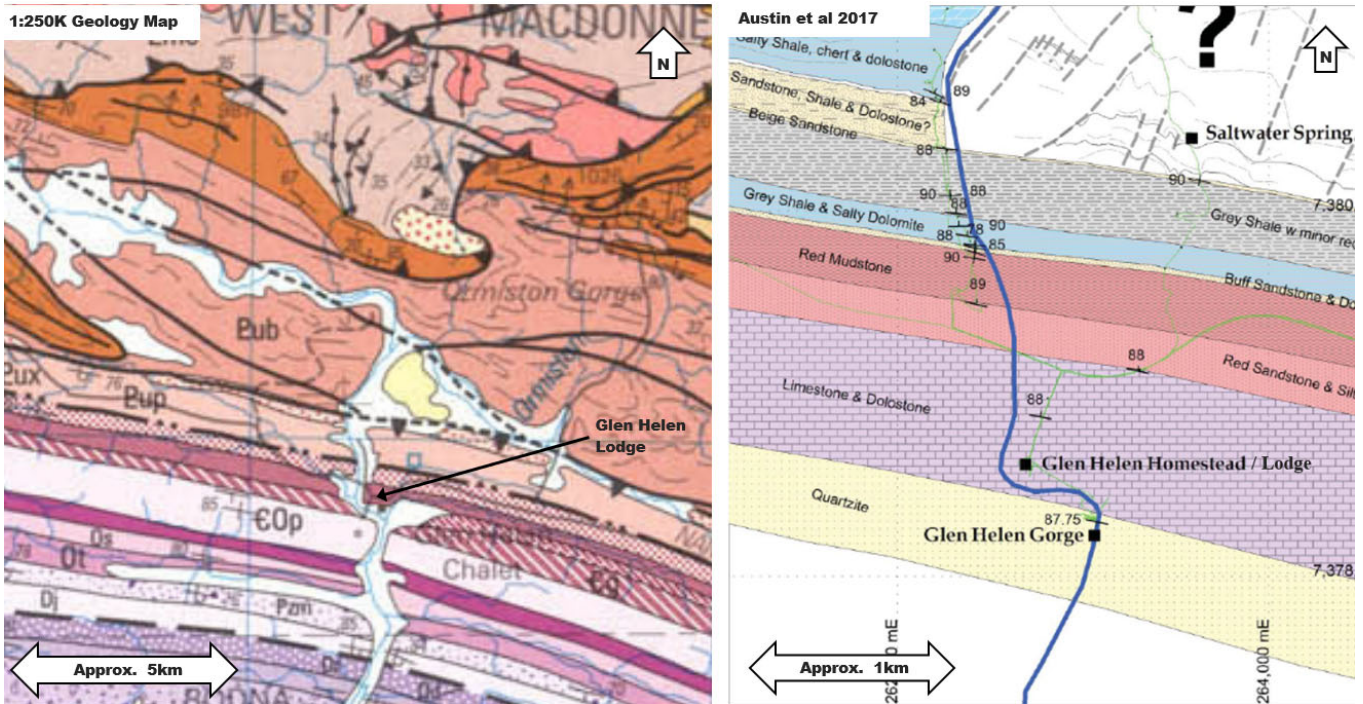


Figure 9. Geological mapping Glen Helen area

Auditor Comments (geology and hydrogeology)

The reporting reviewed for this environmental audit program adequately covered most of the information expected for this aspect, with reference to the reporting checklist from the NT Contaminated Land Guideline and the relevant sections of the ASC NEPM. Omissions and / or other issues with the reporting are noted below:-

The reporting did not convey a very clear understanding of the regional or site-specific geology.

The reporting did not convey a very clear understanding of groundwater occurrence and the flow regime (elevation, flow direction, rate etc.).

The reporting did not convey a very clear understanding or interpretation of potential groundwater surface water interaction.

3.3 Environmental Values

The following text and tables provide a summary of the environmental values, indicators and objectives considered for this environmental audit. In the absence of NT specific information, these have been adopted using the Victorian framework based on the current and proposed future use of the audit site, but also with regard to the fact the property is located within a National Park, the proximity of an important watercourse (Finke River), and the ongoing connection of Traditional Owners.

Beneficial uses and water quality objectives or guidelines can be declared in the Northern Territory under the Water Act 1992. Beneficial uses or values have been set for major aquifers and river catchments, but as far as the auditor can determine, there has not been a declaration made to this effect for this portion of the Finke River catchment so the audit has considered other information including the Tjoritja / West MacDonnell National Park Joint Management Plan. This Plan provides an overview of the significance of the Park and its values in terms of three broad categories:-

- Culture. The Plan notes there is evidence of a long history of Aboriginal occupation and the need for the Traditional Owners to maintain strong ties and connection to the land.
- Country. The Plan notes the Park lies within the MacDonnell Ranges bioregion; one of 85 bioregions identified nationally. It also notes the Greater MacDonnell Ranges are recognised as an international Site of Conservation Significance for their threatened species, endemic species, floral diversity, geological formations and wetland values. The Plan also notes the obligations of Traditional Owners under traditional law to protect the land.
- Tourism. The Plan notes Tjoritja is one of the premier tourist experiences in Central Australia, and makes specific mention of Glen Helen Homestead Lodge and Standley Chasm as two commercial operations closely associated with the Park.

With regard to water resources, the Plan notes *“permanent and semipermanent watercourses, waterholes and groundwater in the Park support a significant percentage of the aquatic and terrestrial biodiversity within the region, including species that are found nowhere else in arid Australia. Permanent water sources in the gorges, were invaluable to Traditional Owners in the past, and continue to retain cultural importance.”*

The environmental values, indicators, and objectives adopted for this audit are outlined in the following tables.

Land Use Categories & Environmental Values

Based on the proposed ongoing use of the audit site for tourism and accommodation this audit has considered the environmental values for the land use categories under the Victoria framework including ‘Recreational Open Space’ and ‘Commercial’, but also noting the fact the site is located within a national park. It is also noted that although groundwater is included in the definition of land within the Victorian ERS⁸ and also within the Victorian Environment Protection Act⁹, the ERS also addresses groundwater and lists environmental values for groundwater as part of the water environment, and this is considered in the following section. It is considered these values broadly align with the categories of culture, country and tourism as nominated as the values of the national park in the Tjoritja / West MacDonnell National Park Joint Management Plan.

Table 5. Environmental values for land

Environmental values (EVs) of land	Description	Land use categories (shaded categories were considered for this audit)						
		Parks and Reserves	Agricultural	Sensitive Use (High Density)	Sensitive Use Other (lower density)	Recreation / Open space	Commercial	Industrial
Land dependent ecosystems and species	Land quality that is suitable to protect soil health and the integrity and biodiversity of natural ecosystems, modified ecosystems and highly modified ecosystems	✓						
- natural ecosystems		✓	✓		✓	✓		
- highly modified ecosystems			✓	✓	✓	✓	✓	✓
Human health	Land quality that is suitable for the specific land use and safe for the human use of that land	✓	✓	✓	✓	✓	✓	✓
Buildings & structures	Land quality that is not corrosive to buildings, structures, property and materials	✓	✓	✓	✓	✓	✓	✓

⁸ The ERS defines the “land environment” as including soil, fill, rock, weathered rock, and sand, the vapour and liquids within the interstitial spaces in the unsaturated zone, and sub-aqueous sediment.

⁹ Section 3(1) of the Victorian Environment Protection Act 2017 defines land as “...any land, whether publicly or privately owned, and includes (a) any buildings or structures permanently fixed to the land; and (b) groundwater.” This is broadly consistent with the definition of land in the NT *Waste Management and Pollution Control Act 1998* includes water and air on, above or under land.

Environmental values (EVs) of land	Description	Land use categories (shaded categories were considered for this audit)						
		Parks and Reserves	Agricultural	Sensitive Use (High Density)	Sensitive Use Other (lower density)	Recreation / Open space	Commercial	Industrial
Aesthetics	Aesthetic issues do not adversely impact the use of land. Aesthetic issues include the quantity, type and distribution of foreign material or odours in relation to the specific land use and its sensitivity	✓		✓	✓	✓	✓	
Production of food, flora and fibre	Land quality that is suitable for the safe human consumption of food, flora and fibre and that does not adversely affect produce quality or yield	✓	✓		✓			

The ERS defines "sensitive use" to include land residential use, a child care centre, pre-school, or primary school being either high density where there is minimal access to soils, and other (lower density) where there is generally substantial access to soil.

Waters – Surface Water and Groundwater & Environmental Values

The following table lists the environmental values considered for surface water and groundwater. These have been adopted based on the Victorian regulatory framework outlined in the ERS, which defines the environmental values of groundwater that are protected in a groundwater segment which is based on the background TDS of the groundwater. For this particular site, the groundwater TDS in the monitoring bores installed ranged from 2,400 – 3,000 mg/L which corresponds to groundwater segment B as defined in the ERS (1,201 – 3,100 mg/L TDS). It is considered these values broadly align with the categories of culture, country and tourism as nominated as the values of the national park in the Tjoritja / West MacDonnell National Park Joint Management Plan, although it could be argued that compared to Victoria an even higher value might be placed on any water reserves in this location given the arid climate and general scarcity of water resources.

Table 6. Groundwater Segments and Protected Environmental Values *

Environmental Values	Groundwater segments (based on TDS range as listed)						
	A1 (0-600)	A2 (601-1,200)	B (1,201-3,100)	C (3,101-5,400)	D (5,401-7,100)	E (7,101-10,000)	F (>10,000)
Water dependent ecosystems and species	✓	✓	✓	✓	✓	✓	✓
Potable water supply (desirable)	✓						

Environmental Values	Groundwater segments (based on TDS range as listed)						
	A1 (0-600)	A2 (601-1,200)	B (1,201-3,100)	C (3,101-5,400)	D (5,401-7,100)	E (7,101-10,000)	F (>10,000)
Potable water supply (acceptable)		✓					
Potable mineral water supply	✓	✓	✓	✓			
Agriculture and irrigation (irrigation)	✓	✓	✓				
Agriculture and irrigation (stock watering)	✓	✓	✓	✓	✓	✓	
Industrial and commercial use	✓	✓	✓	✓	✓		
Water-based recreation (primary contact recreation)	✓	✓	✓	✓	✓	✓	✓
Traditional Owner cultural values	✓	✓	✓	✓	✓	✓	✓
Buildings and structures	✓	✓	✓	✓	✓	✓	✓
Geothermal properties	✓	✓	✓	✓	✓	✓	✓

*environmental values as defined under the Victoria framework in the Environmental Reference Standard (ERS)

4. SITE HISTORY AND POTENTIAL CONTAMINATION

4.1 Desktop Information and Site Inspection

There were a number of reports produced by Low Ecological that include limited historical information on the activities being considered in this audit (ie. historical petroleum product storage and dispensing). Some limited detail was provided on the history of the fuel storage and dispensing, tank repairs / maintenance, which is understood to have been based on discussions with one or more personnel who had been involved as contractors at the site.

The due diligence report (LES, 2020) stated that, "*following the site inspection, phone discussions were had with Scott Murdoch of Territory Electrical (the fuel station maintenance contractors), Jason Hansen of Pump and Power (diesel generators and pumps maintenance contractors), and Sherwin Owen of Bullet Plumbing (general plumbing, sewage system and local wastewater system maintenance).*"

The information conveyed in the reporting related to the history fuel storage and dispensing systems at the Site was as follows: -

- According to the due diligence report (LES, 18 November 2020):
 - Glen Helen was a cattle station since the early 1900s with several homesteads being built over the years.
 - The third homestead was built on the current site of the Glen Helen Lodge.
 - NT Portion 830 (freehold land parcel) was created in 1963.
 - There was a fire in the 1980s which burnt most of the old homestead / lodge.
 - The lodge was purchased by the Ngurratjuta Aboriginal Corporation in 1992 and has been operated as camping area with fuel and beverage sales.
 - The volume and age of the unleaded fuel tank is unknown, and the age of the diesel tank age is unknown, however it was reportedly in place in 1992.
 - The diesel tank was deemed to be at risk due to its age and lack of integrity testing, and the proximity to the waterhole and Glen Helen Gorge.
 - A site representative was not aware of any leaks, spills or issues related to the fuel system in the past.
 - The lodge was leased out from 1999 through to 2018 when the Ngurratjuta Aboriginal Corporation reclaimed ownership / management.
 - The fuel system maintenance contractor (Territory Electrical) noted the following:
 - The diesel tank is pre-1992.
 - The diesel pump suction line had corroded, so all diesel pipework was replaced, and four to five inches of sludge (indicative of internal corrosion) was cleaned out of the diesel tank about 15 years prior to the date of the due diligence report (i.e., around 2005). The contractor also recalled that external surface corrosion on the top of the diesel tank was evident during the replacement and cleaning works.

- The unleaded pump has been replaced twice (2002 and 2012) due to corrosion of the pump frame from irrigation water hitting the pump, however it was unknown at these times if the tank and pipework had been similarly affected.
 - According to the final investigation and remediation report (LES, 2022):
 - The diesel system was pre-1992 and had showed obvious signs of spillage or leakage around the bowser in its final days. The diesel system (including the UST, the bowser, fuel pipes, vent, and concrete plinths) was removed on 23 March 2021 and determined to be in “*very poor condition*” with obvious signs of corrosion and pitting in the tank and pipework, which “*are the source of the extensive leakage*”.
 - The opal petrol system was the newer petrol system on the site. Although the installation date is unknown it was reportedly also pre-1992. The soil around the tank was found to be contaminated with petrol. The opal system (including the UST, the bowser, canopy, fuel pipes, vent, and concrete plinths) was removed on 23 March 2021 and was also determined to be in “*poor condition with signs of corrosion and likely leakage points on the tank and pipework*”.
 - An older decommissioned petrol tank was also removed on 23 March 2021. In this case there were reportedly no signs of possible leakage observed. The UST was deemed to be “*in good condition, likely due to the pit having been backfilled with river sand when installed, thus reducing corrosion potential*”.

4.2 Preliminary Conceptual Site model

There was no preliminary conceptual site model (CSM) presented in the reporting. The following table presents an initial conceptual site model (CSM) developed by the Auditor in the absence of this information in the reports reviewed. As noted elsewhere, the focus of this audit program was the former fuel storage tanks and bowser area. The typical list of contaminants of concern for this scenario would generally include fuel related petroleum hydrocarbons and associated additives with typical indicator analytes including total recoverable hydrocarbons (TRH) or total petroleum hydrocarbons (TPH), monocyclic aromatic hydrocarbons including BTEX (benzene, toluene, ethyl benzene, xylenes), polycyclic aromatic hydrocarbons (naphthalene being the main indicator analyte), lead, methyl-tert-butyl ether (MTBE) and other oxygenates used as additives in petrol products. Potential exposure pathways and receptors are indicated in the preliminary CSM below.

Table 7: Preliminary CSM (Sources, Pathways, Receptors)

Sources	Contaminants of potential concern	Likelihood of impacts and potentially impacted media	Potential Exposure Pathways	Potential receptors
On-site sources				
Fuel leakage from historical fuel storage / dispensing including underground fuel storage tanks, fuel	Petroleum hydrocarbons, benzene, toluene, ethylbenzene and xylenes (BTEXN), Petrol additives including methyl	Moderate to high based on national and international experience with underground fuel storage tanks and related impacts.	Soil Dermal contact. Incidental ingestion. Vapour inhalation.	Intrusive maintenance workers. Site occupants / visitors.. Finke River. Groundwater.

Sources	Contaminants of potential concern	Likelihood of impacts and potentially impacted media	Potential Exposure Pathways	Potential receptors
bowser and associated pipework.	tert-butyl ether (MTBE) and lead.		Groundwater Dermal contact Ingestion. Vapour inhalation. Surface water:- Direct contact. Incidental ingestion.	
Off-site sources				
None identified	N/A	N/A	N/A	N/A

Auditor Comments

The first stage of assessment advocated in the ASC NEPM is what is termed a Preliminary site Investigation (PSI). A PSI normally comprises a desktop review of available information on the physical and environmental setting, and the history of the site, and an inspection of the site.

The outcomes should include a review of historical uses / activities and current conditions, and an assessment of potential and / or known contamination. An initial conceptual site model (CSM) should be developed outlining the site layout / condition, potential contamination source/s, receptors, and potential migration and exposure pathways.

Some elements of what could be considered as a historical or desktop information review have been included in the reports reviewed including an inspection of the site. However the information cannot be considered strictly in compliance with what is normally expected for reporting of this phase of the assessment with reference to the reporting checklist from the NT Contaminated Land Guideline and the relevant sections of the ASC NEPM. Omissions and / or other issues with the reporting are noted below:-

Limited detail provided re ownership history and supporting documents such historical land titles.

No historical aerial photographs provided.

No government records search (aside from a search of registered bores).

No dangerous goods storage licenses / records.

No review of local literature about the site.

No attempt to source any previous investigations / reports relating to the site.

No review of heritage matters (Aboriginal or other).

No evaluation of gaps in knowledge, uncertainties.

No review of potentially contaminating activities and potential contaminants of concern.

No initial conceptual site model (CSM) including known and potential sources of contamination, migration and exposure pathways, and receptors of concern. It is acknowledged there is a section in the March 2022 report titled 'Preliminary Conceptual Site Model', however this is simply a listing of the elements of a CSM rather than an initial CSM for this particular site.

The reporting reviewed did not include a specific listing of contaminants of concern based on the site history and operations for the fuel storage / dispensing area or anywhere else across the site for that matter. Potential contaminants of concern for the fuel related storage include petroleum hydrocarbons and also petroleum product additives (such as MTBE or tetra ethyl lead). Potential contaminants of concern for the remainder of the site might be expected to include those associated with general mechanical maintenance and fuel storage (oil and fuel related chemicals), building / demolition wastes (asbestos, various metals), general refuse from the lodge operations, and wastewater treatment / disposal (nutrients and pathogens). There is also increasing recognition of a class of chemicals termed 'emerging contaminants' which cover a wider range of contaminants that are not routinely considered in environmental assessment / monitoring programs but are being found to be associated with wastewater treatment plants. Examples of these 'emerging contaminants' include pharmaceuticals and personal care products, endocrine disrupting compounds, pesticides, veterinary products, disinfection by-products, and fire retarding chemicals (Sardiña et al, 2019)¹⁰.

The reporting produced by Low Ecological Services and reviewed by the Auditor did not include any discussion regarding potential off-site sources of contamination or contaminants of concern. It is acknowledged there do not appear to be any obvious source/s that might be affecting the area of interest, noting again the main focus of this audit was the former USTs and bowsers that were located close to the campground and buildings.

It is emphasized again however that these are not relevant to the area of interest for this particular audit which was concerned with potential fuel related contamination associated with the former USTs and bowsers area.

¹⁰ P Sardiña, P Leahy, L Metzeling, G Stevens, A Hinwood. *Emerging and legacy contaminants across land-use gradients and the risk to aquatic ecosystems*. Science of the Total Environment, 695 (2019) 133842.

5. AUDIT CRITERIA

5.1 Land / Soil

The soil assessment results were assessed against screening criteria generally in accordance with the sources specified as follows.

- For assessing potential impacts on ecological receptors, the assessment reports and this audit adopted values from the prevailing Australian guidance (primary source = EILs and ESLs from the ASC NEPM), supplemented with applicable international values where there were no such Australian investigation or screening value is available. The ASC NEPM notes the EILs and ESLs are generally applicable to the top 2m of soil but will be site specific to the pattern of land use for the site. They intended to be protective of the following receptors – biota supporting ecological processes (microorganisms and soil invertebrates), flora and fauna (native and introduced), wildlife (secondary poisoning in birds and small rodents). Pets were ultimately excluded from the EIL derivation because it was ultimately assumed that the human investigation levels (HILs) will also protect pets (further, pets have restricted access to national park regions). The EILs and ESLs are also not applicable for agricultural soils, which need evaluation in relation to crop toxicity, plant contaminant uptake, and detailed consideration of soil type – see notes below re ‘production of food, flora and fibre’. The EILs and ESLs derived in the ASC NEPM also do not consider sediment runoff, leaching to groundwater or surface water, exposure to airborne contaminants, or aquatic ecosystems.
- In terms of the protection of human health, the assessment reporting and this audit adopted values from the prevailing Australian guidance, supplemented with international values where there were no applicable values in the Australian guidance. The assessment reporting and this audit have adopted health-based investigation indicators using Appendix A, Schedule B2 of the ASC NEPM as their primary source. The Auditor also considered some additional screening values for TPH and BTEX from CRC CARE Technical Report 10.
- For the environmental value ‘aesthetics’, the assessment reporting, the Auditor also referred to general guidance in Section 3.6 in Schedule B1 in the ASC NEPM.
- For the environmental value ‘buildings and structures’, the assessment reporting and this audit had regard for the objective that land is not to be corrosive or to otherwise adversely affect the integrity of building material and structures. Particular indicators for the Building and Structures environmental value include pH, sulfate, chloride, redox potential, salinity or any chemical substance or waste that may have a detrimental impact on the structural integrity of buildings or other structures. Section 6 of the *Australian Piling Code (AS2159-2009)* was referred to by the assessor as a general assessment of the presence of any other impacts that might potentially affect the integrity of buildings and structures.
- For the environmental value ‘production of food, flora and fibre’, the ERS objectives require that contamination of land must not adversely affect produce quality or yield, or affect the level of any indicator in food, flora and fibre produced at the site such that the level of that indicator is greater than that specified by the *Australia New Zealand Food Authority, Food Standards Code*. In this case the Auditor did not require any site-specific assessment because the land is not intended for food production.

The ASC NEPM notes investigation and screening levels are not clean-up or response levels, nor are they desirable soil quality criteria. They are intended to be used for assessing existing contamination, and trigger consideration of an appropriate site-specific risk-based approach or risk management options when exceeded. Clean up objectives for impacted land can be derived via a site-specific risk assessment, where appropriate, in accordance with the ASC NEPM.

The following table provides a review of the screening values adopted by Low Ecological Services for the soil assessment undertaken. The Auditor has commented on the screening values adopted by the consultant, with exceptions as noted below.

Table 8. Review of adopted screening criteria for soil results

Aspect	Approach adopted by assessment consultant	Auditor Comments
Background concentrations	<p>Metals:- A 'control sample' [sic] was collected to assess background concentrations of metals.</p> <p>Organics:- There was no consideration of background levels for organic chemicals, or the premise that detectable / ambient levels of organic (anthropogenic) chemicals are expected in soils. .</p>	<p>The consideration of background concentrations in the assessment reporting is not clearly documented, and cannot be considered to be in line with expectations in the current guidance.</p> <p>This is not a significant omission in the case of the organics such as TPH/BTEX which are the main contaminants of concern. Any detects of these above lab reporting limits are clearly above background. Regarding metals, there should be sufficient information available to make an informed interpretation of the likely background concentrations.</p>
General soil properties	<p>The assessment reporting did not collect the appropriate soil properties data / information for use in subsequent derivation of some of the soil screening levels.</p>	<p>The consideration of general soil properties in the assessment reporting is not clearly documented, and cannot be considered to be in line with expectations in the current guidance.</p> <p>This means that any EIL / ESL values being derived in future reporting will need to make some reasonable and conservative assumptions re soil properties. Ideally however, some additional site-specific data should be collected for future reporting / interpretation.</p>
Ecological investigation / screening levels	<p>The assessor referenced EILs / ESLs from the ASC NEPM, but did not clearly justify the applicability of the particular values adopted in the context of the site's location or the contaminants of interest. Review of the values in the summary tables indicates the assessment reporting adopted values for TPH/BTEXN based on urban residential and public open space, and values for fine grained soils.</p> <p>The report indicates the metals EIL values were adopted based on the same land use assumption (urban residential / public open space) and using the most conservative assumptions re soil properties in the absence of site-specific data.</p>	<p>The TPH/BTEXN ESLs adopted in the assessment reporting were reasonable. There is a more conservative land use assumption available for EILs and ESLs – areas of ecological significance. This covers particularly sensitive land areas including national parks. It is accepted that this is not realistic to be applied for the lodge area because of the degree of human impacts that have likely occurred so the urban residential use assumption is still reasonably conservative for land such as this which adjoins but is not on land designated as a national park.</p> <p>The rationale for the metals EILs listed in the assessment report tables is not as clear as they were always based on the most conservative assumed circumstances as indicated in the report text. Some of the values are not considered to have been based on appropriate and conservative assumptions – for example the values for copper and nickel in particular look questionable in the absence of site-specific data re soil properties.</p> <p>Ideally however, some additional site-specific data should be collected for future reporting / interpretation.</p>

Aspect	Approach adopted by assessment consultant	Auditor Comments
Health investigation levels	<p>The assessment reporting referenced the HILs and HSLs from the ASC NEPM as their primary source.</p> <p>There are some tables provided in the annexures of the most recent report from March 2022 which include values from CRC CARE Tech Report 10 and the ASC NEPM.</p> <p>The text in the report indicates values were adopted based on recreation / open space land use (HIL / HSL C values).</p>	<p>Re metals, the HILs adopted seem reasonable and applicable but they are not very clearly referenced or justified.</p> <p>Re petroleum hydrocarbons, the reporting has not clearly justified the applicability of the various HIL / HSL values adopted. It is difficult to follow the logic and rationale regarding this aspect of the reporting.</p>

Table 9. Review of adopted screening criteria for water results

Aspect	Approach adopted by assessment consultant	Auditor Comments
Background concentrations	Background groundwater samples were not collected.	<p>The absence of any consideration of background concentrations is not strictly in accordance with the approach to assessment of water quality advocated in the ASC NEPM and National Water Quality Management Strategy.</p> <p>For fuel related indicators TPH, BTEXN and MTBE the Auditor considers it would be appropriate to regard any detections above laboratory reporting limits as being above 'background concentrations'.</p> <p>For inorganics (metals, nutrients) further consideration would be warranted on a case by case basis for any results above any of the adopted screening values using available local and/or regional information.</p>
Groundwater screening values	<p>The following values were adopted by Tierra Environment for comparison of water analysis results: -</p> <ul style="list-style-type: none"> o Groundwater investigation levels (GILs) from the ASC NEPM for freshwater ecosystems. o For a Tier 1 risk assessment of vapour intrusion, health screening levels are provided in Schedule B1 of the ASC NEPM. The health screening levels (HSLs) considered most appropriate is "Groundwater HSL for Vapour Intrusion, HSL A/B, 4m to <8m, sand soils", on the basis of the most conservative soil type, the land use scenario and the depth to groundwater. 	<p>The reporting by Low Ecological did not consider this aspect in line with current guidance.</p> <p>The reporting by Tierra provided adequate justification for the rationale and applicability of the adopted screening values.</p> <p>Tierra used an approach based on the ASC NEPM and National Water Quality Management strategy (NWQMS). They considered current and realistic future uses / values of the water body (in this case the Finke River). Although no specific values have been assigned under NT legislation, the general uses / values that might be expected to be applicable for this water body might include:-</p> <ul style="list-style-type: none"> o Freshwater ecosystems. Primary source / reference for screening values – ASC NEPM and the Australian and New Zealand Guidelines for fresh and marine water quality. The Auditor is in agreeance with Tierra Environment for the consideration of 99% default species protection for unmodified ecosystems. o Health and aesthetic guideline values provided in Table 10.6 of the 2011 Australian Drinking Water Guidelines (ADWG). <p>The auditors has also given consideration to the following:-</p>

Aspect	Approach adopted by assessment consultant	Auditor Comments
		<ul style="list-style-type: none"> ○ Recreational water. Primary source / reference for screening values - GMRRW-NHMRC (2008) <i>Guidelines for Managing Risks in Recreational Water</i>. <p>As noted earlier in this audit report, the Tjoritja / West MacDonnell National Park Joint Management Plan provides an overview of the significance of the Park and its values in terms of three broad categories – culture, country and tourism. With regard to water resources, the permanent and semipermanent waterholes and groundwater in the Park support a significant percentage of the aquatic and terrestrial diversity in the region, and were and continue to be invaluable in terms of cultural importance to Traditional Owners.</p> <p>The various sources of screening values above should be sufficient to allow for an assessment of water quality for initial screening purposes, noting that potential threats to the cultural values of water will warrant a more nuanced and holistic qualitative assessment.</p>

Table 10. Review of adopted screening criteria for soil vapour results

Aspect	Approach adopted by assessment consultant	Auditor Comments
Soil Vapour Screening Values	<p>The following values were used for comparison of soil vapour results: -</p> <ul style="list-style-type: none"> ○ Petroleum hydrocarbon health screening levels (HSLs) for the vapour intrusion pathway from the ASC NEPM. Values adopted were for clay soils and for a source 0-1m depth. Receptors / land use scenarios considered included public open space and intrusive maintenance workers. 	<p>The rationale and justification of the adopted screening values is not considered sufficient and doesn't cover all potential exposure scenarios and receptors of potential concern.</p> <p>It is agreed that intrusive maintenance workers were worthy of consideration, however the open space areas are not so critical in comparison to potential vapour intrusion exposures for occupants of the lodge buildings near the former fuel tanks. On this basis HSLs for occupants of nearby buildings should also have been considered in the assessment of the soil vapour survey results, with the most applicable exposure setting being commercial / industrial land use.</p>

The following table provides a selection of the ecological and health-based investigation levels adopted by the auditor for the main contaminants of interest at the Site.

Table 11. Screening Criteria for Main Contaminants of Interest in Soil

Screening values	Ecological investigation and screening levels	Health investigation and screening levels			
		Residential A. Residential with garden / accessible soil (<10% intake of fruit and vegetables from home grown produce, no poultry)	Residential B. Residential with minimal opportunity for soil access (including apartments)	HIL C Public open space such as parks, playgrounds, playing fields, secondary schools and footpaths	Commercial / industrial D
Land use category	'Urban residential and public open space'				
Default source (unless alternative values are adopted)	NEPM EIL and ESL Values ¹	NEPM HIL A ²	NEPM HIL B ²	NEPM HIL C ²	NEPM HIL D ²
Metals / metalloids					
Arsenic	100	100	500	300	3,000
Cadmium	-	20	150	90	900
Chromium (III)	220 ³	-	-	-	-
Chromium (VI)	-	100	500	300	3,600
Copper	80 ³	6,000	30,000	17,000	240,000
Lead	1,100	300	1,200	600	1,500
Nickel	75 ³	400	1,200	1,200	6,000
Zinc	190 ³	7,400	60,000	30,000	400,000
TPH / BTEX					
C6-C10 TPH	180	50	50	NL	310
>C10-C16 TPH	120	280	280	NL	NL
>C16-C34 TPH	1,300	4,500	5,800	5,300	27,000
>C34-C40 TPH	5,600	6,300	8,100	7,400	38,000
Benzene	65	0.7	0.7	NL	4
Toluene	105	480	480	NL	NL
Ethyl benzene	125	NL	NL	NL	NL
Xylenes	45	110	110	NL	230
Naphthalene	170	5	5	NL	NL
Total PAHs	See note 4 below	300	400	300	4,000
Benzo(a)pyrene	20	-	-	-	-
B(a)P TEQ	-	3	4	3	40

Unless specified otherwise, all values are in milligrams per kilogram (mg/kg). NL denotes non-limiting.

1. Refer Tables 1 B(1) to 1 B(7) in Schedule B(1) of the ASC NEPM. All values assume aged (not fresh) contamination in soil.
2. Refer Tables 1 A(1) to 1 A(3) in Schedule B(1) of the ASC NEPM. For TPH / BTEX, HSLs for volatile fractions were sourced from the ASC NEPM, vapour intrusion HSLs using the most conservative assumptions re exposure and soil properties i.e. building with source in soil 0-1m depth, and clay soil. For the non-volatile fractions (>C16 TPH), the health screening values were the HSLs for direct contact as listed in CRC CARE Technical Report10 (again assuming a clay soil).
3. The consultant adopted generic EILs and ESLs for arsenic, lead, DDT, naphthalene, benzene, toluene, ethyl benzene, xylene and benzo(a)pyrene, applicable to residential land use (as per Tables 1B(4), 1B(5) and 1B(6) of Schedule B1 of the ASC NEPM.
4. There is more recent information that represents the current state of knowledge in relation to benzo(a)pyrene and PAHs in soils. According to CRC CARE Technical Report 39¹¹, the ESLs in the ASC NEPM for benzo(a)pyrene (1.4 mg/kg for both coarse and fine textured soils) are based on an older set of Canadian soil quality guidelines, which have been subsequently revised. This Technical Report developed a higher reliability ESL of 20 mg/kg for BaP in urban residential and public open space areas. This value was developed using additional and more recent information following the NEPM methodology, whilst also assuming (conservatively)

¹¹ CRC CARE 2017, Risk-based management and remediation guidance for benzo(a)pyrene, CRC CARE Technical Report no. 39, CRC for Contamination Assessment and Remediation of the Environment, Newcastle, Australia.

the contamination is 'fresh' and not taking into account changing bioavailability associated with ageing and organic carbon content in soil. The derived screening levels are considered to be conservative and of higher reliability compared to the current NEPM values. The Technical Report notes the higher reliability ESL values are more than an order of magnitude greater than the ESLs previously listed in the NEPM, and more generally accord with the revised Canadian guideline levels. In the case of urban land, the revised ESLs are considerably higher than the corresponding HSLs, and are not likely to determine the requirements for remediation. This audit has not adopted any ecological screening values for BaP, but has considered any results above health based screening values would also likely be indicative of potential adverse ecological effects. This is still considered to be conservative and reflective of the current state of knowledge.

Table 12. Auditor Screening Criteria – Soil Health Screening Levels for Direct Contact

Chemical	Health based screening levels for direct contact exposure (where relevant)				
	HSL-A (low density residential)	HSL-B (high density residential)	HSL-C (recreation / open space)	HSL-D (commercial / industrial)	Intrusive maintenance worker – shallow trench
Benzene	100	140	120	430	1,100
Toluene	14,000	21,000	18,000	99,000	120,000
Ethylbenzene	4,500	5,900	5,300	27,000	85,000
Xylenes	12,000	17,000	15,000	81,000	130,000
Naphthalene	1,400	2,200	1,900	11,000	29,000
TPH C6-C10	4,400	5,600	5,100	26,000	82,000
TPH >C10-C16	3,300	4,200	3,800	20,000	62,000
TPH >C16-C34	4,500	5,800	5,300	27,000	85,000
TPH>C34-C40	6,300	8,100	7,400	38,000	120,000

Source:- Health screening levels for petroleum hydrocarbons in soil and groundwater (CRC CARE Tech Report 10, Authors – Friebe & Nadebaum, 2011)
Unless specified otherwise, all values are in milligrams per kilogram (mg/kg).

Table 13. Auditor Screening Criteria – Management Limits for TPH fractions F1 -F4 in Soil

TPH fraction	Soil texture	Management Limits (mg/kg dry soil) ¹	
		Residential, parkland and public open space	Commercial and industrial
F12 C6- C10	Fine	800	800
F22 >C10-C16	Fine	1,000	1,000
F3 >C16-C34	Fine	3,500	3,500
F4 >C34-C40	Fine	10,000	10,000

Source:- ASC NEPM, Schedule B1, Table 1 B(7).

1 Management limits are applied after consideration of relevant ESLs and HSLs

2 Separate management limits for BTEX and naphthalene are not available hence these should not be subtracted from the relevant fractions to obtain F1 and F2.

5.2 Groundwater

Groundwater results collected by Tierra Environmental were compared with the indicators for groundwater are primarily derived from the current ANZG, ANZECC and NHMRC documents, and are referenced as follows:

- Water dependent ecosystems and species: ANZG (2018) Australian and New Zealand Guidelines for Fresh and Marine Water Quality. The nearest waterway where groundwater in the locality could in theory discharge is the Finke River, namely the Glen Helen Gorge waterhole. Based on the location of the Glen Helen Gorge (within a National Park and is within an area of International Conservational Significance, the water quality criteria is to be based on 99% level species protection (high conservation or ecological value systems).
- Potable water. Australian drinking water guidelines. Latest available version.
- Potable mineral water supply: Australian drinking water guidelines. Latest available version.

- Agriculture and irrigation (Stock watering): ANZECC & ARMCANZ (2000) guidance for livestock drinking water, with drinking water guidelines used in the absence of stock water criteria.
- Agriculture and irrigation (Irrigation): ANZECC & ARMCANZ (2000) guidance, with long term trigger values used where specified.
- Industrial and commercial: Indicators under this environmental value are specific to the particular industrial or commercial activity and their use of water. The Auditor has made an assessment, based on professional judgement, of the uses that might be supported by the background water quality and the suitability of the groundwater for other uses (noting it would likely be suitable for a wide variety of industrial uses on the proviso other beneficial uses are not precluded by the water quality).
- Water-based recreation (primary contact recreation). The Victorian ERS indicates that the risk-based approach recommended in Guidelines for Managing Risks in Recreational Water (NHMRC, 2008 most recently updated September 2022) should be applied for the environmental quality indicators and objectives for this beneficial use of groundwater. This guideline notes that waters contaminated with chemicals that are either toxic or irritating to the skin or mucous membranes are unsuitable for recreational purposes and advocates a simple screening approach where “a substance occurring in recreational water at a concentration of 10 times that stipulated in the drinking water guidelines may merit further consideration”. The Auditor adopted screening values of 10 x potable criteria for the majority of analytes but retained the potable screening values for some organics to account for uncertainty in dermal absorption, or where an aesthetic / odour-based threshold applied. In addition, some values were adopted based on advice from EPA, where discrepancies exist between the ANZECC 1992 values and more recent criteria. The Auditor also had regard for guidance in the NHMRC 2008 document in relation to aesthetic aspects of recreational water (“the water should be free from visible materials that may settle to form objectionable deposits including floating debris, oil, scum and other matter, substances producing objectionable colour, odour, taste, or turbidity, and substances and conditions that produce undesirable aquatic life”). The undesirable aquatic life referred to include toxic algal blooms and cyanobacteria, primarily caused by eutrophication (nutrient enrichment). The Auditor agreed with the majority of values adopted by the assessor who took over the reporting on water assessment (Tierra Environments).
- Traditional Owner Cultural Values and Cultural and Spiritual Values: Consistent with the approach outlined in the ERS, this audit has considered whether the site is in proximity to any areas of cultural heritage sensitivity, referring to the Tjoritja / West MacDonnell National Park Joint Management Plan which indicates surface and groundwater within the Park have and continue to be invaluable in terms of cultural importance to Traditional Owners. If a culturally sensitive area was found to be under threat from contamination derived from the audit site, then the auditor would require the proponent to engage with Traditional Owners to determine an appropriate and mutually acceptable response and management strategy. In this case the audit site is not within or close proximity to any such sensitive area based on the above source.
- Buildings and structures: indicators of pH, sulphate, chloride, redox potential, salinity, pH any chemical substance or waste that may have a detrimental impact on the structural integrity of buildings or other structures. Results were considered with regard to Section

6 of the Australian Piling Code (AS2159) for groundwater conditions and potential adverse effects on buildings and structures.

- o Geothermal properties: The objectives for the purposes of geothermal use that no activity must affect the geothermal properties of groundwater and the specific indicators include temperatures between 30 and 70 degrees Celsius.

Table 14: Auditor Screening Criteria for Main Contaminants of Interest in Groundwater

Beneficial Uses	Water Dependent Ecosystems (Freshwater)	Potable	Agr & Irr (Irrigation)	Agr & Irr (Stock)	Water Based Recreation (Primary Contact Recreation) ***
Lead	1	10	2,000	100	100
Benzene	600	1	-	1	10
Toluene	110	25 (aesthetics)	-	800	25 **
Ethyl Benzene	50	3 (aesthetics)	-	300	3 **
Xylenes***	50	20 (aesthetics)	-	600	20 **
TPH C10-C36 ****	600	600	600	600	600
Naphthalene	2.5				
Methyl tert-butyl ether (MTBE) [^]	23,000 ^{^^}	15	15	15	15

Unless specified otherwise, all results are in micrograms per litre (µg/L).

** Primary contact recreation screening criteria for TEX were sourced from the aesthetics-based guideline values from the Australian Drinking Water Guidelines (NHMRC, 2011)

*** default guideline for m-xylene (most conservative of m-xylene, o-xylene and p-xylene default guidelines).

**** TPH criteria. In the absence of Australian criteria, the >C10 TPH criteria adopted for this audit are based on the intervention value for mineral oil in groundwater as specified in the Netherlands (2009) Circular on Target Values and Intervention Values, Spatial Planning and the Environment (0.6mg/L or 600ug/L). This value has been adopted by Victorian EPA in recent clean up to extent practicable (CUTEP) determinations (under the Environment Protection Act 1970) and reiterated in advice to the auditor that these are the values considered applicable by EPA for assessment of groundwater pollution by TPH. For < C10 TPH fractions, the Auditor has had regard for WHO (2008)¹² which concluded it was not appropriate to set formal health-based guidelines for TPH / TRH fractions in drinking water due to the fact that taste and odour will in most cases be detectable at concentrations below those of concern with respect to health, and that there are specific guidelines for those constituents in petroleum mixtures that are commonly the main risk drivers (e.g. benzene and to a lesser degree TEX).

[^] Screening criteria for MTBE were taken from 'Guidance for the assessment, remediation and management of MTBE' (CRC CARE Technical Report 36, Dec 2016).

^{^^} Freshwater protection 99%protection level, considered to be appropriate for waters of high ecological value (e.g. world heritage areas).

5.3 Soil Vapour (Volatile Organic Compounds)

The following sources were used for screening values for volatile fuel related chemicals.

- o Groundwater. Measured groundwater concentrations were compared against vapour intrusion health screening levels in Schedule B1 of NEPM 1999 (as amended) health screening levels (HSL) for TPH, BTEX and naphthalene. Tierra's groundwater assessment report adopted screening values based on groundwater depth of 4m to <8m, sand soils, and a sensitive land use scenario (HSL A/B). The Auditor considers that whilst the assumptions re soil type and depth to groundwater were reasonable, use of HSL A/B values was not consistent with the land use scenarios at the site. It would have been more appropriate to adopt the vapour intrusion HSL based on a commercial / industrial land use scenario (HSL D), and adopted those values instead.

¹² *Petroleum products in drinking water*. Background document for development of WHO Guidelines for Drinking Water Quality. WHO, 2008.

- Soil vapour. The reporting of the soil investigations and soil vapour monitoring by Low Ecological did not adequately explain or justify screening values applicable for interpreting the soil vapour results generated from the passive diffusion samplers deployed as part of the investigation. The Auditor has compared measured soil vapour concentrations against vapour intrusion health screening levels in Schedule B1 of NEPM 1999 (as amended) health screening levels (HSL) for TPH, BTEX and naphthalene. Various values were considered for different scenarios including occupants of buildings, and intrusive e maintenance workers.

The vapour intrusion HSLs have been derived using current accepted air quality guidelines and using an attenuation factor (AF) of 0.005 from subsurface vapour to indoor air (Friebel and Nadebaum, 2011)¹³.

¹³ Friebel, E. & Nadebaum, P. 2011. *Health screening levels for petroleum hydrocarbons in soil and groundwater. Part 1: Technical development document*, CRC CARE Technical Report no. 10., CRC for Contamination Assessment and Remediation of the Environment, Adelaide, Australia.

6. REVIEW OF ASSESSMENT AND CLEAN UP WORKS

6.1 Overall Scope / Timing of Works

This section provides a summary of the assessment and remediation works completed along with the Auditor's review of the quality and completeness of the works.

Works undertaken by Low Ecological Services 2021 - 2023

- February 2021. Advancement of six soil bores around the two underground storage tanks. The report indicates the bores were drilled by hand auger methods and were extended to approximately 3m depth, where refusal was encountered on what was believed to be bedrock.
- March 2021. Contractors removed the underground storage tanks (USTs) and associated pipework. Low Ecological collected validation samples from the base and walls of the excavated pits following removal of the tanks. Samples of the stockpiled soils were also collected for the purpose of classification for re-use or disposal.
- April 2021. Further soil borings completed in areas surrounding the former tanks / bowsers. Advancement of eight soil bores (H1-H8) in the areas around the former tank pits and targeting interpreted surface water drainage paths from the tank areas. Two additional samples were collected, one inside the wall of the backfilled petrol / Opal pit (P2 – 0.1), and one inside the wall of the backfilled diesel pit (D3 – 0.1).
- September 2021. Water samples collected from the banks of the Finke River adjacent to the site. Soil vapour survey (SV1 – SV6) completed in vicinity of the former tanks / bowsers, and the nearest buildings to the former tanks / bowsers. Further sampling / analyses of excavated soils completed to determine applicable classifications for off-site disposal.
- May 2022. Groundwater monitoring bores were installed. Subsequent groundwater monitoring was undertaken (August and November 2022), however due to factors including inadequate development of the monitoring bores prior to sampling, the results of sampling was considered unreliable and were not likely to be representative of the actual groundwater conditions.

Some of the more heavily contaminated soils were transported to Alice Springs for temporary storage. Some of those soils were eventually transported to Adelaide for disposal at an appropriately licensed facility, with the remainder disposed at the Alice Springs council's landfill. Other less contaminated soils were used to reinstate the tank excavations, supplemented by clean imported materials. Further details are provided in the following sections.

Tierra Environmental

- May 2023. Tierra attended the site, attempted to locate the groundwater monitoring bores (locating 3 of the 4 bores), redeveloped and sampled the bores, and also collected a surface water samples within the Finke River up and down-stream of the former UST locations.

Further details are provided in the following tables, with further discussion of results provided in the following sections.

Table 15. Sampling and Analysis Program (Soil)

Date / Assessor	Report reference	Summary of work / Scope	Analysis undertaken	Summary of results
February 2021 Low Ecological Services Pty Ltd	'Preliminary Site Investigation for Fuel Leakage from UPSSs' (Low Ecological, February 2021).	Advancement of six soil bores around the two underground storage tanks in use at the time - diesel UST (G1, G2, G3); and - petrol / Opal tank (G4, G5, G6). The works are documented in the report. The report indicates the bores were drilled by hand auger methods and were extended to approximately 3m depth, where refusal was encountered on what was believed to be bedrock. Field screening for volatiles was conducted using a photoionisation detector (PID) and samples of soils were collected and submitted for laboratory analyses.	Samples were analysed for a suite of metals, total petroleum hydrocarbons (TPH), benzene, toluene, ethylbenzene and xylenes (BTEX) and polycyclic aromatic hydrocarbons (PAHs).	Fuel related impacts were evident in all bores drilled, with elevated PID readings reported in the field, and elevated TPH/BTEX results reported in lab analyses. Maximum reported results are noted below:- <ul style="list-style-type: none"> Diesel tank area (bores G1-G3). C6-C10 TPH minus BTEX (582mg/kg), >C10-C16 TPH (21,000mg/kg), (no difference for this fraction minus naphthalene), >C16-C34 TPH (39,200mg/kg), benzene <0.2mg/kg, toluene (7mg/kg), ethyl benzene (8mg/kg), xylenes (44mg/kg). Petrol / Opal tank area (bores G4-G6). C6-C10 TPH minus BTEX (1,930mg/kg), >C10-C16 TPH (550mg/kg), (no difference for this fraction minus naphthalene), >C16-C34 TPH (<100mg/kg), benzene (0.9mg/kg), toluene (12mg/kg), ethyl benzene (17mg/kg), xylenes (49mg/kg).
March 2021 Low Ecological Services Pty Ltd	Underground Petroleum Storage Systems Fuel Contamination Investigation and Remediation Report (Low Ecological, March 2022).	Validation samples were collected from the base and walls of the excavated pits following removal of the tanks of the opal, diesel and old petrol UST excavations following the removal of the USTs and associated infrastructure. Stockpiled soil samples were collected for the purpose of classifying and determining appropriate disposal (samples analysed for TPH, BTEX, naphthalene, metals). A 'control sample [sic]' (more commonly referred to as a background sample) was also collected from a location remote from the UST area to assess background concentrations of metals in soils. (Samples – B1, B3, B5, B7, B9, B13, B15, B10, D11, D17, P29, P31, BP13, P11, P13, P14, P17, Control 100m north).	Validation samples Analysed for TPH, BTEX, naphthalene, metals ¹⁴ . Stockpile samples analysed for TPH, BTEX, naphthalene, metals. Background sample Analysed for metals.	Fuel related impacts were evident in the samples collected from the diesel UST pit, petrol / Opal UST pit, and some of the stockpiled samples, with elevated PID readings reported in the field, and elevated TPH/BTEX results reported in lab analyses. Maximum results were reported in the samples collected from beneath the base of the respective tank pits and are summarized below:- <ul style="list-style-type: none"> Diesel tank area. C6-C10 TPH minus BTEX (370mg/kg), >C10-C16 TPH (14,900mg/kg)(no difference for this fraction minus naphthalene), >C16-C34 TPH (13,100mg/kg), benzene <0.2mg/kg, toluene (7mg/kg), ethyl benzene (7mg/kg), xylenes (37mg/kg). Petrol / Opal tank area. C6-C10 TPH minus BTEX (569mg/kg), >C10-C16 TPH (270mg/kg), (no difference for this fraction minus naphthalene), >C16-C34 TPH (<100mg/kg), benzene (0.2mg/kg), toluene (5mg/kg), ethyl benzene (5mg/kg), xylenes (13mg/kg). Redundant petrol tank ('old petrol tank'). No detects of TPH / BTEX reported. Elevated results were also reported in some of the stockpiled samples. Maximum reported results are summarized below:- <ul style="list-style-type: none"> C6-C10 TPH minus BTEX (415mg/kg), >C10-C16 TPH (15,800mg/kg), (no difference for this fraction minus naphthalene), >C16-C34 TPH (11,000mg/kg), benzene <0.2mg/kg, toluene (1.4mg/kg), ethyl benzene (1.8mg/kg), xylenes (17mg/kg).
April 2021 Low Ecological Services Pty Ltd	Underground Petroleum Storage Systems Fuel Contamination Investigation and Remediation Report (Low Ecological, March 2022).	Eight Geoprobe cores (H1 to H8) were advanced around the parking area, mainly along a surface / stormwater drainage path, to the south of the diesel UST and two shallow samples from the backfilled opal and diesel pits. (Samples – D3 – 0.1m, P2-0.1m, H1-2.3m, H2-2.6m, H3-0.0m, H3-2.2-2.7m, H4-1.0m, H5-3.0m, H6-0.0m, H6-2.0m, H7-2.0m, H8-1.0m).	12 samples were analysed for TPH and BTEXN.	Significant TPH impacts were reported in the sample from the diesel pit wall, and trace detects in the sample taken from the petrol / Opal tank pit wall. No detects of TPH/BTEX were reported in the samples from the other 8 soil bores. Maximum results reported are noted below:- <ul style="list-style-type: none"> Diesel tank area (pit wall sample D3 – 0.1). C6-C10 TPH minus BTEX (660mg/kg), >C10-C16 TPH (32,000mg/kg), (no difference for this fraction minus naphthalene), >C16-C34 TPH (30,500mg/kg), benzene <0.2mg/kg, toluene (2mg/kg), ethylbenzene (5mg/kg), xylenes (36mg/kg). Petrol / Opal tank area (pit wall sample P2 – 0.1). C6-C10 TPH minus BTEX (42mg/kg), >C10-C16 TPH (110mg/kg), (no difference for this fraction minus naphthalene), >C16-C34 TPH (<100mg/kg), BTEX results were all below the lab reporting limit. While the sample nomenclature suggests that D3-0.1 and P2-0.1 were collected at a depth of approximately 0.1m, however clarification provided by LES indicates that the sample was collected from a depth from between 1.5m to 3.5m. A copy of the email response from LES, dated 23 November 2023 is presented in Appendix J. LES further reported in clarification correspondence that soils from the pit walls in the location of the elevated samples were further excavated and moved to the soil storage area for offsite disposal. As further validation samples were not reported to have been collected following the additional impacted soil chasing and excavation from the pits, sample D3-0.1 must be considered as indicative of concentrations that remain onsite.

¹⁴ Metals suite was for 8 priority metals – arsenic, cadmium, chromium, copper, lead, mercury, nickel, zinc.

Date / Assessor	Report reference	Summary of work / Scope	Analysis undertaken	Summary of results
<p>May 2022</p> <p>Low Ecological Services Pty Ltd</p>	<p><i>Fuel Contamination from Underground Petroleum Storage System: A Progress Update Report</i> (Low Ecological, report received November 2023).</p>	<p>Advancement of four groundwater monitoring bores (MW01 to MW04).</p> <p>Soil samples collected for analysis and PID field readings obtained at nominated depths.</p>	<p>Ten soil bore samples were submitted for the following analysis:-</p> <ul style="list-style-type: none"> ○ Metals²² ○ TPH / TRH ○ BTEXN <p>One sample (MW4-6m) underwent additional PAH analysis.</p>	<p>PID field readings were collected during bore advancement. The highest field results were reported at MW1 (located within the diesel tank pit) at a depth of 6m (607ppm) and MW2 (within the former Opal tank pit at 6m (792ppm). Fill was encountered in the tank pits to a depth of approximately 3m. Petroleum hydrocarbon concentrations were below LOR at the four locations, except MW1-6m where TRH>C10 – C40 concentrations were reported as 1,060mg/kg. BTEXN concentrations were below LOR. PAH concentrations were reported below LOR at MW4-6m.</p> <p>While borelogs were not provided by LES, a monitoring well installation summary was present within section 3.1.1 of the November 2023 report, reproduced as follows:-</p> <p>DH1/MW1</p> <ul style="list-style-type: none"> ○ Rocky Layer 3-6m bgl ○ Bedrock 4.9m bgl ○ Groundwater depth 14m bgl ○ Depth of well 19m ○ 6m long perforated screen pipe installed at bottom of well ○ Bottom bentonite plug installed at 19m bgl ○ Mid-section bentonite plug installed ~9m bgl <p>DH2/MW2</p> <ul style="list-style-type: none"> ○ Rocky layer 3-6m bgl ○ Groundwater depth 13m bgl ○ Depth of well 15m ○ 6m long perforated screen pipe installed at bottom of well ○ Bottom bentonite plug installed at 15m bgl ○ Mid-section bentonite plug installed ~9m bgl <p>DH3/MW3</p> <ul style="list-style-type: none"> ○ Rocky layer 3-6m bgl ○ Groundwater depth 14m bgl ○ Depth of well 15m ○ 3m long perforated screen pipe installed at bottom of well ○ Bottom bentonite plug installed at 15m bgl ○ Mid-section bentonite plug installed ~9m bgl <p>DH4/MW4</p> <ul style="list-style-type: none"> ○ Rocky layer 3-6m bgl ○ Groundwater depth 19.3m bgl ○ Depth of well 19.5m ○ 3m long perforated screen pipe installed at bottom of well ○ Bottom bentonite plug installed at 19.5m bgl ○ Mid-section bentonite plug installed ~9m bgl

PAH = polycyclic aromatic hydrocarbons

TRH = total recoverable hydrocarbons

BTEXN= benzene, toluene, ethyl benzene, xylenes, naphthalene

metals = (As, Cd, Cr, Cu, Pb, Hg, Ni and Zn).

Table 16: Sampling and Analysis Program (Groundwater / Water)

Date / Assessor	Report reference	Summary of work / Scope	Analysis undertaken	Summary of results	Reliability of data obtained
September 2021 Low Ecological Services Pty Ltd	<i>Underground Petroleum Storage Systems Fuel Contamination Investigation and Remediation Report</i> (Low Ecological, March 2022).	Sampling water from four holes (W1-W4) and water standpipes dug into the bank of the Finke River. Samples were reportedly collected in the following locations: <ul style="list-style-type: none"> o W1 (2.8m back from water edge in sand. 270 mm bgl). o W2 (2.1m back from water edge in sand. 370 mm bgl). o W3 (3.8m back from water edge in sand. 400 mm bgl). o W4 (1.3m back from water edge in sand. 250 mm bgl). 	Four samples analysed for TPH / BTEXN.	TPH and BTEXN concentrations were reported below LOR. Low Ecological reported no staining or contamination odour within sands or surface water.	Data considered reliable for consideration in this report.
15 November 2022		Groundwater monitoring wells MW01 to MW04. Samples collected via disposable bailer.	Four samples analysed for lead, TRH and BTEXN.	Field notes indicate that samples were highly turbid on collection. Naphthalene concentrations were reported below LOR in samples MW1, MW3 and MW4 and 6µg/L at MW2. BTEX concentrations were below LOR, with the exception of benzene concentrations of 4µg/L and ethylbenzene concentrations of 2µg/L at MW2 and toluene concentrations of 3µg/L as MW4. Concentrations of TRH C6 – C9 were reported between 30µg/L (MW3) and 740µg/L (MW4).	Data and information obtained indicates that groundwater monitoring wells were not adequately developed prior to sampling. Low Ecological subsequently completed two rounds of groundwater monitoring via bailing (September and December 2022). The methods adopted raised uncertainty as to the validity of the results obtained. In addition, factors such as the sample blank showing no petroleum impact, while the primary sample indicated detections, photographs showing the turbidity of the sampled water column within the bailers and issues with decanting groundwater from the bailer into sampling containers, resulted in the sample results of the September and December 2022 monitoring events not being considered further for the purposes of the audit.
13 December 2022		Groundwater monitoring wells MW01 to MW04. Samples collected via disposable bailer.	Four samples analysed for lead, TRH and BTEXN.	Field notes indicate that samples were highly turbid on collection. Naphthalene concentrations were reported below LOR in samples MW1, MW3 and MW4 and 6µg/L at MW2. BTEX concentrations were below LOR, with the exception of benzene concentrations of 2µg/L. Concentrations of TRH C6 – C9 were reported from below LOR (MW1) and 60µg/L (MW2). TRH C10 – C36 ranged between below LOR (MW1) and 250µg/L (MW2).	
29 May 2023 Tierra Environmental Pty Ltd	<i>Glen Helen Discovery Park Groundwater Monitoring Event May 2023</i> (Tierra Environmental, July 2023).	Development of the groundwater monitoring wells.	-	All monitoring wells were buried under a layer of crushed rock, with Tierra Environmental using past photographs to dig and locate the monitoring wells. MW02 was unable to be located at this time. The monitoring well installation was found not to have not been completed with flush gatic covers or metal standpipes. Significant sediment load was reportedly removed from MW01 and MW03 in particular. During development fuel odours and sheen were not observed. The odour in the first 10L of MW4 was a rotten odour similar to rotting organic matter and not fuel or decomposed fuel.	Data considered reliable for consideration in this report.
31 May 2023 Tierra Environmental Pty Ltd	<i>Glen Helen Discovery Park Groundwater Monitoring Event May 2023</i> (Tierra Environmental, July 2023).	Gauging and groundwater sampling of three wells (MW01, MW03 and MW04). Sampling was undertaken using low flow sampling (MW04) and bailing (MW01 and MW03). The report indicates the sampling method was changed to bailing due to malfunction of the low flow pump after sampling at MW4 had been completed. Groundwater parameters (pH, DO, redox potential, temperature and EC) were recorded at time of sampling with a calibrated water quality meter.	Three samples analysed for lead, TRH, BTEX and MTBE	Depth to groundwater ranged between 5.26m (MW4) and 6.13m (MW1). Groundwater contours indicated groundwater flow to the south / southwest towards the Finke River. Concentrations of TRH, BTEX and MTBE were reported below LOR in all three sampled wells. Lead was detected in all wells (0.010 mg/L in MW1, 0.056 mg/L in MW3, 0.002 mg/L in MW4). The results were above the adopted screening value of 0.001 mg/L (ANZG 99% freshwater ecosystems). MW3 also exceeded the ADWG of 0.010 mg/L. The Auditor notes the highest results were reported in the samples from MW1 and MW3 which were the samples collected via bailer. Those results were notably different from the result from MW4 collected via low flow sampling, suggesting some possibility of influence from the sampling method.	Data considered reliable for consideration in this report.
31 May 2023 Tierra Environmental Pty Ltd	<i>Glen Helen Discovery Park Groundwater Monitoring Event May 2023</i> (Tierra Environmental, July 2023).	Collection of two surface water samples, FR1 (up-stream of the former tank pits) and FR2 (down-stream of the former tank pits).	Two samples analysed for lead, TRH, BTEX and MTBE	Samples were collected were reported as colourless and clear with no odour or sheen. All concentrations were below LOR.	Data considered reliable for consideration in this report.

TRH = total recoverable hydrocarbons

BTEX = benzene, toluene, ethyl benzene and xylenes

MTBE = Methyl tert-butyl ether

Table 17: Sampling and Analysis Program (Soil Vapour)

Date / Assessor	Report reference	Summary of work / Scope	Analysis undertaken	Summary of results
September 2021 Low Ecological Services Pty Ltd	<i>Underground Petroleum Storage Systems Fuel Contamination Investigation and Remediation Report</i> (Low Ecological, March 2022).	<p>Installation of passive diffusion samplers (Waterloo WMS-LU type) to a reported depth of 1.5m, deployed in soil bores at six locations (SV1-SV6).</p> <p>The locations included the backfilled former tank pits for the diesel UST (SV1) and petrol / Opal UST (SV4), plus four other locations between the tank pits and the closest buildings associated with the lodge.</p> <p>The samplers were retrieved seven days after deployment.</p>	Six samples analysed for TRH and BTEXN.	<p>Detects of BTEX and TPH volatile fractions were reported in most samples, but the reported results were below screening criteria that Low Ecological had adopted for their assessment. The highest results reported were in the samples from the diesel tank pit and petrol / Opal tank pit and are summarized below:-</p> <ul style="list-style-type: none"> ○ Diesel tank pit (location SV1). C6-C10 TPH minus BTEX (46mg/m³), >C10-C16 TPH (120mg/m³), (no difference for this fraction minus naphthalene, benzene <0.007mg/m³), toluene (0.067mg/m³), ethyl benzene (0.051mg/m³), xylenes (0.52mg/m³). ○ Petrol / Opal tank pit (location SV4). C6-C10 TPH minus BTEX (1,800mg/m³), >C10-C16 TPH (550mg/m³), (no difference for this fraction minus naphthalene, benzene 0.016mg/m³), toluene (0.008mg/m³), ethyl benzene (<0.004mg/m³), xylenes (<0.013mg/m³).

TRH = total recoverable hydrocarbons

BTEXN = benzene, toluene, ethyl benzene, xylenes, and naphthalene

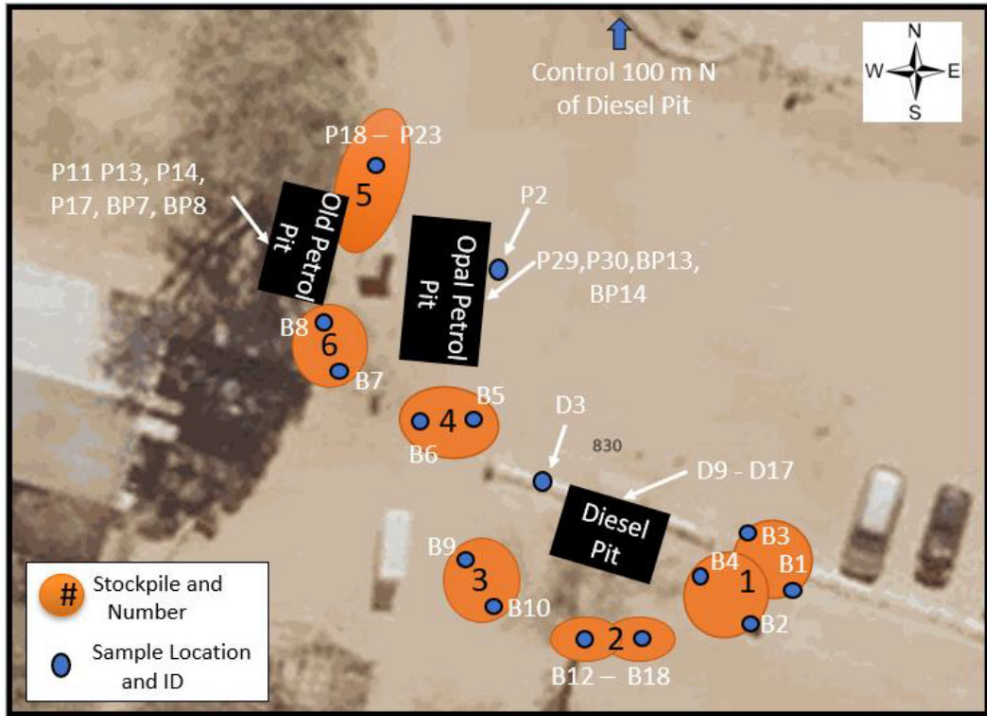


Figure 10. Test Locations – UST Removal Works, March 2021 (Low Ecological, 2022)

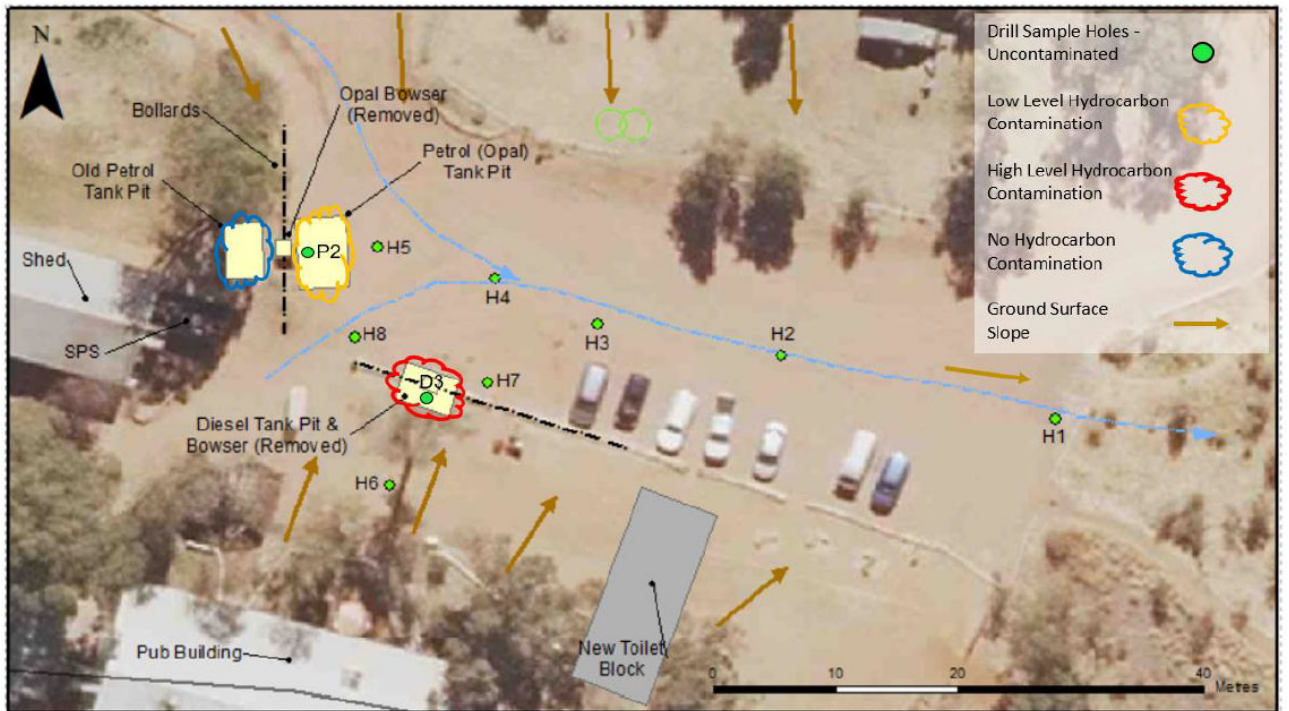


Figure 11. Test Locations – Further Soil Assessment, April 2021 (Low Ecological, 2021)



Figure 12. Test Locations – Soil vapour bores and surface water samples, September 2021 (Low Ecological, 2022)



Figure 13. Test Locations – Groundwater bore locations (Low Ecological, 2022)

6.2 Soil Assessment and Remediation

General Soil Conditions and Lithology

Reasonably consistent observation of the lithology was documented through the various phases of investigations and were consistent with the desktop geological findings. The soil profile encountered comprised alluvial silty sands and reworked natural soils filling the tank pit locations. A thin layer of limestone gravels was reported within the opal tank pit by Low Ecological at a depth of 1.8m. Rock reportedly was encountered from a depth of between 2.4 m and 4.9 m.

While bore logs produced to a standard generally consistent with current guidelines and standards including the ASC NEPM (Amendment 2013) and AS4482.1-2005 could not be obtained from LES, general drilling information was provided. Hydrocarbon impacts were evident in bores MW1 (diesel tank pit) and MW2 (petrol / Opal tank pit) and extended to approximately 6-7m depth. Field screening / PID readings ranged up to approximately 600-700 ppm. As noted elsewhere, a representative from Kirsia Environmental was present during the drilling of MW1 and can confirm those observations. As noted in the following sections, groundwater was not struck until about 15-16m depth, which suggests a reasonably significant separation distance between the depth of petroleum impacts in the soil and rock, and where water was struck.

Sample Location/ID	Depth from Surface (m)	Time	PID (ppm)	Soil Description & Other Notes	Lab Sample Taken
DH1/MW1	4.0	11:00:00 AM	19.7	Backfill	
	5.0	11:05:00 AM	21.5	Rock, Bedrock @ 4.9m bgl	
	6.0	11:10:00 AM	607.1	Rock	X
	7.0	11:15:00 AM	150.7	Yellow Claystone	
	8.0	11:20:00 AM	6.5	Yellow Claystone	
	9.0	11:25:00 AM	7.2	Yellow Claystone	
	10.0	11:30:00 AM	2.8	Yellow Claystone	X
	11.0	11:35:00 AM	2.8	Yellow Claystone	
	12.0	11:40:00 AM	1.4	Yellow Claystone	
	13.0	11:45:00 AM	15.2	Yellow Claystone Moist	X
	14.0	11:50:00 AM	1.4	Water!	
	15.0	11:55:00 AM	2.1	Water!	
	16.0	12:00:00 PM	7.4	Water!	
	17.0	12:05:00 PM	4.6	Water!	
18.0	12:10:00 PM	3.3	Water! Quartz Sandstone		
DH2/MW2	3.0	1:20:00 PM	517.4	Backfill	
	6.0	1:25:00 PM	792.1	Rock Quartz	X
	9.0	1:30:00 PM	94	Yellow Claystone	
	12.0	1:35:00 PM	18.9	Yellow Claystone	
	13.0	1:40:00 PM	7.9	Yellow Claystone Moist	
	14.0	1:45:00 PM		Water!	

	15.0	1:50:00 PM	10	Water! Quartz Sandstone	X
DH3/MW3	3.0	4:00:00 PM	1.8	Topsoil	
	5.0	4:05:00 PM	3.5	Rock	X
	6.0	4:10:00 PM	1.4	Rock	
	7.0	4:15:00 PM	1.8	Black To Yellow Claystone	
	9.0	4:20:00 PM	2.2	Yellow Claystone	
	12.0	4:25:00 PM	0.8	Yellow Claystone	
	13.0	4:30:00 PM	0.9	Water! Yellow Claystone	
	15.0	4:35:00 PM	6.1	Water! Rock	X
DH4/MW4	3.0	5:00:00 PM	0.4	Topsoil	
	5.0	5:05:00 PM	3.9	Rock	X
	6.0	5:10:00 PM	1.8	Rock	
	8.0	5:15:00 PM	1.2	Loose Yellow Claystone	
	10.0	5:20:00 PM	4.3	Loose Yellow Claystone	X
	13.0	5:25:00 PM	1.8	Moist Yellow Claystone	
	14.0	5:30:00 PM		Hard Dense Moist Yellow Claystone	
	15.0	5:35:00 PM	1.2	Hard Dense Moist Yellow Claystone	
	17	5:40:00 PM	1.3	Moist Yellow Claystone	
	19.0	5:45:00 PM	0.4	Moist Yellow Claystone	
	19.3	5:50:00 PM	0.9	Water!	

Figure 14. PID readings vs depth monitoring bore advancement.
(Low Ecological, November 2023)

Asbestos and Other Waste Materials

No waste materials such as asbestos, solid inert or putrescible waste was reported by Low Ecological within the soils encountered.

Demolition / Site Clearance and Removal of Underground Infrastructure

Low Ecological Services reported that the underground diesel, Opal and petroleum storage systems infrastructure was removed on 23 March 2021. The site clearance works included the removal of three USTs, one above ground diesel bowser and associated infrastructure.

Table 18. Summary of removed USTs

Tank	Volume	Observed Conditions / comments
Diesel UST	Safe fill volume of 4,500L	Diesel system was reported to pre-date 1992. Staining was observed on the soils surrounding the diesel system bowser, suggesting spillage and leakage. The bottom of the UST was measured to be approximately 2.3m below the ground surface. The tank was found to be in very poor condition. Tank, bowser, fuel pipes, vent, and concrete plinths were all

Tank	Volume	Observed Conditions / comments
		removed.
Opal UST	Safe fill volume of 11,900L	The opal system was understood to have been installed prior to 1992. The bottom of the UST was approximately 2.8m below the ground surface. The tank was reportedly found to be in poor condition with signs of corrosion and likely leakage points on the tank and pipework.
Petrol UST	No volume reported	Low Ecological Services reported there were no signs of possible leakage points observed on this older petrol system. The tank was in good condition, likely due to the pit having been backfilled with river sand when installed, thus reducing corrosion potential.

Stockpile Classification and Waste Tracking

Some of the more heavily contaminated soils were transported off-site to Alice Springs for further testing and classification for disposal. There is limited detail provided in the reporting in relation to this transport, storage and eventual disposal. Remaining soils deemed to be uncontaminated based on testing or field screening were used to backfill the former tank pit excavations. The surplus soil required to complete backfilling / reinstatement of the tank pit excavations was reported to have been imported from off-site. There was no supporting information provided in the reporting in relation to the imported soils used for this backfilling. The audit report will be recommending the NT EPA seek further details in relation to this aspect of the site reinstatement work.

Some information relating to the classification and disposal of contaminated soils is provided in the report '*Underground Petroleum Storage Systems Fuel Contamination Investigation and Remediation Report*' (Low Ecological, March 2022).

The reporting noted that the highest levels of TPH impacts were found in the soils excavated from the base of the diesel tank pit. The report indicates those soils were segregated and transported by licensed contractors (Cleanaway) for disposal in South Australia. There are no records provided of the transport or disposal of those soils. The reporting noted the less impacted soils from the diesel tank pit and those from the petrol / Opal tank pit were segregated and following confirmatory testing and liaison with Alice Springs Council, the soils were disposed as 'General Fill' at the council's Waste Management Facility. There is a docket provided in the report appendices recording that 9.1 tonnes of soil at the Alice Springs Town Council landfill.

As discussed previously, remaining soils deemed to be uncontaminated based on testing or field screening were used to backfill the former tank pit excavations. The surplus soil required to complete backfilling / reinstatement of the tank pit excavations was reported to have been imported from off-site but with no further detail provided.

Reiterating the data gaps / issues identified in relation to waste soils disposal and or soil importation:-

- No records were provided in the reporting of the transport or disposal of the most heavily contaminated soils to South Australia.
- No records were provided of the transport and storage in Alice Springs of the lesser category of impacted soils. There were records provided of the eventual disposal of a quantity of soils at Alice Springs Council landfill.

Reinstatement of the former fuel tank pits

It is understood that in early September 2021, contractors reinstated the excavations where the former underground tanks had been removed from. The intention was for the areas to be reinstated and made safe for the resumption of the site's use as a campground / lodge by the new owners.

The general approach for backfilling the pits was determined in consultation with the Auditor, with in principle agreement that the primary source/s of impacts (i.e. the tanks and pipework) had been removed, along with a majority of the impacted soils surrounding the former tanks based on the lateral delineation works reported.

Perforated pipes were installed into the base of the diesel and petrol / Opal pits with the intention of providing a simple / passive connection between ambient air and the subsurface in the pits. It was thought this may improve the rate of natural biodegradation processes for the residual impacted soils in the base of those pits, as the depth of oxygen ingress for natural soils in this area is not well understood. The pipes were perforated PVC and were covered in a geotextile to protect them from becoming clogged. The pipes were connected to the surface via vertical riser pipes and vent outlets.

It was reported the pits were backfilled with a clean imported soil product obtained from Alice Springs. There were no further details provided in relation to the material source or assessment of its suitability for this purpose, other than noting it was a road base product with some clay content. Concept sketches of the planned reinstatement works are included in the audit report appendices.



*Figure 15. Reinstated Tank Pit Areas – diesel (top) and petrol / Opal (below)
(Photos by Low Ecological)*

Auditor's Review of the Hydrocarbon Impacts in Soil

The following sections document the auditor's further assessment of the residual petroleum hydrocarbon impacts via comparison against various petroleum hydrocarbon screening values from CRC CARE Technical Report 10 and the ASC NEPM.

Table 19: Summary listing of main residual TPH and BTEX impacts

Sample IDs & location information	Maximum reported concentrations (mg/kg)							
	Benzene	Toluene	Ethylbenzene	Xylenes	Naphthalene	TPH F1 C6-C10 (-BTEX)	TPH F2 C10-C16 (- Nap)	TPH F3 >C16-C34
Petrol / Opal Tank (all samples understood to have been collected from below 1m depth)								
P29 (Mar 21) (B) approx. 3.5m	<0.2	3.3	3.3	14	<2	469	60	<100
P30 (Mar 21) (B) approx. 3.5m	<0.2	<0.5	0.8	2.8	2	93	130	<100
P31 (Mar 21) (B) approx. 3.7m	0.2	4.9	4.7	13	<2	569	270	<100
P2 (Mar 21) approx. 0.5m	<0.2	<0.5	<0.5	<1	<2	<10	<50	<100
MW2-6m (May 22)	<0.2	<0.5	<0.5	<0.5	<1	<10	<50	<100
MW2-13m (May 22)	<0.2	<0.5	<0.5	<0.5	<1	<10	<50	<100
Diesel Tank (all samples understood to have been collected from below 1m depth)								
D11 (Mar 21) S wall of pit	<0.2	<0.5	<0.5	2.8	<2	114	9,580	11,000
D17 (Mar 21) (B) approx. 4m	<0.2	6.7	7.2	36.5	1	370	14,900	13,100
D3 - 0.1 (Apr 21) NW wall of pit (between 1.5 to 3.5m) [^]	<0.2	1.9	5.2	36	<2	660	32,000	30,500
MW1-6m (May 22)	<0.2	<0.5	<0.5	<0.5	<1	<10	380	700
MW1-10m (May 22)	<0.2	<0.5	<0.5	<0.5	<1	<10	<50	<100
MW1-13m (May 22)	<0.2	<0.5	<0.5	<0.5	<1	<10	<50	<100

(B) denotes samples collected from below base of tank pit)

[^] while the sample nomenclature suggests that D3-0.1 was collected at a depth of approximately 0.1m, however clarification provided by LES indicates that the sample was collected from a depth below a depth of between 1.5m to 3.5m. A copy of the email response from LES, dated 23 November 2023 is presented in Appendix J.

Table 20: Soil Data compared against HSLs for direct contact exposures

Chemical	HSL Intrusive maintenance worker – shallow trench	Max Result (Petrol / Opal UST)	Max Result (Diesel UST)
Benzene	1,100	0.2	<0.2
Toluene	120,000	4.9	6.7
Ethylbenzene	85,000	4.7	7.2
Xylenes	130,000	14	37
Naphthalene	29,000	<2	<2
TPH C6-C10 (-BTEX)	82,000	569	660
TPH >C10-C16 (-Nap)	62,000	270	32,000
TPH >C16-C34	85,000	<100	30,500
TPH>C34-C40	120,000	<100	<100

Unless specified otherwise, all values are in milligrams per kilogram (mg/kg).

For comparison with the respective HSL values, the C6-C10 TPH results have had total BTEX subtracted, and the >C10-C16 TPH results have had the naphthalene results subtracted.

Because the soils are buried beneath surface and located in a car park / open space area, the only plausible exposures might be for future intrusive maintenance workers who might come into contact with the impacted soils in the former tank areas. All results were below the respective HSLs based on direct contact exposures.

Table 21: Soil data compared against ESLs for TPH Fractions and BTEX

Sample IDs & location information	Maximum reported concentrations (mg/kg)							
	Benzene	Toluene	Ethylbenzene	Xylenes	Naphthalene	TPH C6-C10	TPH C10-C16	TPH >C16-C34
ESL residential / open space*	50	85	70	105	-	180	120	2,800
ESLs, commercial and industrial*	75	135	165	180	-	215	170	3,300
Petrol / Opal Tank (all samples understood to have been collected from below 1m depth)								
P29 (Mar 21) (B) approx. 3.5m	<0.2	3.3	3.3	14	<2	469	60	<100
P30 (Mar 21) (B) approx. 3.5m	<0.2	<0.5	0.8	2.8	2	93	130	<100
P31 (Mar 21) (B) approx. 3.7m	0.2	4.9	4.7	13	<2	569	270	<100
P2 (Mar 21) approx. 0.5m	<0.2	<0.5	<0.5	<1	<2	<10	<50	<100
MW2-6m (May 22)	<0.2	<0.5	<0.5	<0.5	<1	<10	<50	<100
MW2-13m (May 22)	<0.2	<0.5	<0.5	<0.5	<1	<10	<50	<100
Diesel Tank (all samples understood to have been collected from below 1m depth)								
D11 (Mar 21) S wall of pit	<0.2	<0.5	<0.5	2.8	<2	114	9,580	11,000
D17 (Mar 21) (B) approx. 4m	<0.2	6.7	7.2	36.5	1	370	14,900	13,100
D3 – 0.1 (Apr 21) NW wall of pit (between 1.5 to 3.5m)	<0.2	1.9	5.2	36	<2	660	32,000	30,500
MW1-6m (May 22)	<0.2	<0.5	<0.5	<0.5	<1	<10	380	700
MW1-10m (May 22)	<0.2	<0.5	<0.5	<0.5	<1	<10	<50	<100
MW1-13m (May 22)	<0.2	<0.5	<0.5	<0.5	<1	<10	<50	<100

Notes:

- ESL values sourced from Table 1B(6) of the ASC NEPM. Assumed fine-grained soils (clays / sandy clays).
- Shading indicates results above the assessment levels.

*As stated in schedule B1 ASC NEPM, section 2.6.3 ESLs apply from the surface to 2 m depth below finished surface/ground level, which corresponds to the root zone and habitation zone of many species. In arid regions, where the predominant species may have greater root penetration, specific considerations may result in their application to 3 m depth. All samples collected from the monitoring borehole advancement were collected at depths below the applicability of ESLs.

The above comparison is relevant in the context of potential future garden and landscaped areas. Given there are results above the ESLs for an open space and commercial / industrial land use scenario, this indicates a potential detriment to soil ecology / terrestrial ecosystems and associated vegetation. However, based on the current circumstances where the impacted soils are buried at depth beneath a car park area this is not considered to be a significant concern unless the areas in question were to be redeveloped with plants / vegetation with deeper root systems. Other potential concerns regarding indirect exposures via vapour intrusion, and leaching to groundwater are dealt with in later sections.

Table 22: Soil data compared against vapour intrusion HSLs for intrusive maintenance worker (Shallow Trench)

Sample IDs & location information	Maximum reported concentrations (mg/kg)						
	Benzene	Toluene	Ethylbenzene	Xylenes	Naphthalene	TPH C6-C10 less BTEX (F1)	TPH >C10-C16 less naphthalene (F2)
Vapour HSLs for Intrusive worker – trench	350	NL	NL	NL	NL	NL	NL
Petrol / Opal Tank (all samples understood to have been collected from below 1m depth)							
P29 (Mar 21) (B) approx. 3.5m	<0.2	3.3	3.3	14	<2	469	60
P30 (Mar 21) (B) approx. 3.5m	<0.2	<0.5	0.8	2.8	2	93	130
P31 (Mar 21) (B) approx. 3.7m	0.2	4.9	4.7	13	<2	569	270
P2 (Mar 21) approx. 0.5m	<0.2	<0.5	<0.5	<1	<2	<10	<50
MW2-6m (May 22)	<0.2	<0.5	<0.5	<0.5	<1	<10	<50
MW2-13m (May 22)	<0.2	<0.5	<0.5	<0.5	<1	<10	<50
Diesel Tank (all samples understood to have been collected from below 1m depth)							
D11 (Mar 21) S wall of pit	<0.2	<0.5	<0.5	2.8	<2	114	9,580

Sample IDs & location information	Maximum reported concentrations (mg/kg)						
	Benzene	Toluene	Ethylbenzene	Xylenes	Naphthalene	TPH C6-C10 less BTEX (F1)	TPH >C10-C16 less naphthalene (F2)
D17 (Mar 21) (B) approx. 4m	<0.2	6.7	7.2	36.5	1	370	14,900
D3 – 0.1 (Apr 21) (between 1.5 to 3.5m)	<0.2	1.9	5.2	36	<2	660	32,000
MW1-6m (May 22)	<0.2	<0.5	<0.5	<0.5	<1	<10	380
MW1-10m (May 22)	<0.2	<0.5	<0.5	<0.5	<1	<10	<50
MW1-13m (May 22)	<0.2	<0.5	<0.5	<0.5	<1	<10	<50

Notes:

- Soil HSLs for VI pathway.
- Values for intrusive maintenance worker sourced from Table B3 in CRC CARE Technical Report 10 (Part 2, Application Document). Assumes clay soil (applicable to the sandy clays at this site) and source <2 m deep.
- NL denotes concentration for this chemical / substance is not limiting.

The above results comparison is relevant for inhalation exposures for future intrusive maintenance workers who might be required to run shallow trenching through the former tank areas. Results were also well below adopted screening values for intrusive maintenance workers in a shallow trench.

Table 23: Soil data compared against TPH Management Limits

Sample IDs & location information	Maximum reported concentrations (mg/kg)			
	TPH C6-C10	TPH C10-C16	TPH >C16-C34	TPH >C34-C40
Management Limits – Residential, Open Space (fine soil)	800	1,000	3,500	10,000
Management Limits – Commercial / Industrial (fine soil)	800	1,000	5,000	10,000
Petrol / Opal Tank (all samples understood to have been collected from below 1m depth)				
P29 (Mar 21) (B) approx. 3.5m	489	60	<100	
P30 (Mar 21) (B) approx. 3.5m	97	130	<100	
P31 (Mar 21) (B) approx. 3.7m	592	270	<100	
P2 (Mar 21) approx. 0.1m	<10	<50	<100	
MW2-6m (May 22)	<10	<50	<100	<100
MW2-13m (May 22)	<10	<50	<100	<100
Diesel Tank (all samples understood to have been collected from below 1m depth)				
D11 (Mar 21) S wall of pit	114	9,580	11,000	
D17 (Mar 21) (B) approx. 4m	370	14,900	13,100	
D3 – 0.1 (Apr 21) NW wall of pit (between 1.5 to 3.5m)	660	32,000	30,500	
MW1-6m (May 22)	<10	380	700	<100
MW1-10m (May 22)	<10	<50	<100	<100
MW1-13m (May 22)	,10	<50	<100	<100

Notes:

- Management Limits are from Table 1 B(7) in Schedule B1 of the ASC NEPM.
- Values are based on fine grained soils (applicable for the sandy clays at this site).

The above table compares the maximum reported results against the petroleum hydrocarbon management limits listed in Schedule B2 of the ASC NEPM. The management limits are applicable for screening residual petroleum hydrocarbon impacts in terms of aspects not covered in the health and ecological investigation levels including avoiding or minimizing formation of observable non - aqueous phase liquids (NAPLs), fire and explosive hazards, and potential effects on buried infrastructure. The highest reported results for >C10-C16 TPH and >C16-C34 TPH were above the respective management limits. There is no indication from the field observations and various data collected that any of those other aspects such as fire / explosion risk or formation of LNAPL have been (or will be) a concern. The observations by the Auditor's representative during drilling of the groundwater bores, and various other data collected Indications the residual impacts in the subsurface are associated with a relatively old and weathered fuel product (noting very little if any BTEX remains in soil or soil vapour).

The TPH management limits are intended to be used as interim Tier 1 guidance values, which is the level of assessment that has been applied at this stage for the assessment at the Glen Helen Lodge fuel tank areas. On this basis further consideration of the significance of the results is warranted. This audit report will therefore be recommending a longer term Groundwater Quality Monitoring and Management plan be implemented to provide confidence to stakeholders that there will be no significant impacts particularly to the surrounding environment, noting the sensitivity of this location.

Table 24. Soil vapour data compared against vapour intrusion HSLs

Sample IDs & location information	Maximum reported concentrations (mg/m3)						
	Benzene	Toluene	Ethylbenzene	Xylenes	Naphthalene	TPH C6-C10 less BTEX (F1)	TPH >C10-C16 less naphthalene (F2)
Vapour intrusion HSLs – HSL D (commercial / industrial) (1)	5	6,500	1,800	1,200	4	1,000	800
Vapour HSLs for Intrusive worker – trench (2)	6,500	NL	NL	NL	NL	NL	NL
SV1 (diesel pit)	<0.007	0.067	0.051	0.520	<0.005	46	120
SV2	<0.007	0.006	<0.004	<0.008	<0.005	5	2
SV3	<0.007	0.006	<0.004	<0.008	<0.005	<0.86	0.5
SV4 (petrol / Opal pit)	0.016	0.008	<0.004	0.009	0.008	1,800	550
SV5	<0.007	0.007	<0.004	<0.008	<0.005	<0.86	0.47
SV6	<0.007	0.005	<0.004	<0.008	<0.005	<0.86	0.74

(1) Source:- ASC NEPM Schedule B2. Table 1A(5). Assume clay soil and source 0-1m depth.

(2) Source:- CRC CARE Tech Report 10.

The above table compares the maximum reported results against petroleum hydrocarbon HSLs for vapour intrusion. Two scenarios are evaluated – one for intrusive maintenance workers in a shallow trench, and the other for a building in a commercial / industrial land use scenario (applicable for the land use at Glen Helen Lodge). Results well below adopted screening values for intrusive maintenance workers in a shallow trench. There was one result that exceeded the adopted screening criteria for a commercial / industrial building – the F1 TPH result (>C6-C10 TPH minus BTEX) at SV4 (former petrol / Opal tan pit). Results in the vapour survey locations near existing buildings were well below adopted screening criteria. The results indicate vapour intrusion risks are negligible under the current site layout, but there would be a need for further consideration of potential vapour intrusion risks if there was to be a building established over the former petrol / Opal tank area in the future. The audit report will be recommending this is flagged in a longer-term site management plan.

Auditor’s review of Metals and PAHs in Soil

While some minor differences in metals results were identified within samples collected in the impacted zone at the former USTs as compared to the results of the control sample collected approximately 100m north, the concentrations did not exceed the adopted HSL / HIL values.

Elevated total PAH concentrations were reported within the impacted soils identified in the diesel fuel pit, with the highest concentration reported for sample G1-1.0m (26 mg/kg). The concentration did not exceed either the adopted commercial / industrial HIL (4,000mg/kg), or the more conservative residential A and recreational open space HILs (both 300mg/kg).

Based on the concentrations reported, no significant health or ongoing environmental risks are indicated by the metals and PAHs concentrations reported in the assessment work.

Table 25. Results for Contaminants of Interest in Soil (Metals)

Screening values	Ecological investigation and screening levels	Health investigation and screening levels			Sample Results representative of pre-remediation soils	Sample results representative of residual soil conditions	Control sample collected 100m north of impacted area of site
		Residential A. Residential	HIL C Public open space	Commercial / industrial D			
		'Urban residential and public open space'	NEPM HIL A ²	NEPM HIL C ²			
Default source (unless alternative values are adopted)	NEPM EIL and ESL Values ¹						
Metals / metalloids							
Arsenic	100	100	300	3,000	<5	<5	<5
Cadmium	-	20	90	900	<1	<1	<1
Chromium (III) Chromium (VI)	220 ³ (III)	100 (VI)	300 (VI)	3,600 (VI)	8 – 17	5 – 17	10
Copper	80 ³	6,000	17,000	240,000	6 – 13	<5 – 13	<5
Lead	1,100	300	600	1,500	<5 – 34	<5 – 14	8
Nickel	75 ³	400	1,200	6,000	6 – 10	3 – 10	5
Zinc	190 ³	7,400	30,000	400,000	12 – 82	6 – 82	10
Mercury	-	40	80	730	<0.1 – 0.1	<0.1	<0.1
PAHs							
Naphthalene [^]	170	5	NL	NL	0.6 – 3.2	-	-
Total PAHs [^]	-	300	300	4,000	4.5 – 26.1	-	-
Benzo(a)pyrene [^]	20	-	-	-	<0.5	-	-
B(a)P TEQ [^]	-	3	3	40	1.2 – 1.3	-	-

All results reported in mg/kg.

[^]in the case of the G1 to G6 samples (collected 12 February 2021). As PAH samples were collected during later rounds of investigation, these samples were considered for the purposes of worst-case scenario PAH conditions.

6.3 Groundwater And Surface Water Assessment

As stated in previous sections, groundwater assessment was initially completed by Low Ecological and was supplanted with additional monitoring by Tierra Environment. A summary of the results is presented in the following sections.

General Observations

A network of groundwater monitoring bores has been established at the Site by Low Ecological. Bores were installed to depths varying from approximately 15-19m, targeting the upper portion of the water table aquifer, which is located within fractured rock believed to be limestone and dolostone of the Goyder Formation. Standing water levels varied from approximately 5.26 to 6.13m below ground level.

Groundwater Chemistry

As discussed further in section 7 of this audit report, groundwater sampling was undertaken by LES, however due to insufficient development of the monitoring bores prior to sampling, the results of the analysis could not be relied upon for the purposes of audit. The subsequent groundwater monitoring event conducted by Tierra Environment is considered to have produced more reliable data. Groundwater TDS in the monitoring bores installed in the assessment area varied from approximately 2,400-3,000 mg/L. The field pH results ranged from approximately 6.6–6.8 and dissolved oxygen was generally in the range of 0.9 to 2.6 mg/L. The oxidation-reduction potential was reported to range from -130 to -146 mV, indicating reducing conditions in the aquifer.

Petroleum Hydrocarbons in Groundwater and Surface Water

Some trace detects of TPH and benzene had been reported in the initial groundwater samples collected by Low Ecological soon after the groundwater monitoring bores were installed in late 2021. Regardless, as outlined in other sections of this audit, the groundwater well development, purging and sampling activities reported by LES were considered unreliable.

Tierra Environment were subsequently commissioned to undertake further development of the monitoring bores and collect samples in accordance with current industry standards and protocols. Results for TPH, BTEXN and MTBE were below laboratory reporting limits in all three samples collected by Tierra in May 2023. In addition, no other evidence of fuel related impacts was noted such as odours during purging / sampling, and no evidence was noted suggesting non-aqueous phase liquid (NAPL) was present in any of the monitoring bores.

Metals in Groundwater and Surface Water (Lead)

During the May 2023 monitoring event, the groundwater samples were analysed for lead, noting petrol products prior to the early 2000s had a lead based additive and this is commonly used as another line of evidence for assessing potential fuel related impacts in water samples. All lead concentrations were reported above adopted screening criteria for water dependent ecosystems (ANZG 99% freshwater criteria of 0.001mg/L). reported lead concentrations were highest within MW3 (0.056mg/L) and MW1 located within the diesel pit (0.01mg/L) whilst significantly lower result was reported at MW4 (cross-gradient to the east of the former UST area (0.002mg/L).

Tierra suggested the data was indicative of possible impacts from fuel leakage, but noted there is a need to confirm the results and review the likely background concentration in the area. The Auditor agrees, also noting the two (significantly higher) results were reported in the bores sampled using the bailer method, compared to the result at MW4 which was collected via the micropurge / low flow sample method. Unfortunately, the low flow pump malfunctioned after MW4 had been sampled, and so the alternative methods had to be adopted for sampling the two remaining bores. It will be important to check and confirm results for lead once samples have been collected from all the locations using a consistent method before making judgements on the basis of the May 2023 results alone.

It is noted lead was not elevated in the samples collected from the Finke River by Tierra Environment.

Discussion of Groundwater and Surface Water Results

The Auditor has completed the assessment of groundwater and surface water sample results during the various stages of site assessment in accordance with the Northern Territory regulatory framework and EPA guidance for completion of environmental audit reports. The figures and tables on the following pages document the Auditor's interpretation of key questions relating to groundwater contamination. The main points to note from this review are as follows: -

- The current information suggests that groundwater beneath the former USTs and bowser area has not been impacted by fuel leakage.
- There were some elevated lead results reported in the latest monitoring completed in May 2023. There is some uncertainty regarding how reliable and repeatable those results might be due to differences in sampling methods that became necessary because of the malfunction of a pump during the May 2023 sampling event.
- There have not been any fuel related impacts detected in samples of water collected from within the Finke River upstream, downstream and adjacent to the former USTs and bowzers at Glen Helen Lodge.
- Further monitoring is considered necessary to provide confidence to the NT EPA and other stakeholders that there is no longer term threat to either groundwater or the water in the Finke River associated with past fuel leakage beneath the former USTs and bowser area.

Table 26: Summary of Notable Groundwater Results (most recent concentrations)

Beneficial Uses	Water Dependent Ecosystems (Freshwater 99%)	Potable	Agr & Irr (Irrigation)	Agr & Irr (Stock)	Water Based Recreation (Primary Contact Recreation) ***	Groundwater results (May 2023)	Surface water Results (May 2023)
Lead	1	10	2,000	100	100	2 – 56	<1
Benzene	600	1	-	1	10	<1	<1
Toluene	110	25 (aesthetics)	-	800	25 **	<1	<1
Ethyl Benzene	50	3 (aesthetics)	-	300	3 **	<1	<1
Xylenes***	50	20 (aesthetics)	-	600	20 **	<2	<2
TPH C10-C36 ****	600	600	600	600	600	<100	<100
Naphthalene	2.5	-	-	-	-	<10	<10
Methyl tert-butyl ether (MTBE)						<1	<1

Notes:

Unless specified otherwise, all results are in micrograms per litre (µg/L).

7. QUALITY AND COMPLETENESS OF INFORMATION

This section provides a general overview of the Auditor's opinions of the overall quality and completeness of the assessment and remediation works. More detailed reviews and communications by the Auditor during the site assessment works are attached in the audit report appendices.

- **Historical information and desktop information review.** The information provided on the general history of the Glen Helen site was inadequate for the purposes of this type of investigation and did not meet relevant state and national guidance. There was some limited information provided on the historical fuel storage and dispensing operations and related contractor / maintenance activities associated with this infrastructure. Ultimately these deficiencies led to deficiencies and inefficiencies in the assessment and remediation works program, and delays which have been frustrating to the client, Auditor and NT EPA.
- **Sampling rationale and scope:** The reporting did not provide a reasonable and justified explanation for the rationale and scope of the various stages of investigations that were completed to assess the nature / extent of contamination. Specific comments on particular media are noted below.

- Soils.

The investigation comprised three stages of soil sampling. The first stage (February 2021) involved three hand auger bores around the opal and diesel USTs to determine if there had been any fuel leaks. At that time the investigation had not determined the existence of the old petrol UST. The second stage of the soil sampling (March 2021) involved sampling around the petrol / Opal, diesel and old petrol USTs during the removal of the USTs and associated infrastructure. The third stage (April 2021) involved soil sampling via eight Geoprobe cores around the parking area, mainly along a surface / stormwater drainage path, to the south of the diesel UST and two shallow samples from the backfilled opal and diesel pits. The overall density of sampling locations during the first two stages appears reasonable enough to determine if contamination was present (stage 1) and to determine residual concentrations in the excavated pits (stage 2), however the value of the eight Geoprobe locations (stage 3) is questionable in terms of being able to infer the extent of soil impacts beyond the UST excavations and the efforts would have been more valuable if the bores had been extended to greater depth and they were more judicious in the selection of locations.

Geoprobe locations H1-H5, H7 and H8 appear to be too far away from the excavations to enable any meaningful estimates of the extent / volume of residual soil impacts around the tank pit excavations. Geoprobe location H6 is beyond (south of) the line of dead trees (discussed earlier in this audit report), instead of between the pit dead trees, and the depths of the samples analysed are too shallow to possibly detect impacts that would have seeped laterally and downward from the base of the former diesel UST / pit and perhaps caused these trees to die.

Sample locations P2 and D3 correspond to the petrol / Opal and diesel pits but it is understood (based on the sample IDs, and the timing of the sampling) that these samples were from 0.1mbgl and are likely to represent some of the material that was used to backfill these pits.

Additional soil samples were collected during the advancement of the four groundwater monitoring bores by LES following remediation of the tank pits. Bores were advanced to a maximum depth of 18m into bedrock. PID field readings were collected and there were visual and olfactory indicators noted of hydrocarbon impacts depleting as the bores were advanced which provides some evidence of the depth where the hydrocarbon impacts had penetrated beneath these areas.

- Groundwater.

Four holes were dug into the bank of the Finke River for water sampling purposes by LES. The locations shown for these samples appear to be appropriate with W1-W3 being between the USTs and the river, and W4 being where surface water is expected to drain from the parking lot area toward the river. Table 6 of the DSI records the depths of W1-W4 and their distances from the water's edge.

Four groundwater monitoring bores were originally installed by contractors under the supervision of LES in 2021. The locations of three bores coincided with former tank pits or close by, whilst the fourth location (MW4) was located to the east and was understood to be trying to target possible impacts from surface runoff from the UST/bowser area. These locations were reasonable and appropriate for the initial assessment of potential impacts to groundwater.

Three of the four groundwater monitoring wells installed by LES were sampled by Tierra Environments (MW1, MW3 and MW4). As discussed previously, MW2 could not be located during the monitoring event due to overlying gravel.

The monitoring bores were advanced within the area of impact (i.e. within the footprint of the former tank pits and bowser area). The number of bores and locations were considered generally reasonable based on the audit site contaminating activities. MW4 has been positioned to the east of the impacted area and therefore may be considered as a background bore. Ultimately the overall network established was reasonable. The bores were installed to assess the upper portion of the water table aquifer, which was reasonable and appropriate in the circumstances. The bore installations, drilling / lithology, contamination indicators and subsequent bore construction were poorly documented. Multiple attempts to get additional information from the drillers and LES were unsuccessful.

The initial bore development and sampling event by LES in 2021 was poorly documented and the data is not considered suitable for reliance in this audit report. As a consequence, Tierra Environment were commissioned to complete a second round of bore development and sampling which they completed in May 2023. On this occasion one of the monitoring bores was unable to be located (MW2) because the area had been covered with gravel hardstand and the bores / assets had not been adequately completed with covers that enable ready location and access for future monitoring purposes. The data generated from this monitoring event is considered suitable for reliance and has been discussed elsewhere in the audit report.

Tierra has reported there was a malfunction of the sampling pump which meant that only one of the bores was able to be sampled using low flow methods (MW4). The other two bores were subsequently sampled via bailers (MW1, MW3).

The loss of MW2 is not considered critical as MW1 is located close by and directly beneath the tank pit where the most heavily impacted soils were reported to

remain. Tierra has indicated they will attempt to locate MW2 on their next visit for scheduled monitoring and will sample it if the bore is deemed to be functional.

- **Soil vapour / ground gas.**

Six Waterloo Membrane Samplers (WMS) were deployed in 1.5m deep soil bores adjacent to the backfilled tank pits (SV1, SV4 and SV5), between the buildings and the tank pits (SV2 and SV3), and in the carpark to the east of the USTs. The locations shown for SV1-SV5 appear to be appropriate in terms of assessing vapour concentrations at the sources (i.e., SV1, SV4 and SV5) and vapour concentrations near human receptor areas / buildings (i.e., SV2 and SV3). The location of SV6 appeared to be based on the idea that contamination might have migrated along the parking lot via surface water flows, which the Auditor considers to be a relatively unlikely scenario, but the other key locations of interest were included in the survey.

The approach and rationale for completing a soil vapour survey using the passive diffusion samplers was reasonable and appropriate for this type of assessment. The vapour survey locations were generally considered reasonable and appropriate for the purposes of assessing potential vapour intrusion risks for the current buildings and layout in the assessment area. It is considered there was sufficient scope of works completed to inform future risk management.

- **Documented procedures and field records and field QA/QC:** The reporting of the various sampling programs by LES were generally poorly documented and with limited field records and supporting information. Despite requests by Kirsas Environmental for field sampling sheets for soil sampling, bore logs and plans other than those included within the current versions of the reporting, none were forthcoming. The bore log information received was not completed to a standard generally consistent with current guidelines and standards including the ASC NEPM (Amendment 2013) and AS4482.1-2005. Additional requests were made by the Auditor to both LES and the driller and some general information was provided, however no bore logs of industry standard were obtained. Following requests, some of the laboratory sample receipt notices were provided, so as to allow for comparison with sample nomenclature and evidence of sample handling at the point of laboratory custody. The records provided by Tierra Environments were of suitable quality and consistent with expected industry standards.
- **Analyte selection:** The Auditor is satisfied the range of analytes covered in the various sampling / analysis programs is appropriate based on the potential contamination sources being assessed for this particular audit.
- **Accreditation of laboratories:** The current guidance to Auditors (refer Vic EPA Publication 2041) requires that analyses should be performed in laboratories with National Association of Testing Authorities (NATA) accreditation for the analyses undertaken and have test reports bearing a NATA stamp of endorsement. NATA accredited laboratories have demonstrated the ability to produce reliable, repeatable data for a range of parameters in a range of sample matrices. The accreditation is dependent on participation in NATA and other national and international proficiency programs, and performance against certified reference materials/standards. The laboratory reports included with the assessment reports indicated they held NATA accreditation for all analyses conducted.
- **Laboratory QAQC.** The assessment reporting by LES did not include an appropriate evaluation of the quality assurance / quality control measures implemented by the laboratories for the various stages of assessment. The evaluation by Tierra for their groundwater monitoring report was reasonable and appropriate. The Auditor has reviewed

the laboratory reports for the various stages of works / assessment and considers the internal QA/QC reporting is not indicative of any significant internal laboratory QA/QC issues. Refer to the assessment reporting and auditor's reviews provided in the audit report appendices for further detail.

- **Assessment criteria:** The assessment reporting by LES did not clearly justify their adopted criteria or demonstrate a suitable understanding of the selection of screening criteria for soils or soil vapour for this type of assessment and validation exercise. This has meant the Auditor has had to make an independent assessment and adopt criteria believed to be appropriate. For the groundwater, Tierra reported and justified their selection of screening values for surface and groundwater appropriately and the values adopted were considered reasonable and appropriate.
- **Risk evaluation and impact assessment for chemicals/substances of concern:** For this particular assessment and validation work, because of the inadequacies of the reporting (particularly the soil and vapour assessments), the Auditor has made an independent review of the risks of harm based on the reported results.
- **Records relating to classification and off-site disposal of any soils and/or other wastes.** The reporting noted that the highest levels of TPH impacts were found in the soils excavated from the base of the diesel tank pit. The reporting indicates those soils were segregated and transported by licensed contractors (Cleanaway) for disposal in South Australia. There are no records provided of the transport or disposal of those soils. The reporting noted the less impacted soils from the diesel tank pit and those from the petrol / Opal tank pit were segregated and following confirmatory testing and liaison with Alice Springs Council, the soils were disposed as 'General Fill' at the council's Waste Management Facility. There is a docket provided in the reporting appendices recording that 9.1 tonnes of soil at the Alice Springs Town Council landfill.

As discussed previously, remaining soils deemed to be uncontaminated based on testing or field screening were used to backfill the former tank pit excavations. The surplus soil required to complete backfilling / reinstatement of the tank pit excavations was reported to have been imported from off-site but with no further detail provided.

- **Records of the final site condition.** The three USTs found within the assessment area have been excavated and the information suggests that most of the impacted soils have been removed, with the exception of the base and walls of two of the former tank pits as discussed elsewhere. The documentation does not convey a very clear understanding of the final site condition at the time of this audit being completed, and we have relied to a large degree on the observations by Tierra when they completed their groundwater monitoring in May 2023.

8. IMPACTS AND RISK ASSESSMENT

This section provides an overview of the Auditor's evaluation of the type, amount and distribution and mobility of contaminants and wastes present in the environment resulting from the activities (ie. petroleum storage / dispensing), and associated risks of harm to the land, surface water and groundwater environments as required by the s48 Notice.

8.1 Conceptual Site Model

Physical & Environmental Setting

The audit site at Glen Helen Lodge is located within the Tjoritja / West MacDonnell Ranges National Park about 130km west of Alice Springs. The tourist accommodation / campsite areas at Glen Helen Lodge are on relatively flat land at an elevation of about 635m AHD. The MacDonnell Ranges are oriented approximately east-west in this area with one of the ranges forming a large escarpment on the south side of the Finke River at Glen Helen Lodge, rising to about 800m AHD. The Finke River runs along the western and southern boundaries of the property, and continues south through Glen Helen Gorge, approximately 800m to the southeast.

It has been reported the Finke River is an ephemeral watercourse which flows for short periods after significant rains, with waterholes persisting adjacent to the Glen Helen Lodge site after river flows cease. Glen Helen Gorge downstream is a permanent waterhole. Aside from being within the national park, the Finke River Headwater Gorges System, which includes Glen Helen Gorge, is listed on the Directory of Important Wetlands in Australia (ID: NT002) with the gorge being one of eight permanent water bodies along the Finke River system.

Site History

The site was historically a cattle station from the early 1900s with homesteads constructed and demolished over time. The freehold land parcel containing Glen Helen Lodge is understood to have been created in 1963, and that there has been a campground or tourist accommodation and facility in some form or another on the site since the 1970s. Glen Helen Lodge was purchased by the Ngurratjuta Aboriginal Corporation in 1992 and operated as camping area with fuel and convenience store. The property has been recently acquired by new owners and it is currently being upgraded to continue operations as part of the Discovery Parks group of tourist accommodation and facilities.

Current and Proposed Land Use

The tourist accommodation facilities have been closed since mid 2022, but it is understood the intention is to resume the tourist accommodation facility in the future.

Geology & Hydrogeology

Review of geological mapping and other technical pers indicates the West MacDonnell ranges in the Glen Helen area are part of a complex sequence of ancient sediments which date from the Middle to late Cambrian (488-542 million years of age). The bedding in the Glen Helen area is reported to be nearly vertical with the formations increasing in age from south to north. The information indicates the formation directly beneath Glen Heln Lodge is a limestone / dolostone (Goyder Formation), with the escarpment to the south across the Finke River interpreted as a quartzite (Pacoota Sandstone).

NT government online mapping indicates groundwater in the Glen Helen area is present within an aquifer classified as 'fractured and karstic rocks (local and intermediate scale)'. A network of groundwater monitoring bores has been established at the audit site. Bores were installed to depths varying from approximately 15-19m, targeting the upper portion of the water table aquifer, which is located within fractured rock, which is consistent with the regional information. Kirsa Environmental has been advised groundwater was intersected at approximately 15 to 16m depth during drilling, with standing water levels in monitoring bores eventually settling at approximately 5.1–6.2m depth, indicating the water table aquifer is probably semi confined or confined.

Groundwater TDS in the monitoring bores installed in the assessment area varied from approximately 2,400-3,000 mg/L. The field measured pH results ranged from approximately 6.6–6.8 and dissolved oxygen was generally in the range of 0.9 to 2.6 mg/L. The oxidation-reduction potential was reported to range from -130 to -146 mV, indicating reducing conditions in the upper portion of the water table aquifer.

Sources of Contamination and Waste

The s48 Notice required the environmental audit to focus on the potential for historical fuel leakage from underground petroleum storage tanks and bowzers ("the activities"). The area where the tanks and bowzers were located can be considered to be the 'source' in the context of the conceptual site model. As noted elsewhere, the former USTs found in the area included one Opal / petrol tank with an estimated volume of 12,300L, one diesel UST with an estimated volume of 5,000L, and another redundant UST (capacity and former contents unknown).

Distribution of contamination and waste

The distribution of contamination and/or waste identified in the assessment works and remaining after the tank removal and validation works are summarized in the following dot points.

- The former tanks bowzers and associated pipework relating to "the activities" specified in the s48 Notice were removed in 2021.
- Land. Residual petroleum hydrocarbon impacts remain in soils in the vicinity of the former underground fuel storage tanks. The information indicates the impacts are relatively localised, and at a depth below approximately 1.5m.
- Soil vapour. There have been petroleum vapour detected in shallow soils in the vicinity of the former tanks and bowzers. A vapour survey has found the impacts dissipate over a relatively short distance from the former tank and bowser area, and does not extend as far as the nearest buildings.
- Groundwater. There have been no detects of petroleum hydrocarbons reported in groundwater directly beneath the former tanks and bowser area in the latest round of monitoring (May 2023). It is noted there were some trace detects of petroleum hydrocarbon indicators reported in an earlier monitoring phase conducted in late 2021, however those results were not considered reliable due to inadequate development of the monitoring bores and poorly documented records of sampling, as well as the sample handling storage and transport. There has however been some elevated lead detected in groundwater in the latest monitoring, which could be an indicator of fuel related impacts as it was historically additives to petrol prior to the early 2000s. In our experience it would be unusual for lead to be found at a fuel impacted site without at least some trace of other petroleum indicators, and it is considered likely this might be an anomaly that can be

resolved via further monitoring to provide confidence to the NT EPA and other stakeholders that the groundwater has not been impacted by the historical activities.

- Surface water. There have been no detects of petroleum hydrocarbons reported in the Finke River adjacent to Glen Helen Lodge. Samples have been collected on multiple occasions and there is a high level of confidence in this monitoring.

Potential exposure pathways and receptors

The main potential receptors for this particular audit include occupants and visitors to the tourist accommodation facilities, future intrusive maintenance / excavation workers, the land environment in general, the Finke River, and groundwater. Given the impacted area is a car park, flora and fauna are not considered relevant receptors, other than terrestrial ecosystems as noted below.

The main potential migration and exposure pathways identified for these receptors are summarized below.

Occupants / visitors.

- There are no complete exposure pathways in the current circumstances. The only impacts remaining are in soils at depth (>1.5m) below a car parking area. Whilst the area remains beneath a car park and is left undisturbed there are no complete exposure pathways. There is also no evidence of any indirect exposure via vapour intrusion, with no significant vapour impacts reported in the vicinity of existing buildings.

Intrusive maintenance / excavation workers.

- In the event intrusive maintenance works are required there is potential for direct and indirect exposures for the workers involved. The results for soils were below applicable screening values for workers via direct contact exposures and vapour intrusion exposures for shallow trenching works.

Land environment.

- Considering the depth of the residual impacts beneath a car park area the only receptors that might be currently exposed to these impacts may be the terrestrial ecosystem and associated lifeforms, with potential for direct and indirect exposure to petroleum hydrocarbon impacts in soils and soil vapour.

Groundwater.

- There is potential for groundwater to become impacted if historical fuel leakage had leached into the subsurface and reached groundwater. The current information suggests this has not occurred and this is not a complete exposure pathway, but it is being recommended that further monitoring is carried out to confirm this.

Finke River

- There is potential for impacts to the Finke River if contaminated groundwater has been impacted by historical fuel leakage and was to discharge to the river. The current information suggests this is not a complete exposure pathway, but it is being recommended that further monitoring is carried out to confirm this.

8.2 Risk of Harm to Environmental Values

The following tables summarise the Auditor’s considerations regarding the risk of harm posed by the identified contamination to the land and water environments. These are framed in terms of the environmental values under the Victorian regulatory framework, which as noted earlier are considered to broadly align with the categories of culture, country and tourism as nominated in the Tjoritja / West MacDonnell National Park Joint Management Plan.

Table 27. Environmental indicators and objectives for land

Environmental values (EVs) of land	Protected in this land use category?	Indicators	Objectives	Relevance to this audit	Risk of harm posed by waste / contamination
Land dependent ecosystems and species – natural ecosystems	Y	Inorganic and organic contaminants set out in Appendix A of Schedule B2 of the NEPM (ASC) and any other contaminants present at the site as determined by the current use or site history assessed in accordance with the NEPM (ASC)	Ecological and health based investigation or screening level in the NEPM (ASC), unless – (a) there is no such investigation or screening level; or (b) due to site specific characteristics the more appropriate objective is: (i) the level derived using the risk assessment methodology described in the NEPM (ASC); or (ii) the background level determined in accordance with section 36 of the Act, in which case the objective for the indicator is (i) or (ii), as applicable.	These are fundamental values that are relevant for consideration for most environmental audits involving land and water, and are considered relevant to this audit.	The information reviewed indicates there has been some degree of harm arising from the activities to the land in the immediate vicinity of the former tanks and bowzers. As noted elsewhere, the impacts are relatively localised in the immediate vicinity of the former tanks and bowzers, and are also limited to soils at a depth below approximately 1.5m. Taking into consideration the localised impacts, depth of impacts, and use of the area as a car park, the risk to the environment and human health is acceptably low. The risk profile could change if the use of the area changed to something more sensitive.
- modified ecosystems	Y				
- highly modified ecosystems	Y				
Human health	Y				
Buildings & structures	Y	pH, sulfate, chloride, redox potential, salinity or any chemical substance or waste that may have a detrimental impact on the structural integrity of buildings or other structures	Land that is not corrosive to or otherwise adversely affecting the integrity of structures or building materials	Not currently relevant as the area is a car park and it is believed there are no utilities or services running through this area.	Taking into consideration the localised impacts, depth of impacts, and the use of the area as a car park, the risk is considered acceptably low.

Environmental values (EVs) of land	Protected in this land use category?	Indicators	Objectives	Relevance to this audit	Risk of harm posed by waste / contamination
Aesthetics	Y	Any chemical substance or waste that may be offensive to the senses	Land that is not offensive to the senses of human beings	Not currently relevant as the area is a car park overlying the affected area and there is no current plausible access to the remaining affected soils.	Taking into consideration the localised impacts, depth of impacts, and the use of the area as a car park, the risk is considered acceptably low.
Production of food, flora and fibre	N	Inorganic and organic contaminants set out in Appendix A of Schedule B2 of the NEPM (ASC) and any other contaminants present at the site as determined by the site history assessed in accordance with the NEPM (ASC)	The levels specified in the Food Standards Code detected in any food, flora or fibre produced at the site. Levels that do not adversely affect produce quality or yield	Not relevant under the current or proposed ongoing land use.	Taking into consideration the localised impacts, depth of impacts, and the use of the area as a car park, the risk is considered acceptably low.

The ERS defines "sensitive use" to include land residential use, a child care centre, pre-school, or primary school being either high density where there is minimal access to soils, and other (lower density) where there is generally substantial access to soil.

Table 28. Environmental values, indicators and objectives for waters (groundwater)

Environmental values (EVs) of the groundwater	Protected in this groundwater segment?	Indicators (as specified in the ERS)	Objectives (as specified in the ERS unless noted otherwise)	Relevance to this audit	Risk of harm posed by waste / contamination
Water dependent ecosystems and species (including surface waters and subterranean waters with a hydrogeological setting conducive to the presence of troglofaunal and stygofauna)	Y	For groundwater that discharges to surface water, the indicators are those applicable to the relevant surface water as specified in the ERS. Indicators that are relevant to the subterranean species of troglofauna and stygofauna, which may include TSS, salinity, toxicants in water, toxicants in sediment and dissolved oxygen	<p>Objectives specified in the ERS:- Values specified either in the ERS for some general water pollutants, and otherwise values listed in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG) (available on the webpage www.waterquality.gov.au/anz-guidelines).</p> <p>The ERS also notes the groundwater quality should not adversely affect the troglofauna and stygofauna that depend on the groundwater.</p>	<p>This is relevant in the context of potential groundwater interaction with the waters in the nearby Finke River, which is located approximately 110m from the former fuel bowsers and underground fuel storage tanks, and approximately 50m from the boundary of the Glen Helen Lodge property, and about 90m from where the fuel tanks and bowsers were located.</p> <p>As stated in the ANZG 2018, effectively unmodified or other highly valued ecosystems, typically (but not always) occur in national parks and conservation reserves, or in remote and inaccessible locations. Based on the remote location and the Finke River being within a national park, the audit has adopted water quality criteria based on 99% level species protection (high conservation or ecological value systems).</p> <p>The current version of the Groundwater Dependent Ecosystems (GDEs) Atlas¹⁵ indicates there have been no subterranean GDEs analysed within this region, so this is of limited use at this point in time in identifying potential for subterranean GDEs. A CSIRO report by Hose et al (2015)¹⁶ notes "stygofauna are found in aquifers across Australia, predominantly in aquifers with large (mm or greater) pore spaces, especially alluvial, karstic and some fractured rock aquifers. The size of the pore spaces is a key determinant of the suitability of an aquifer as stygofauna habitat."</p> <p>This CSIRO publication also noted that stygofauna are found across a range of water quality conditions (from fresh to saline) but most common in fresh and brackish water (with EC of less than 5000uS/cm) (3,200mg/L TDS).</p>	<p>Some elevated lead results have been reported but as discussed in the report these are considered likely to be anomalous and will need to be checked via further monitoring.</p> <p>Taking into consideration the absence of any petroleum impacts in the groundwater directly beneath the area, the risk is considered acceptably low, but this needs to be confirmed with further monitoring.</p>

¹⁵ Groundwater Dependent Ecosystems Atlas. Australian Government, Bureau of Meteorology. <http://www.bom.gov.au/water/groundwater/gde/>

¹⁶ Hose GC, J Sreekanth, Barron O, Pollino C (2015) Stygofauna in Australian Groundwater Systems: Extent of knowledge. CSIRO, Australia.

Environmental values (EVs) of the groundwater	Protected in this groundwater segment?	Indicators (as specified in the ERS)	Objectives (as specified in the ERS unless noted otherwise)	Relevance to this audit	Risk of harm posed by waste / contamination
				In the absence of any definitive information otherwise, this audit has taken a conservative approach and assumed there could be at least some subterranean GDEs present, even if it might not be of any recognised importance at this point in time, and has used the same indicators as for other water dependent ecosystems to assess risks to these.	
Potable water supply (desirable)	N	Indicators specified in the ADWG	Health-related guideline value for each indicator specified in the ADWG. Aesthetic guideline value for each indicator specified in the ADWG.	Relevant. Under the Victorian regulatory framework, this is not a protected EV in this groundwater segment according to the ERS. However, because of the remote location and limited options for water supply, the possible use for this purpose should not be ruled out as in theory the water could be subjected to treatment to allow for use for this purpose.	Taking into consideration the absence of any petroleum impacts in the groundwater directly beneath the area, the risk is considered acceptably low, but this needs to be confirmed with further monitoring.
Potable water supply (acceptable)	N	Indicators specified in the ADWG	Health-related guideline value for each indicator specified in the current version of the Australian Drinking Water Guidelines (ADWG). Aesthetic guideline value for each indicator specified in the ADWG.	Relevant. Under the Victorian regulatory framework, this is not a protected EV in this groundwater segment according to the ERS. However, because of the remote location and limited options for water supply, the possible use for this purpose should not be ruled out as in theory the water could be subjected to treatment to allow for use for this purpose.	Taking into consideration the absence of any petroleum impacts in the groundwater directly beneath the area, the risk is considered acceptably low, but this needs to be confirmed with further monitoring.
Potable mineral water supply	Y	Indicators specified in the ADWG	Health guideline values for each indicator specified in the ADWG. Aesthetic guideline values for each indicator set out in the ADWG.	Not relevant. The audit site is not in a recognised mineral water producing area.	Not considered further
Agriculture and irrigation (irrigation)	Y	Indicators specified for irrigation and water for general on-farm use in the ANZG	Level of that indicator specified in the ANZG	Relevant. This is a protected EV in this groundwater segment according to the ERS. Because of the remote location and limited options for water supply, the possible use for this purpose should not be ruled out on the basis of the water quality alone (irrespective of possible limitation relating to yields from the water table aquifer).	Taking into consideration the absence of any petroleum impacts in the groundwater directly beneath the area, the risk is considered acceptably low, but this needs to be confirmed with further monitoring.
Agriculture and irrigation (stock watering)	Y	Indicators specified for livestock drinking water quality in the ANZG	Level of that indicator specified in the ANZG	Not relevant. This EV is not compatible and is unlikely to be realised within this conservation setting.	Not considered further

Environmental values (EVs) of the groundwater	Protected in this groundwater segment?	Indicators (as specified in the ERS)	Objectives (as specified in the ERS unless noted otherwise)	Relevance to this audit	Risk of harm posed by waste / contamination
Industrial and commercial use	Y	Indicators specific to the particular industrial or commercial activity and their use of water	Groundwater quality that is suitable for its industrial or commercial use	Relevant. This is a protected EV in this groundwater segment according to the ERS. Because of the remote location and limited options for water supply, the possible use for this purpose should not be ruled out on the basis of the water quality alone (irrespective of possible limitation relating to yields from the water table aquifer).	Taking into consideration the absence of any petroleum impacts in the groundwater directly beneath the area, the risk is considered acceptably low, but this needs to be confirmed with further monitoring.
Water-based recreation (primary contact recreation)	Y	E.coli Chemical hazards, aesthetic effects	10 E. coli/100 mL (if no human faecal contamination sources identified) 0 E. coli/100 mL (if human faecal contamination sources identified) Level of indicators (where specified) and descriptions in applicable guidance, in the Guidelines for Managing Risks in Recreational Water, published by the National Health and Medical Research Council in 2008	Relevant. This is a protected EV in this groundwater segment according to the ERS. Because of the remote location and limited options for water supply, the possible use for this purpose should not be ruled out on the basis of the water quality alone (irrespective of possible limitation relating to yields from the water table aquifer).	Taking into consideration the absence of any petroleum impacts in the groundwater directly beneath the area, the risk is considered acceptably low, but this needs to be confirmed with further monitoring.
Traditional owner cultural values	Y	The ERS does not specify indicators for this EV, but notes indicators for this EV must be developed in consultation with Traditional Owners. The ANZG guidelines describe a process by which Traditional Owner cultural values can be determined and indicators and objectives identified (refer to the 'Cultural and spiritual values' webpage of the ANZG, 2018. Other approaches developed in consultation with	Water quality that meets relevant objectives determined in consultation with Traditional Owners via the process outlined in ANZG2018 or an alternative approach.	This audit acknowledges and recognises the need for engagement with Traditional Owners when the cultural values of waters may be threatened by contamination. According to the ANZG website, cultural and spiritual values may relate to a range of uses and issues, including spiritual relationships, language, song lines, stories, sacred places, customary use, the plants and animals associated with water, drinking water, and recreational or commercial activities. Based on the audit site's proximity to the Finke River and Glen Helen Gorge, it is considered to be within an area of cultural sensitivity. If a culturally sensitive area was found to be under threat from contamination derived from the audit site, then the auditor would require the responsible entity to engage with Traditional Owners. Consideration of whether this waterway might be under threat from contamination at this particular audit site is provided later in this audit report.	Taking into consideration the absence of any petroleum impacts in the groundwater directly beneath the area, the risk is considered acceptably low, but this needs to be confirmed with further monitoring.

Environmental values (EVs) of the groundwater	Protected in this groundwater segment?	Indicators (as specified in the ERS)	Objectives (as specified in the ERS unless noted otherwise)	Relevance to this audit	Risk of harm posed by waste / contamination
		Traditional Owners can be adopted.			
Buildings and structures	Y	pH, sulphate, chloride, redox potential, salinity or any chemical substance or waste that may have a detrimental impact on the structural integrity of buildings or other structures	Groundwater that is not corrosive to or otherwise adversely affecting structures or building. Results were considered with regard to Section 6 of the Australian Piling Code (AS2159) for groundwater conditions and potential adverse effects on buildings and structures.	Not relevant. Depth to groundwater (5.2-6.1m) means it is unlikely any buildings or structures will come into contact with groundwater.	Not considered further
Geothermal properties	Y	Temperature between 30 and 70 degrees Celsius	Geothermal properties of groundwater to be maintained for current and future users of the resource	Not relevant. Background water quality (temperature) is not within the range that could support geothermal applications.	Not considered further

Table 29: Impacted environmental value summary table (groundwater)

Precluded environmental values	Contaminant(s)
Water dependent ecosystems and species	Lead (considered likely to be anomalous and will need to be checked via further monitoring)
Potable water supply	Lead (considered likely to be anomalous and will need to be checked via further monitoring)
Mineral water supply	NE
Agriculture and irrigation (Irrigation)	NE
Agriculture and irrigation (Stock watering)	NE
Water-based recreation (Primary contact recreation)	NE
Industrial and commercial use	NE
Traditional Owner cultural values	NE
Buildings and structures	NE
Geothermal properties	NE

Notes:

(B/N) – background elevation (R) – regional contamination

NA – Not applicable NE – No exceedance

Note that the values listed above against the environmental values ‘water dependent ecosystems and species’ are simply those results that exceeded the adopted screening criteria. As discussed elsewhere in this report, the environmental value is considered to be precluded at the site only, but does not threaten the nearest surface water where groundwater might in theory discharge.

8.3 Practicability / Need for Further Remediation

The Victorian regulatory framework requires groundwater contamination to be cleaned up so that environmental values of groundwater are restored. The framework recognises that in some cases this will not be possible or feasible, however in all cases contaminated groundwater must be cleaned up so far as reasonably practicable. In this particular case, the primary source/s (ie. the former tanks, bowsers and pipework) have been removed. Based on the comparatively limited and localised impacts remaining in soils at depth (>1.5m) and their location beneath what is now a car park, and the absence of any detects of petroleum in groundwater, it is considered there is no pressing need for any further remediation action at this time.

8.4 Further Management

Further management measures considered necessary are outlined below.

- Groundwater monitoring. Longer term groundwater monitoring is considered necessary to provide confidence to the NT EPA and other stakeholders that there has been no harm to groundwater arising from the activities. A groundwater monitoring plan (GMP) has been developed which provides for two additional monitoring events to be completed over the next 12 months, with a review of the need (if any) for further monitoring beyond that. This GMP should be implemented and closed out in accordance with the mechanisms included in the plan. Timetable for implementation – over the 12 months following completion of this audit report.

- Groundwater use / extraction. Given there is potential contamination of groundwater by lead (to be confirmed by further monitoring), groundwater should not be extracted or used at the site unless it is first tested and confirmed to be suitable for the intended use.
- Building controls. If any buildings (above ground or including basements) are proposed to be constructed either directly above or in the vicinity of the former USTs and bowser area, then this should be subject to further assessment to consider the need (if any) for vapour mitigation measures for those buildings. This requirement should be included in the site's existing management documentation to ensure it is carried forward for future site owners / occupants. Timetable for implementation – to be written into the site's management documentation within 6 months following completion of this audit report.
- Subsurface works controls. Any subsurface works in the vicinity of the former USTs and bowser area (for example, utility maintenance or installation) should be planned and executed with regard to the possible presence of hydrocarbon impacted soils below approximately 1.5m depth, with an appropriate environmental management plan and health and safety plan in place. This requirement should be included in the site's existing management documentation to ensure it is carried forward for future site owners / occupants. Timetable for implementation – to be written into the site's management documentation within 6 months following completion of this audit report.

9. AUDIT CONCLUSIONS

This environmental audit has been completed for a portion of the Glen Helen Lodge site. The audit has been performed in accordance with the relevant provisions of Part 6 of the *Waste Management and Pollution Control Act 1998*, and (as far as applicable to the Northern Territory) with the relevant provisions of the *Environment Protection Act 2017* of Victoria which is the jurisdiction where this auditor holds accreditation recognized by the Northern Territory Environment Protection Authority (NT EPA).

The audit was required to satisfy conditions of a notice to carry out an environmental audit program issued by the NT EPA pursuant to Section 48(1) of the *Waste Management and Pollution Control Act 1998* (referred to hereon as “the s48 Notice”).

The audit provides an independent review of the information relating to the assessments, remediation and validation works completed and specifically to address the requirements for the audit as specified in the s48 Notice reproduced below:-

- a. determine the type, amount and distribution and mobility of contaminants and wastes present in the environment resulting from the activities;
- b. determine the risk of any possible harm or detriment to the land, surface water and groundwater environments as a result of identified contamination;
- c. where a risk of any possible harm or detriment to a segment of the environment has been determined in requirement b above, recommend any further assessment, risk analysis (human health or ecological) or remedial measures necessary to reduce the risk to an acceptable level; and
- d. include an indicative implementation timetable for any recommended clean-up and/or management works referred to in requirement c

It is noted the s48 Notice specifically relates to impacts associated with underground petroleum products storage and dispensing in a specific area of the property, and that is what has been considered as “the activities” referred to in item a. above. Various other potentially contaminating activities have been identified at the Glen Helen Lodge site such as above ground fuel storage / dispensing in other parts of the site, landfilling and wastewater / effluent treatment and disposal but these are specifically excluded from this audit as they were not required to be considered as part of the s48 Notice.

The objectives of the audit have been achieved, including determining the type, amount and distribution and mobility of contaminants and wastes present in the environment resulting from the activities, and associated risks of harm. The auditor concludes that the site is suitable for ongoing commercial and recreational open space as currently developed.

Further details of the audit outcomes are provided in the following points.

Type amount and distribution of contamination and waste

- o The former tanks bowzers and associated pipework relating to “the activities” specified in the s48 Notice were removed in 2021. The information reviewed indicates the contaminants and wastes present in the environment resulting from the activities are limited to residual petroleum hydrocarbon impacts in soils in the vicinity of the former

underground fuel storage tanks. The information indicates the impacts are relatively localised, and at a depth below approximately 1.5m.

- There have been no detects of petroleum hydrocarbons reported in groundwater directly beneath the former tanks and bowser area in the latest round of monitoring (May 2023). It is noted there were some trace detects of petroleum hydrocarbon indicators reported in an earlier monitoring phase conducted in late 2021, however those results were not considered reliable due to inadequate development of the monitoring bores and poorly documented records of sampling, as well as the sample handling storage and transport. There has however been some elevated lead detected in groundwater in the latest monitoring, which could be an indicator of fuel related impacts as it was historically additives to petrol prior to the early 2000s. In our experience it would be unusual for lead to be found at a fuel impacted site without at least some trace of other petroleum indicators, and it is considered likely this might be an anomaly that can be resolved via further monitoring to provide confidence to the NT EPA and other stakeholders that the groundwater has not been impacted by the historical activities.
- There have been no detects of petroleum hydrocarbons reported in the Finke River adjacent to Glen Helen Lodge. Samples have been collected on multiple occasions and there is a high level of confidence in this monitoring.
- There have been petroleum vapour detected in shallow soils in the vicinity of the former tanks and bowsers. A vapour survey has found the impacts dissipate over a relatively short distance from the former tank and bowser area, and does not extend as far as the nearest buildings.

Risk of harm or detriment to land, surface water and groundwater

- Land. The information reviewed indicates there has been some degree of harm arising from the activities to the land in the immediate vicinity of the former tanks and bowsers. As noted above, the impacts are relatively localised in the immediate vicinity of the former tanks and bowsers, and are also limited to soils at a depth below approximately 1.5m.
- Groundwater. The information reviewed suggests there is unlikely the activities have resulted in any harm to groundwater, although as noted above this will need to be confirmed via some further monitoring.
- Surface water. The information reviewed suggests there is unlikely the activities have resulted in any harm to surface water in the Finke River.

Further assessment, risk analysis or remedial measures

- Groundwater monitoring. Longer term groundwater monitoring is considered necessary to provide confidence to the NT EPA and other stakeholders that there has been no harm to groundwater arising from the activities. A groundwater monitoring plan (GMP) has been developed which provides for two additional monitoring events to be completed over the next 12 months, with a review of the need (if any) for further monitoring beyond that. This GMP should be implemented and closed out in accordance with the mechanisms included in the plan. Timetable for implementation – over the 12 months following completion of this audit report.
- Groundwater beneath the site is possibly contaminated, based on an evaluation of lead and is potentially not suitable for the environmental value of water-dependant ecosystems and species and potable water. The site is potentially a source of the lead impacts (subject to confirmation via the GMP), and the groundwater should not be used without prior testing and review of results by a suitably qualified professional to confirm its suitability for the

proposed use. It may be extracted for the purposes of environmental monitoring or remediation.

- Building controls. If any buildings (above ground or including basements) are proposed to be constructed either directly above or in the vicinity of the former USTs and bowser area, then this should be subject to further assessment to consider the need (if any) for vapour mitigation measures for those buildings. This requirement should be included in the site's existing management documentation to ensure it is carried forward for future site owners / occupants. Timetable for implementation – to be written into the site's management documentation within 6 months following completion of this audit report.
- Subsurface works controls. Any subsurface works in the vicinity of the former USTs and bowser area (for example, utility maintenance or installation) should be planned and executed with regard to the possible presence of hydrocarbon impacted soils below approximately 1.5m depth, with an appropriate environmental management plan and health and safety plan in place. This requirement should be included in the site's existing management documentation to ensure it is carried forward for future site owners / occupants. Timetable for implementation – to be written into the site's management documentation within 6 months following completion of this audit report.

10. REFERENCES

Primary legislation

- Environment Protection Act 2017 (Vic)
- Northern Territory of Australia Water Act 1992 (NT)
- Waste Management and Pollution Control Act 1998 (NT)

Subordinate legislation

- Environment Protection Regulations 2021 (Vic)
- Environment Reference Standard 2021 (Vic)
- Northern Territory of Australia Water Regulations 1992 (NT)

Guidelines issued by NT EPA

- Northern Territory Contaminated Land Guideline, version 1.0, June 2017

Guidelines issued by EPA Victoria under s 203 of the Environment Protection Act 2017

- Environmental auditor guidelines for appointment and conduct (publication 865)
- Environmental auditor guidelines – Provision of environmental audit statements and reports for environmental audits and preliminary risk screen assessments (publication 2022)
- Guidelines for conducting environmental audits (publication 2041)
- Guideline for conducting preliminary risk screen assessments (publication 2021)
- Guideline on clean up and management of contaminated groundwater (publication 2001)

National Environment Protection Measures

- National Environment Protection (Assessment of Site Contamination) Measure (ASC NEPM), 1999, as amended from time to time
- National Environment Protection Measure (Ambient air quality) 1998, as amended from time to time

Policies

- EPA Victoria Contaminated Land Policy (publication 1915)

EPA Victoria Publications

- Arsenic in mine tailings, sand, and rock (IWRG431)
- Assessing and controlling contaminated land risks: a proposed guide to meeting the duty to manage for those in management or control of land (publication 1977)
- Assessing planning proposals within a buffer of a landfill (publication 1642)
- Closed landfill guidelines (publication 1490)
- Contaminated land: understanding section 35 of the Environment Protection Act (publication 1940)
- Department of Sustainability Victorian Best Practice Guideline on Assessing and Managing Coastal Acid Sulfate Soils, October 2010
- Government Initiative website <https://www.waterquality.gov.au/issues/acid-sulfate-soils> Groundwater sampling guidelines (publication 669)
- Guide to the Environment Reference Standard (publication 1992)
- Hydrogeological assessment (groundwater quality) guidelines (publication 668)
- Landfill gas fugitive emissions monitoring guideline (publication 1684)
- Landfill licensing (publication 1323)

- Notifiable contamination guideline: Duty to notify of contaminated land (publication 2008)
- Proposed methodology for deriving background level concentrations when assessing potentially contaminated land (publication 1936)
- Using SEPPs and WMPs in the new environment protection framework (publication 1994)

Other Published Guidelines and Standards

- Australian and New Zealand Guidelines for Fresh and Marine Water Quality website
<https://www.waterquality.gov.au/anz-guidelines>
- Australian Government. National Health and Medical Research Council (*2008). Guidelines for Managing Risks in Recreational Waters.
- Australian and New Zealand Environment and Conservation Council and Agriculture & Resources Management Council of Australia and New Zealand (2000). Australia and New Zealand Guidelines for Fresh and Marine Water Quality. National Water Quality Management Strategy.
- AS 4482.1 Guide to the sampling and investigation of potentially contaminated soil, Part 1: Non-volatile and semi-volatile compounds
- AS 4482.2 Guide to the sampling and investigation of potentially contaminated soil, Part 2: Volatile substances
- Technical Reports issued by the Cooperative Research Centre for Contamination Assessment and Remediation of the Environment (CRC CARE).
https://www.crccare.com/publications/technical_reports
- CRC Care National Remediation Framework, 2019
https://www.crccare.com/knowledge_sharing/national-remediation-framework
- PFAS National Environmental Management Plan (NEMP) (2020), Developed by the National Chemicals Working Group (NCWG) of the Heads of EPAs Australia and New Zealand (HEPA).

Contaminated land and planning

- Department of Sustainability and Environment 'writing planning permits', June 2003 Ministerial Direction No. 1 Potentially Contaminated Land, 27 August 2021
- Planning Authority, Greenfield subdivision permits – a model approach, May 2020
- Planning Practice Note 30 – Potentially Contaminated Land, July 2021
- Victoria Planning Provisions (clause 13.04-1S) Contaminated land and potentially contaminated land
- Victorian Planning Provisions (clause 45.03) Environmental Audit Overlay
- Victorian Planning Provisions (clause 65.01) Decision Guidelines, Approval of an Application or Plan
- Victorian Planning Provisions (clause 73.01) Meaning of Terms – General Terms (Potentially Contaminated Land)
- Victorian Planning Provisions (clause 37.05-8) Docklands Zone
- Victorian Planning Provisions (clause 37.07-6) Urban Growth Zone

ENVIRONMENTAL AUDIT STATEMENT



Environmental audit statement

Under Part 8.3 of the *Environment Protection Act 2017*

Publication F1032 published September 2021



The purpose of an environmental audit is:

- a) to assess the nature and extent of the risk of harm to human health or the environment from contaminated land, waste, pollution or any activity; and
- b) to recommend measures to manage the risk of harm to human health or the environment from contaminated land, waste, pollution or any activity; and
- c) to make recommendations to manage the contaminated land, waste, pollution or activity.

This statement is a summary of the findings of an environmental audit conducted under Part 8.3 of the *Environment Protection Act 2017* for:

Glen Helen Lodge, 8495 Namatjira Drive, Mount Zeil, NT

Further details are provided in the environmental audit report that accompanies this statement.

Section 1: Environmental audit overview

Environmental audit ID number: NTEPA2021/0004-270

Environmental auditor details

Name: Steven Jon Kirsanovs
Company: Kirs Environmental
Address: PO Box 1243 Unley SA 5061
Phone: 08 8271 9025
Email: stevek@kirsenv.com.au

Site owner or occupant

Name: Discovery Parks
Company: Beston Parks Land Co Pty Ltd (ACN 111 783 423)

Environmental auditor engaged by

Name: Cameron Miller
Company: Ngurratjuta/Pmara Ntjarra Aboriginal Corporation
Relationship to site owner: Authorised representative of the former site owner

Reason for the environmental audit

- Requirement under the *Planning and Environment Act 1987* (e.g. planning permit)
No details of planning permit provided
- Requirement under the *Environment Protection Act 2017* (e.g. remedial notice or licence)
- Requirement under other legislation

Environmental audit statement

-
- Other
Requirement of Notice issued under S48(1) of the *Waste Management and Pollution Control Act* (NT) 1998 (dated 26 August 2021)
-

Section 2: Environmental audit scope

Details of the site in respect of which the environmental audit was conducted

Site/premises name:	Glen Helen Lodge
Address:	8495 Namatjira Drive, Mount Zeil 0872
Title details:	NT Portion 830 from Plan A 000315 (CUFT Volume 849 Folio 156)
Area (m ²):	71,800m ² (area of Portion 830, noting the actual investigation area is only a small part of this land parcel)

- a plan of the site is attached

Use or proposed use for which the site is being audited

Sensitive land use categories

Note that sensitive land uses in the *Environment Reference Standard* (ERS 2021) are categorised as lower and high density. Lower density is where there is generally substantial access to soil and high density is restricted to developments that make maximum use of available land space, and there is minimal access to soil. For planning purposes, the *Ministerial Direction No.1* (MD No.1) considers secondary schools and children's playgrounds to be sensitive land uses.

- High density
- Other (lower density)
- Children's playground (indoor)
- Children's playground (indoor)
- Residential land use
- Child care centre
- Pre-school
- Primary school
- Secondary school

Other land use categories

- Recreation/open space
- Parks and reserves
- Agricultural
- Commercial
- Industrial
- Other land uses not captured by the above as described here:

Elements of the environment assessed in the environmental audit

- Ambient air
- all environmental values were considered
- all environmental values other than the following were considered.
- o Life, health and well-being of other forms of life, including the protection of ecosystems and biodiversity
 - o The useful life and aesthetic appearance of buildings, structures, property and materials;

Environmental audit statement

- Climate systems that are consistent with human development, the life, health and well-being of humans, and the protection of ecosystems and biodiversity.

Ambient sound

- all environmental values were considered
- all environmental values other than the following were considered:

Land

- all environmental values that apply to the land use category were considered
- all environmental values that apply to the land use category, other than the following, were considered:
 - Production of food, flora and fibre.

Water

- Surface water
 - all environmental values that apply to the applicable segment were considered OR
 - all environmental values that apply to the applicable segment, other than the following, were considered:
 - Groundwater
 - all environmental values that apply to the applicable segment were considered OR
 - all environmental values that apply to the applicable segment, other than the following, were considered:
-

Standards and reference documents considered

NT Guidance / references:-

- Waste Management and Pollution Control Act (NT) 1998
- Tjoritja / West MacDonnell National Park Joint Management Plan (NT Parks & Wildlife commission, NT government, March 2018)
- NT EPA, Northern Territory Contaminated Land Guideline, June 2017.

National guidance / references:-

- National Environment Protection (Assessment of Site Contamination) Measure (NEPC 1999, as amended 2013) ("the ASC NEPM")
- Australian Government 2018, *Charter: National Water Quality Management Strategy*, Department of Agriculture and Water Resources, Canberra, March. CC BY 3.0
- The Australian drinking water guidelines (as updated from time to time)
- The Australian and New Zealand Guidelines for Fresh and Marine Water Quality
- The Guidelines for managing risks in recreational water

Victorian guidance / references:-

- Environment Reference Standard 2021 ("the ERS")
- Environmental auditor guidelines for appointment and conduct (EPA publication 865)
- Environmental auditor guidelines – Provision of environmental audit statements and reports for environmental audits and preliminary risk screen assessments (EPA publication 2022)
- Guidelines for conducting environmental audits (EPA publication 2041)
- Guideline on clean up and management of contaminated groundwater (EPA publication 2001)
- Assessing and controlling contaminated land risks: a proposed guide to meeting the duty to manage for those in management or control of land (EPA publication 1977)
- Contaminated land: understanding section 35 of the Environment Protection Act (EPA publication 1940)

Assumptions made during the environmental audit or any limitations

None.

Exclusions from the environmental audit and the rationale for these

The following elements of the environment and environmental values specified in the ERS were excluded:-

Ambient air

- All environmental values excluded.

Environmental audit statement

Rationale / Justification

The only EVs considered relevant for this contaminated land audit were those relating to human health, and 'local amenity and aesthetic enjoyment' and 'visibility'. These were considered in the assessment of the land segment.

Ambient sound

- All environmental values excluded.

Rationale / Justification

All the EVs for this element were excluded as they were not considered relevant for this particular audit (contaminated land and suitability of land).

Water (surface water)

- All environmental values excluded.

Rationale / Justification

All the EVs for this element were excluded as there are no surface water bodies on the audit site. Surface water bodies offsite (Finke River and Glen Helen Gorge) are assessed as a part of groundwater impacts (i.e. impacts arising from groundwater discharge to the nearest surface water).

Water (groundwater)

- No exclusions. All environmental values that apply to the applicable segment were considered.

This statement is accompanied by the following environmental audit report:

Title:	Environmental Audit Report, Glen Helen Lodge 8495 Namatjira Drive, Mount Zeil, NT
Report no:	Audit No.NTEPA2021/0004-270
Date:	30 November 2023

Section 3: Results and recommendations of the environmental audit

Land use suitability

Based on my assessment of the site in relation to the risk of harm to human health or the environment from contaminated land, waste or pollution, I am of the opinion that the site is suitable for the following land uses if the recommendations I have made in this statement are complied with:

Sensitive land use categories

Sensitive land use categories

- ~~High density~~
- ~~Other (lower density)~~
- ~~Children's playground (indoor)~~
- ~~Children's playground (indoor)~~
- ~~Residential land use~~
- ~~Child care centre~~
- ~~Pre-school~~
- ~~Primary school~~
- ~~Secondary school~~

Other land use categories

- Recreation/open space
- ~~Parks and reserves~~
- ~~Agricultural~~
- Commercial

Environmental audit statement

- Industrial
- Other land uses not captured by the above as described here:

Results of the environmental audit

The audit was required to satisfy conditions of a notice to carry out an environmental audit program issued by the NT EPA pursuant to Section 48(1) of the Waste Management and Pollution Control Act 1998) (referred to hereon as “the s48 Notice”). The audit provides an independent review of the information relating to the assessments, remediation and validation works completed and specifically to address the requirements for the audit as specified in the s48 Notice reproduced below:-

- a. determine the type, amount and distribution and mobility of contaminants and wastes present in the environment resulting from the activities;
- b. determine the risk of any possible harm or detriment to the land, surface water and groundwater environments as a result of identified contamination;
- c. where a risk of any possible harm or detriment to a segment of the environment has been determined in requirement b above, recommend any further assessment, risk analysis (human health or ecological) or remedial measures necessary to reduce the risk to an acceptable level; and
- d. include an indicative implementation timetable for any recommended clean-up and/or management works referred to in requirement c

It is noted the s48 Notice specifically relates to impacts associated with underground petroleum products storage and dispensing in a specific area of the property, and that is what has been considered as “the activities” referred to in item a. above. Various other potentially contaminating activities have been identified at the Glen Helen Lodge site such as above ground fuel storage / dispensing in other parts of the site, landfilling and wastewater / effluent treatment and disposal but these are specifically excluded from this audit as they were not required to be considered as part of the s48 Notice.

The objectives of the audit have been achieved, including determining the type, amount and distribution and mobility of contaminants and wastes present in the environment resulting from the activities, and associated risks of harm.

I conclude that the site is suitable for ongoing commercial and recreational open space as currently developed.

Further details of the audit outcomes are provided in the following points.

Type amount and distribution of contamination and waste

- The former tanks bowers and associated pipework relating to “the activities” specified in the s48 Notice were removed in 2021. The information reviewed indicates the contaminants and wastes present in the environment resulting from the activities are limited to residual petroleum hydrocarbon impacts in soils in the vicinity of the former underground fuel storage tanks. The information indicates the impacts are relatively localised, and at a depth below approximately 1.5m.
- There have been no detects of petroleum hydrocarbons reported in groundwater directly beneath the former tanks and bowser area in the latest round of monitoring (May 2023). It is noted there were some trace detects of petroleum hydrocarbon indicators reported in an earlier monitoring phase conducted in late 2021, however those results were not considered reliable due to inadequate development of the monitoring bores and poorly documented records of sampling, as well as the sample handling storage and transport. There has however been some elevated lead detected in groundwater in the latest monitoring, which could be an indicator of fuel related impacts as it was historically

Environmental audit statement

additives to petrol prior to the early 2000s. In our experience it would be unusual for lead to be found at a fuel impacted site without at least some trace of other petroleum indicators, and it is considered likely this might be an anomaly that can be resolved via further monitoring to provide confidence to the NT EPA and other stakeholders that the groundwater has not been impacted by the historical activities.

- There have been no detects of petroleum hydrocarbons reported in the Finke River adjacent to Glen Helen Lodge. Samples have been collected on multiple occasions and there is a high level of confidence in this monitoring.
- There have been petroleum vapour detected in shallow soils in the vicinity of the former tanks and bowzers. A vapour survey has found the impacts dissipate over a relatively short distance from the former tank and bowser area, and does not extend as far as the nearest buildings.

Risk of harm or detriment to land, surface water and groundwater

- Land. The information reviewed indicates there has been some degree of harm arising from the activities to the land in the immediate vicinity of the former tanks and bowzers. As noted above, the impacts are relatively localised in the immediate vicinity of the former tanks and bowzers, and are also limited to soils at a depth below approximately 1.5m.
- Groundwater. The information reviewed suggests there is unlikely the activities have resulted in any harm to groundwater, although as noted above this will need to be confirmed via some further monitoring.
- Surface water. The information reviewed suggests there is unlikely the activities have resulted in any harm to surface water in the Finke River.

Recommendations

- a. Building controls. If any buildings (above ground or including basements) are proposed to be constructed either directly above or in the vicinity of the former USTs and bowser area, then this should be subject to further assessment to consider the need (if any) for vapour mitigation measures for those buildings. This requirement should be included in the site's existing management documentation to ensure it is carried forward for future site owners / occupants. Timetable for implementation – to be written into the site's management documentation within 6 months following completion of this audit report.
- b. Any subsurface works in the vicinity of the former USTs and bowser area (for example, utility maintenance or installation) should be planned and executed with regard to the possible presence of hydrocarbon impacted soils below approximately 1.5m depth, with an appropriate environmental management plan and health and safety plan in place. This requirement should be included in the site's existing management documentation to ensure it is carried forward for future site owners / occupants. Timetable for implementation – to be written into the site's management documentation within 6 months following completion of this audit report.
- c. Groundwater beneath the site is possibly contaminated, based on an evaluation of lead and is potentially not suitable for the environmental value of water-dependant ecosystems and species and potable water. The site is potentially a source of the lead impacts, and the groundwater should not be used without prior testing and review of results by a suitably qualified professional to confirm its suitability for the proposed use. It may be extracted for the purposes of environmental monitoring or remediation.
- d. The groundwater management plan (GMP) attached to this audit statement (prepared by Tierra Environment and dated November 2023) should be implemented by the parties listed in that GMP until such time as it determined to no longer be required pursuant to the process outlined in the GMP.

Environmental audit statement

Other related information

- e. Some soils at the site may have restrictions in relation to off-site disposal. Any soil proposed to be excavated and disposed off-site after the completion of the audit, should be classified and disposed off-site by the contractor undertaking those works in accordance with relevant NT EPA guidance.
- f. Any groundwater monitoring bores installed at the site and offsite should be decommissioned once no longer needed for groundwater assessment and monitoring purposes, in accordance with the requirements of “Minimum Construction Requirements for Water Bores in Australia”, published by the Land and Water Biodiversity Committee [most recent version].

Section 4: Environmental auditor’s declaration

I state that:

- I am appointed as an environmental auditor by the Environment Protection Authority Victoria under the *Environment Protection Act 2017*.
- The information contained in this statement represents a true and accurate summary of the findings of the environmental audit that I have completed.

Date: 30 November 2023

Signed: 

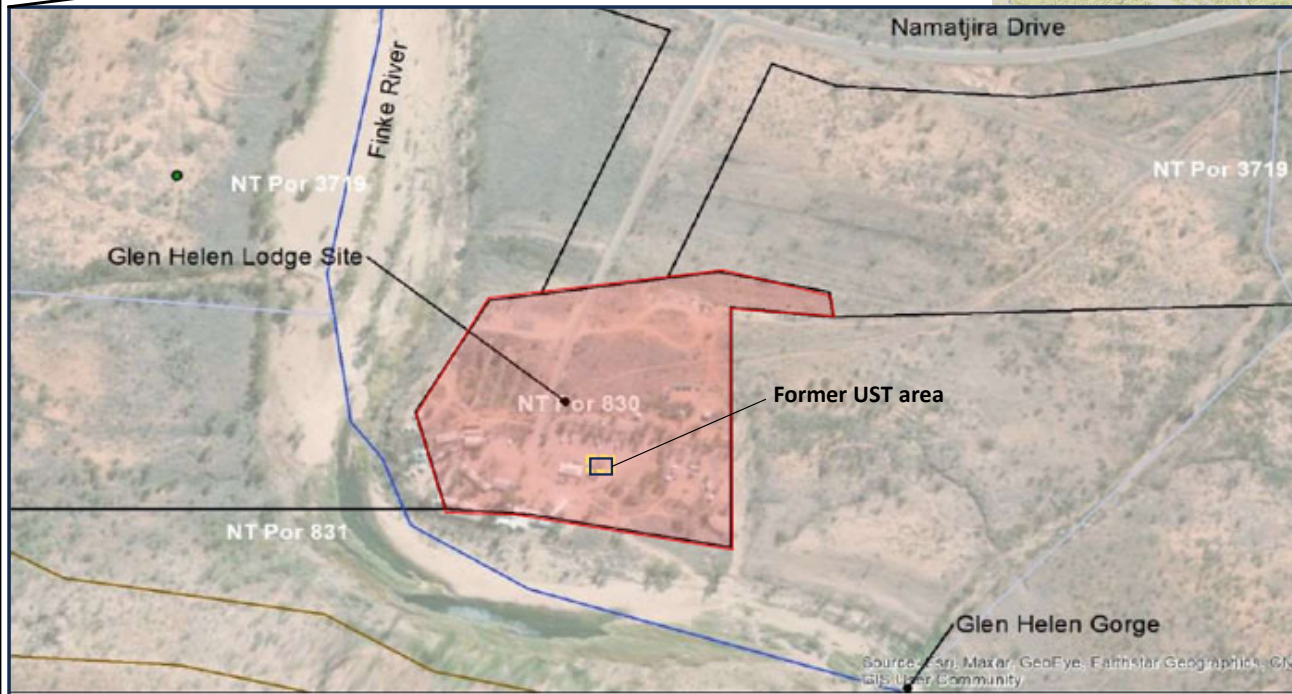
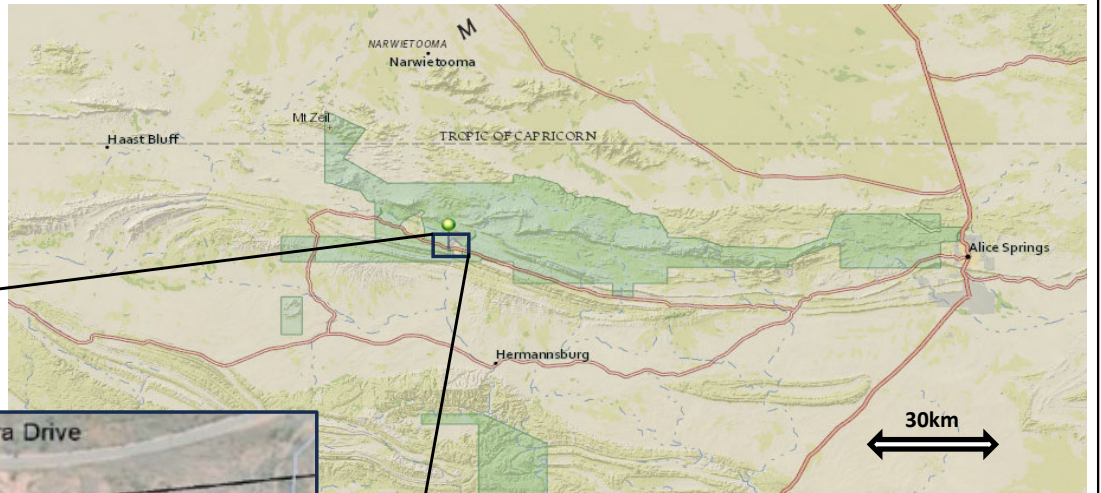
Name: Steven Jon Kirsanovs

Environmental Auditor

ANNEXURE 1

AUDIT SITE BOUNDARY





Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNR, GIS User Community

LEGEND

 AUDIT SITE BOUNDARY

RKH 30 / 11 / 2023
6179 Rev.01



Adapted from:
GeoEye Earthstar Geographic

AUDIT SITE BOUNDARY
8495 Namatjira Drive, Mount Zeil, NT

ANNEXURE 2

GROUNDWATER MANAGEMENT PLAN





**Glen Helen Discovery Park
Groundwater Monitoring Plan**

Prepared for
Ngurratjuta/Pmara Ntjarra Aboriginal
Corporation

28 November 2023

Tierra Environment Pty Ltd
ABN 84 111 615 680

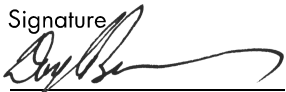
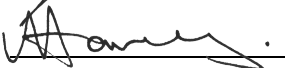
PO Box 360
Mitcham SA 5062
08 8373 2512
general@tierra.com.au

Glen Helen Discovery Park Groundwater Monitoring Plan

Prepared for
Ngurratjuta/Pmara Ntjarra Aboriginal Corporation

28 November 2023

Document Status

	Name	Signature	Date
Approved for Issue <input checked="" type="checkbox"/>	Prepared by <u>Daryl Burrows</u>		<u>28/11/2023</u>
Revision <u>A</u>	Reviewed by <u>Lauren Harvey</u>		<u>28/11/2023</u>

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APPENDIX A

FIGURES

APPENDIX B

SAMPLING AND ANALYSIS QUALITY PLAN

1 INTRODUCTION

1.1 General

This Groundwater Monitoring Plan (GMP) has been prepared by Terra Environment (Terra) on behalf of Ngurratjuta/Pmara Ntjarra Aboriginal Corporation (NPNAC). It provides details of proposed groundwater monitoring events (GMEs) and associated assessments in the vicinity of now removed underground storage tanks (USTs) that were used for fuel storage at a holiday accommodation facility at 8495 Namatjira Drive Mount Zeil, Northern Territory.

A plan showing the location of the site is provided as Figure 1 in Appendix A.

The site subject to monitoring activities is as follows:

Description	Glen Helen Discovery Park
Address	8495 Namatjira Drive Mount Zeil
Area	71,800m ²
Certificate of Title	CUFT Volume 849 Folio 156
Plan Reference	NT POR 830
Council	MacDonnell Regional Council
Zoning	No Zone

The site is subject to an environmental audit undertaken by Steve Kirsonovs who is an accredited Auditor in Victoria. As per Section 11.5 of the NT Contaminated Land Guideline, environmental audits are required to be completed in accordance with the State where the Auditor is accredited, therefore groundwater activities and assessments outlined in this document must be undertaken in accordance with the Environment Protection Act (VIC) 2017.

1.2 Current and Future Land Uses

The site is developed for holiday accommodation and tourism but is currently not in use. If operations resume the use is not anticipated to change.

1.3 Previous Investigations

The Glen Helen Discovery Park is currently owned by the G'DAY Group Holdings, the umbrella company for Discovery Parks. Prior to their ownership the site was owned by NPNAC. Before Discovery Parks purchased the site they undertook due diligence investigations at the site. This initially constituted what was referred to by Low Ecological Services (LES – who undertook the work) as a “high level environmental due diligence inspection of the Glen Helen Lodge”. From this, two underground storage tanks were identified and because of their age they were flagged as a risk. To address this Discovery Parks commissioned LES to undertake a preliminary site investigation (PSI) which then triggered further investigations and remedial works as detailed below.

[Discovery Parks Glen Helen Lodge Preliminary Site Investigation for Fuel Leakage from UPSSs, 25 February 2021 – Low Ecological Services](#)

The scope of work of this investigation was as follows:

- Desktop review to understand the site environment context and fuel systems history.
- Determine the locations of underground fuel storage tanks and infrastructure on the site.
- Sample soils adjacent and beneath the two underground fuel tanks and collect soil samples at various depths down to below the base of the tanks.
- Test all soil samples on-site for the presence of fuel vapours using a portable photo ionisation detector (PID).

- Select representative soil samples based on location, depth, and PID vapour concentrations and have them laboratory analysed for the presence of hydrocarbons and heavy metals.

LES concluded that there is fuel contamination of soil in the immediate vicinity of both UST's down to a rocky layer at approximately three metres. LES concluded that the results,

"indicate that fuel in the soil surrounding the tanks is at sufficient concentration to potentially pose an ecological risk in this area of ecological significance. There are minimal risks to human health from the contaminated soils due to the open location."

From this LES recommended,

"Additional sampling and testing is required to determine the lateral and vertical extents of contamination from both underground fuel systems to assess the risks that the contamination poses, and develop a remediation or management strategy."

Glen Helen Lodge Ngurratjuta/Pmara Ntjarra Aboriginal Corporation Underground Petroleum Storage System's Fuel Contamination Detailed Site Investigation (DSI), 8 December 2021 – Low Ecological Services

To resolve the fuel contamination risks prior to settlement of the property sale NPNAC contracted Territory Electrical to remove the UST's and the associated infrastructure and for LES to further delineate the extent and nature of contamination. The following scope of work was undertaken:

- Desktop review to understand the site environment context and fuel systems history.
- Sample soil from the walls and base of each of the fuel tank pits after removal of the fuel systems.
- Sample soil excavated from the pits and stockpiled during tank removal works.
- Sample soils from the greater perimeter of the two (2) underground fuel tanks at various distances and depths to determine the extent of fuel migration from the source.
- Test all soil samples on-site for the presence of fuel vapours using a portable PID.
- Select representative soil samples based on location, depth, and PID vapour concentrations and have them laboratory analysed for the presence of hydrocarbons and heavy metals.
- Remove all contaminated excavated soil from site.
- Sample and analyse excavated soil to determine level of contamination.
- Dispose of excavated soil appropriately (TRH > 1000mg/kg = Adelaide Cleanaway, TRH < 1000mg/kg = Alice Springs Landfill).
- Backfill tank pits with clean imported material and install perforated vent pipes for aeration purposes.
- Deploy 6 passive diffusion samplers in 1.5m deep soil bores in varying locations around the backfilled tank pits and nearby buildings and have the samples analysed by the laboratory to confirm there is not a vapour risk for buildings.
- Sample shallow groundwater adjacent to the Finke River and have the samples analysed by the laboratory to confirm hydrocarbons have not migrated to the Finke River waterhole.
- Assess the risks of identified contamination and consider remediation options.

LES concluded the following:

- Migration of hydrocarbon contamination off site is not occurring.
- There is no evidence of contamination beyond the pits.
- The source of the fuel leak has been removed.
- The consistent layer of bedrock at ~2.7 mbgl and the clay soils will limit further migration of the residual hydrocarbon contamination. Hence the ecological risk is negligible.
- There is no risk to human health from the residual in-situ contaminated soil in the open car park area in which the tank pits are located. This was confirmed in the soil vapour sampler results having low vapour readings that would not pose health risks to persons inside nearby buildings.

- The lateral and vertical extent of the residual localized contamination will not pose a risk to human health, the environment, or management of the site, given that the current and proposed medium-term future use of this area within the site as a carpark and lawn area.

Glen Helen Lodge Discovery Parks Fuel Contamination from Underground Petroleum Storage System: Investigation and Remediation Report, March 2022 – Low Ecological Services

Key findings of this report are as follows:

- Ngurratjuta Aboriginal Corporation commissioned Territory Electrical and Refrigeration (Territory Electrical) to examine the fuel system for leaks in February 2021. This resulted in Low Ecological Services (LES) being engaged by Territory Electrical to undertake a Preliminary Site Investigation (PSI) of fuel contamination in the soil surrounding the UPSS. The PSI showed hydrocarbon contaminated soils by use of minimally invasive hand auguring around the underground tanks.
- Phase 2 of the DSI with the drilling rig, found bedrock was less than 3.5 mbgl, no water table was present, a levy bank (likely based on rock) formed a geological gully around the tank pits, fuel contaminated soil was localized to the diesel and Opal fuel tank pits and immediate surrounds and the contamination did not extend to drill hole sample points, which were drilled down to bedrock, located 6m to 90m downslope of the UST pit area, along the natural drainage line.
- Due to the ecological sensitivity of the area, in July 2021, the NT EPA issued a s48 Notice requiring the investigations, remediation and validation works to be completed under an environmental audit program under the relevant provisions of the Waste Management and Pollution Control Act 1998.
- The WMS soil vapour results indicated that there is no vapour intrusion risk to people occupying the nearby buildings or to invasive maintenance workers and the groundwater sample analysis detected no levels of hydrocarbons above LOR indicating that the hydrocarbon contamination had not migrated into the Finke River.
- The diesel and petrol pits were lined and backfilled with clean imported soil. A perforated vent pipe system, designed by LES and agreed upon by Mr Kirsanovs (Auditor), was installed in both pits to increase aeration and natural remediation of the soil at the bottom of the pits.
- The findings from each phase of this investigation prove that the migration of hydrocarbon contamination off site is not occurring. There is no evidence of contamination beyond the pits, all proximal soil and water samples were uncontaminated. The source of the fuel leak has been removed, pits have been lined, the consistent layer of bedrock at ~2.7 mbgl and the clay soils will limit further migration of the residual hydrocarbon contamination. Hence the ecological risk is negligible. Furthermore, there is no risk to human health from the residual in-situ contaminated soil in the open car park area in which the tank pits are located, given the contaminated soil is deeper than 1.2 m below the ground surface.
- Thus, the findings of this investigation show that the lateral and vertical extent of the residual localized contamination will not pose a risk to human health, the environment, or management of the site, given that the current and proposed medium-term future use of this area within the site as a carpark and lawn area as agreed upon by the new land owners, Discovery Parks.

Glen Helen Lodge Discovery Parks Fuel Contamination from Underground Petroleum Storage System: A Progress Update Report, January 2023 – Low Ecological Services

This report appears to be an uncompleted draft version. A summary of the key points from the draft report is provided below. It should be noted that the final version of this report should be reviewed once its completed.

A review of the draft report found:

- LES installed 4 groundwater monitoring wells in May 2022.
- Soil samples were collected during the drilling of the wells and analysed for TRH, BTEX and metals. Concentrations of TRH were detected in soil sample MW1-6m. TRH was not detected in the lower sample for this well (MW1-10m).

- Groundwater monitoring was undertaken on 11 November 2002 however due to the recent placement of gravel in the area only well MW1 could be found.
- During the site visit on the 11 November sheen was observed on the surface of the Finke River. Black soil in the river was also observed. A sample of the soil was collected and analysed for metals, TRH and BTEX. Results for TRH and BTEX were less than the limits of reporting.
- LES returned to the site on the 15 November and found all four wells. All wells were subsequently sampled and samples analysed for TRH and BTEX. All wells reported concentrations of TRH above the limits of detection with the highest concentrations reported in MW4. BTEX was also detected in MW2 and MW4.
- Another round of monitoring was undertaken in December 2022. Approximately 80L to 100L were bailed from the wells (assuming collectively) before the wells were left to recover and sampled.
- Concentrations of TRH and BTEX were less than the limits of reporting in MW1 and MW3 while concentrations of TRH and BTEX were detected in MW2 and MW4.
- The report concluded that additional development of the wells should be undertaken, sampling should be undertaken using hydra-sleeves and that monitoring should continue biannually (one event in wet season and one in dry season) for the next three years.

Glen Helen Discovery Park, Groundwater Monitoring Event May 2023, July 2023 – Tierra Environment

This report documented the development, sampling and analysis of three existing groundwater wells at the Glen Helen Discovery Park as well as the sampling and analysis of two surface water samples from the nearby Finke River.

As there were some uncertainties whether the wells were adequately developed when originally installed Tierra undertook development prior to purging and sampling activities. Approximately 115L, 80L and 70L of water and sediment were removed from wells MW1, MW3 and MW4 respectively with 6m, 3.1m and 4.3m of sediment removed.

Light non-aqueous liquid (LNAPL) was not identified in any of the wells during gauging and similarly discolouration, sheen or hydrocarbon odours were not observed during purging and sampling activities. From gauging activities groundwater flow was found to be to the south south-west towards the Finke River which is located approximately 100m to the south.

Laboratory analysis of groundwater and surface water samples did not detect TRH, BTEX or MTBE above the laboratory's limits of reporting. Concentrations of lead were detected in the three groundwater wells exceeding ANZG 99% fresh water criteria and the lead concentration in one well also exceeded ADWG criteria. Lead was not detected above the limits of reporting in the surface water samples.

The CSM identified that it is unlikely that a complete exposure pathway exists between the identified potential chemicals of concern and human receptors, assuming that groundwater is not extracted for use.

Risks to the Finke River are expected to be acceptably low as there appears to be only remnant concentrations of lead in the groundwater near the tank locations (now removed). As there has only been one sampling event where lead was analysed it is not clear if it is associated with the tanks or naturally occurring variability.

Recommendations from the report included the development of a groundwater quality monitoring plan and groundwater monitoring over a 12 month period taking into account the climate and expected seasonal variation.

1.4 Objectives

The objectives of the monitoring programs detailed in this report are as follows:

- To assess if petroleum hydrocarbons associated with a leak from a former UST are present in the groundwater.
- To assess if seasonal variability impacts on concentrations of contaminants in the groundwater.
- To assess whether lead concentrations are attributable to the USTs or is naturally occurring.

- To assess if the groundwater poses a risk to human or environmental health.

The GMP also establishes a means for administering and managing groundwater related risks and providing mechanisms whereby additional management measures or remedial action could be implemented, in the event of unacceptable risks to human health and the environment in the future.

1.5 Roles and Responsibilities

Current site owner	Beston Parks Land Co Pty Ltd (ACN 111 783 423), trading as Discovery Parks Responsibilities – to allow access for monitoring activities under this GMP and to ensure the monitoring bores are maintained in suitable working condition.
Former owners	Ngurratjuta/Pmara Njarra Aboriginal Corporation Responsibilities – implementation of the monitoring program outlined in the GMP.
Environmental consultant	Tierra Environment – Daryl Burrows Responsibilities - undertaking and reporting on groundwater monitoring activities, making amendments to the GMP as necessary, and making recommendations at the appropriate time when it is considered monitoring under the GMP should cease.
Auditor	Kirsa Environmental – Steven Kirsanovs Responsibilities - review of environmental investigations, preparation of Audit Report, reporting to the NT EPA, review of reporting under this GMP, review and approve amendments to the GMP as may be required and recommendations to the NT EPA whether or not the monitoring program should cease.
NT EPA	-

1.6 Changes to the GMP and Review

This Groundwater Monitoring Plan applies for 12 months. After 12 months this plan will be reviewed and subject to confirmation from the Auditor monitoring at the site can be ceased. Changes to the plan can be made prior to the 12 months subject to Auditors input.

1.7 Content

This GMP provides the following information:

- locations proposed to be used for monitoring
- monitoring scopes and frequencies
- sampling and reporting protocols
- triggers which would determine the need for further investigations, risk assessments and remediation activities
- an outline of additional measures (included in a contingency plan) to be implemented if risks to public health and the environment were to exist

2 GROUNDWATER MONITORING PROGRAM

2.1 Well Locations

The locations of groundwater wells to be used for the monitoring activities are shown on Figure 2 in Appendix A.

The monitoring bores shall be provided with surface completions/covers in accordance with relative state and national guidelines. Ideally these should be metal and flush mounted to enable protection of the monitoring bores, and easy location of monitoring bores for future GMEs. This should be a priority item to be addressed as part of the first GME scheduled under this GMP.

These wells shall be maintained throughout the duration of required groundwater monitoring, unless it is determined in the course of future monitoring that select wells may no longer be required. In the event of a well becoming damaged an attempt to repair should be made. If a damaged well or other requires removal, the well shall be decommissioned and a replacement monitoring well shall be installed within 2m of the original well location.

Wells proposed to be used for groundwater sampling are as follows:

Well No	Rationale for use
MW1	The well is located in the potential source area between the two former tank pits.
MW3	The well is likely a background well located up hydraulic gradient from the former tank pits. TRH was also previously detected in this well in November 2022.
MW4	The well is likely a background well located up hydraulic gradient from the former tank pits. Elevated concentrations of TRH and BTEX were also reported in this well in November and December 2022.

2.2 Monitoring Frequencies

The following shall be undertaken:

- commencement in 2024
- biannual GMEs over a 12 month period (ideally in February/March and August/September)

Well/sampling location No	Frequency of use
MW1, MW3 and MW4	All monitoring events
MW2	Attempt to locate, redevelop and monitor during all monitoring events
FR1 and FR2	All monitoring events

2.3 Standards and Guidelines

All groundwater monitoring shall be undertaken in accordance with the following documents:

- Northern Territory of Australia Water Act 1992
- Northern Territory of Australia Water Regulations 1992
- Northern Territory of Australia Waste Management and Pollution Control Act 1998
- Environment Protection Act 2017 (Vic)
- Environment Reference Standard, Victoria Government Gazette No. S 245 (26 May 2021)
- Environment Protection Authority Victoria, Groundwater Sampling Guidelines, Publication 669.1, February 2022
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality, 2018 (ANZG)
- Australian Drinking Water Guidelines 2011 (ADWG)

- Amended National Environment Protection (Assessment of Site Contamination) Measure 1999
- AS5667.1-1998: Water quality – Sampling, Guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples
- AS5667.11-1998: Water quality – Sampling, Guidance on sampling of groundwaters

Groundwater monitoring will be undertaken as per the Sampling and Analysis Quality Plan presented in Appendix B which meets the requirements of the ASC NEPM 1999, Schedule B2 Section 5.

2.4 Field Parameters

During each monitoring round the following field information shall be reported:

- presence/absence of phase separate petroleum hydrocarbons
- depth to groundwater level and depth to the base of well, measured from a designated point in each well; groundwater levels shall be gauged in one dedicated event
- groundwater purging records such as purging duration, purging rate, and groundwater quality records (observations such as water colour, odour, turbidity and sheen)
- groundwater field parameters during purging (pH, electrical conductivity, redox, dissolved oxygen and temperature)

2.5 Contaminants of Concern

The analytical program shall include the following parameters: TRH, BTEXN, MTBE and Pb

These have been selected as the appropriate indicators of fuel related impacts to be included in this monitoring program.

2.6 Sampling and Laboratory QA/QC

The procedures for field sampling undertaken at the site shall be in compliance with ASC NEPM 1999 guidelines and AS5667.1 – 1998.

The following quality control sampling and analytical analysis shall be undertaken per monitoring event:

- one intra-laboratory and one inter-laboratory duplicate for each round of monitoring shall be collected and analysed; duplicates shall be analysed for the same range of analytes as the primary sample
- one equipment rinsate and one field blank shall be collected and analysed for each day of monitoring; rinsate and field blank samples shall be analysed for the same range of analytes as the primary sample
- one trip blank shall be utilised and analysed for BTEXN and TRH C₆ - C₉

2.7 Analytical Procedures

The analytical methods shall comply with industry standards such as USEPA, APHA, or equivalent methods. These shall be stated by the laboratories as part of their reporting procedures. All laboratories must be NATA endorsed for the analyses undertaken.

The laboratories shall implement quality assurance programs including the analyses of internal spikes duplicates and method blanks. Certificates of analysis received from the primary and secondary laboratories shall be provided for each round of monitoring.

Laboratory limits of reporting shall be at or below the values provided below:

Parameter	Limits of Reporting (mg/L)
TRH	0.02 (C ₆ -C ₁₀), 0.05 (>C ₁₀ -C ₁₆), 0.1 (>C ₁₆ -C ₃₄ / $>$ C ₃₄ -C ₄₀)
BTEXN	0.001 (BTE), 0.003 (X), 0.01 (N)
MTBE	0.001
Pb	0.001

3 PERFORMANCE EVALUATION

3.1 Required evidence

The 2023 monitoring event did not identify TRH, BTEX or MTBE in the groundwater. Lead was detected however above ANZG 99% freshwater criteria of 0.001mg/L in all wells and above ADWG criteria of 0.01mg/L in MW3.

The objective of proposed monitoring activities is to demonstrate a continuation of no detectable TRH, BTEXN or MTBE and consistent lead concentrations. For this purpose the following lines of evidence will be used:

Line of evidence	Associated monitoring activities
There is no TRH, BTEXN or MTBE	Monitoring of groundwater wells to demonstrate TRH, BTEXN and MTBE are not present in any well or the Finke River
Pb is consistent with previous rounds	As lead can be naturally occurring lead should be consistent with previous rounds of investigation

3.2 Response to monitoring results

In the event of reported concentrations of tested analytes not confirming to the lines of evidence listed above, contingency measures outlined in Section 4 shall be implemented and the Site Contamination Auditor notified.

In the event of reported concentrations of tested analytes exceeding ASC NEPM groundwater HSLs for vapour intrusion provided in ASC NEPM Schedule B1 Table 1A(4), contingency measures outlined in Section 4 shall be implemented and the Site Contamination Auditor notified.

In the event of evidence of changes in land uses or groundwater uses occurring and adversely affecting the monitoring approach (e.g. groundwater extraction altering the direction of groundwater flow), contingency measures outlined in Section 4 shall be implemented and the Site Contamination Auditor notified.

3.3 Reporting

Groundwater monitoring data shall be reported 4 weeks after the second biannual monitoring event unless triggers are exceeded in the first biannual event. A report shall be provided to NPNAC and the Auditor. The report shall provide the following:

- the scope of monitoring works
- sampling and analytical procedures
- collected field data and field logs
- chain-of-custody forms
- certificates of laboratory analyses
- tabulated data of groundwater depths and levels
- tabulated results of measured field parameters
- tabulated analytical results
- an assessment of data quality using the data quality objectives set contained in AS4482.1-2005
- a plan showing potentiometric groundwater contours
- an evaluation of the direction of groundwater movement
- a plan showing wells with TRH and BTEX concentrations exceeding laboratory reporting limits and a time series comparison with previous rounds of monitoring
- an evaluation of the spatial and temporal distribution of contaminants of concern
- an assessment of generated data against ASC NEPM groundwater HSLs and ANZG 99% freshwater criteria
- recommendations for future actions, e.g. implementation of contingency measures

4 CONTINGENCY MEASURES

4.1 General

As identified in Section 3.2 contingency processes may need to be implemented. This typically includes increased monitoring, additional assessments and possibly active remediation to protect receptors if necessary. Contingency measures should be flexible enough to allow for the incorporation of new information about site risks and technologies as these become available over time.

A contingency plan provides a set of measures to be applied to protect human health and the environment. A five stage approach for contingency measures is proposed in the event of reported concentrations of tested analytes not confirming the lines of evidence listed in Section 3.1, or exceeding ASC NEPM groundwater HSLs for vapour intrusion or ANZG 99% freshwater criteria or in the event of known changes to land or groundwater uses affecting the natural attenuation approach.

Activities associated with contingency measures shall be undertaken by a suitably qualified and experienced environmental consultant with input from the Site Contamination Auditor (refer also to Section 1.5).

4.2 Stage 1 Contingency Measures – Repeat Measurements

As the initial response to the need for contingency measures the most recent groundwater monitoring event should be repeated as soon as practicable. If the measurements which triggered a Stage 1 response are confirmed, Stage 2 of the contingency measures shall be implemented. Otherwise at least one more monitoring event should be undertaken.

4.3 Stage 2 Contingency Measures – Increase Monitoring Frequency

The sampling frequencies listed in Sections 2.2 shall be increased to add one additional round of sampling 3 months after the round which triggered the Stage 2 response. If the measurements which triggered a Stage 2 response are confirmed, Stage 3 of the contingency measures shall be implemented. Otherwise at least one more monitoring event shall be undertaken.

4.4 Stage 3 Contingency Measures – Data Review

A detailed review of available groundwater data shall be undertaken. This review shall involve:

- historic and current monitoring results
- known aquifer and soil characteristics including soil types, groundwater levels, groundwater movement direction and groundwater movement velocity
- changes in the risk profile to receptors including occupants at the accommodation facility or the Finke River, or uncertainties in the level of risk to these receptors that warrant further consideration

The review shall identify whether observed concentrations are reliable and acceptable, or whether additional information on groundwater will be required.

In the event it is deemed the circumstances have changed sufficiently or there is inadequate information for such decision making, then Stage 4 of the contingency measures shall be implemented.

4.5 Stage 4 Contingency Measures – Additional Assessments

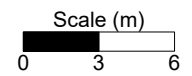
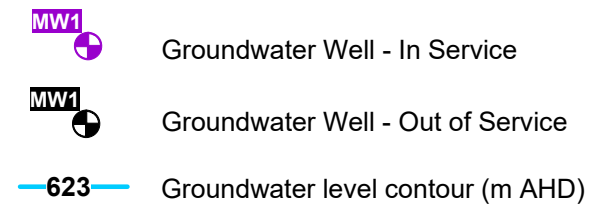
A program of additional investigations and/or monitoring shall be determined in consultation with the Auditor. A scope will take into account the specific uncertainties and information gaps that might have become apparent over the source of the previous monitoring. The scope must consider what if any additional information is required to assess the nature and extent of impacts and associated risks to occupants of the accommodation facility, and to the Finke River.

4.6 Stage 5 Contingency Measures – Remediation

In the event of assessments undertaken during Stage 4 indicating that risks to public health and the environment exist and active remediation is required, a groundwater remediation plan shall be prepared. The remediation options described in the remediation plan(s) will be dependent on the nature and levels of

contaminants reported in groundwater / soil vapour / indoor air, aquifer conditions encountered, environmental receptors to be protected and available technologies.

APPENDIX A
FIGURES



Notes:

1. The extent of the former tank pits are approximate based on a plan provided by Low Ecological Services.
2. The position of MW1, MW3 and MW4 is based on a survey. The position of MW2 is approximate and based on a plan provided by Low Ecological Services.
3. Groundwater contours generated by Surfer software with a grid generated using triangulation with linear interpolation.

Figure 1 - Groundwater Well Locations
Glen Helen Discovery Park
Groundwater Monitoring Plan

APPENDIX B
SAMPLING AND ANALYSIS QUALITY PLAN



**Glen Helen Discovery Park
Groundwater Monitoring Plan
Sampling and Analysis Quality Plan**

Prepared for
Ngurratjuta/Pmara Ntjarra Aboriginal
Corporation

24 November 2023

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**Glen Helen Discovery Park
Groundwater Monitoring Plan
Sampling and Analysis Quality Plan**

Prepared for
Ngurratjuta/Pmara Ntjarra Aboriginal Corporation

24 November 2023

Document Status

	Name	Signature	Date
Approved for Issue <input checked="" type="checkbox"/>	Prepared by <u>Daryl Burrows</u>	_____	<u>24/11/2023</u>
Revision <u>A</u>	Reviewed by <u>Lauren Harvey</u>	_____	<u>24/11/2023</u>

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APPENDIX A

SITE PLAN

APPENDIX B

DATA QUALITY INDICATORS

1 INTRODUCTION

1.1 General

This Sampling and Analysis Quality Plan (SAQP) has been prepared by Terra Environment on behalf of Ngurratjuta/Pmara Ntjarra Aboriginal Corporation ICN for groundwater investigations in the vicinity of former and current underground storage tanks (UST). The aim of these investigations is to further assess the contamination status of the groundwater including any seasonal variability to identify any possible risk to human or environmental health.

1.2 Site Definition

The site subject to investigation comprises of the following:

Description	Glen Helen Discovery Park
Address	8495 Namatjira Drive, Mount Zeil
Area	71,800m ²
Certificate of Title	CUFT 849 Folio 156
Plan Reference	Survey Plan A 000315 NT Por 830
Council	MacDonnell Regional Council
Zoning	No Zone
Owners	G'day Group Pty Ltd

A plan of the site is provided in Appendix A.

General site information is presented in Section 2.1.

1.3 Background

The following assessment reports for the site are available:

- Glen Helen Groundwater Investigation West MacDonnells National Park 1991-1995 – Power and Water, Water Resources Branch May 1996.
- Discovery Parks Glen Helen Lodge Preliminary Site Investigation for Fuel Leakage from UPSSs Low Ecological Services February 2021.
- Glen Helen Lodge Ngurratjuta/Pmara Ntjarra Aboriginal Corporation Underground Petroleum Storage System's Fuel Contamination Detailed Site Investigation (DSI) – Low Ecological Services December 2021. Note this seems to be an uncompleted draft version of the March 2022 report.
- Glen Helen Discovery Parks Fuel Contamination from Underground Petroleum Storage System: Investigation and Remediation Report Low Ecological Services March 2022.
- Glen Helen Lodge Discovery Parks Fuel Contamination from Underground Petroleum Storage System: A Progress Update Report January 2023 – Low Ecological Services.

Steve Kirsanovs of Kirs Environmental has been engaged as the site contamination auditor. The scope of work and this SAQP will be submitted to the Auditor for review and comment and if required revision prior to commencing works.

1.4 Objectives

This SAQP has been prepared for the implementation of groundwater well development and an additional groundwater monitoring event.

The SAQP is prepared to ensure that the groundwater investigation works for the site are undertaken in accordance with the Amended National Environment Protection (Assessment of Site Contamination) Measure 1999, Schedule B2, Section 5 ("Systematic planning for collection of environmental data").

The SAQP specifies the proposed sampling and analytical testing program and nominates Data Quality Objectives (DQO) and Indicators (DQI) to quantify the precision, accuracy, representativeness, completeness and comparability of the analytical results. The SAQP has been developed with reference to the “7-Step” process outlined in Amended ASC NEPM Schedule B2, Appendix B.

1.5 Dissemination of Information

The following will be implemented to ensure that the content of this SAQP will be available to all relevant staff and stakeholders:

- Endorsement for this SAQP will be sought from the site contamination auditor.
- This SAQP will be read and understood by all field staff prior to works commencing on-site.
- A copy of the document will be retained on site by Terra staff throughout the field investigations.

1.6 Communications and Workers Health and Safety

The following will be implemented:

- Field staff will carry a mobile phone for communication.
- The field team will carry a first aid kit.
- A Safe Work Method Statement will be prepared for use by site staff.
- Any accident or incident involving or observed by project staff during the course of the investigation will be reported immediately to the site owner or its representative.

1.7 Limitations Applying to the Proposed Investigations

The following limitations may apply:

- Access to wells
- Access to groundwater – Fluctuations of groundwater level in wells may inhibit the purging and sampling activities.

2 STATUS AND BACKGROUND INFORMATION

2.1 Current Site Conditions

Based on a review of available aerial photography and provided information the following can be noted about the site.

- The site is located on the inner bend of the Finke River with gently rolling hills to the north and steeper ridge lines to the south across the Finke River.
- The site is used for park style accommodation (Discovery Park) with bar and restaurant, motel and hostel style rooms and camp sites.
- Where the tank sites and groundwater wells are located is unsealed carpark and access road which has been recently improved (earthworks undertaken).
- 150m to the north is water treatment ponds.

2.2 Previous Environmental Investigations

2.2.1 Power and Water, Water Resources Branch 1996 Groundwater Report

This report was commissioned to assess water quality and aquifer yields in the vicinity of the park prior to its construction. The assessed water would ultimately be used as a supply to the park. Key findings are as follows:

- Shallow groundwater and surface water supplies associated with the Finke River in this area are invariably non-potable and are not considered a viable resource.
- From the drilling at the Living Area approximately 8 km east of Glen Helen and the results from bores RN 6146 and RN 12021, it was hypothesised that no potable groundwater was present north of the ridgeline which runs in an east-west direction immediately south of the resort.
- It can be seen that, in the Goyder Formation at least, the groundwater gradients slope towards the waterhole, from both the west and east. The siting and design of the resort infrastructure should recognise that the Finke River is the lowest point in the system, is a discharge zone and acts as a sink in the local area.
- From the hydrochemistry of the different waterholes and from the water levels of the Goyder Formation (Figure 5) it appears that the surface water in the Glen Helen area is, to some degree at least dependent on, and connected with the groundwater contained in the aquifers of the different formations. It is beyond the scope of this report to undertake further comment on the relationship between the groundwater and surface water apart from stating that there is a connection.

2.2.2 Low Ecological Services 2021 PSI

A Preliminary Site Investigation for the site was prepared in February 2021.

A summary of key findings of the PSI are as follows:

- Contamination Extent – There is fuel contamination of soil immediately surrounding both underground systems down to a rocky layer or bedrock at approximately 3m. Lab results indicate that fuel in the soil surrounding the tanks is at sufficient concentration to potentially pose an ecological risk in this area of ecological significance.
- Vapour intrusion – Vapour intrusion risk is not of concern in public open spaces such as the area around the fuel systems, carpark and lawns.
- Direct contact – Surface contamination was only observed in the immediate vicinity of the bowzers so there is limited opportunity for direct contact with contaminated soil in this case.
- Groundwater – Local groundwater was not encountered in any of the hand auger sample holes at the site. More investigation is required to understand if local groundwater has been contaminated.

Groundwater extraction for drinking water is from bores approximately 1070m northeast upgradient of the fuel systems.

- Ecological Considerations – The site is surrounded by the West MacDonnell National Park and adjacent to the Finke River and Glen Helen Gorge and waterhole. The site is in an area of ecological significance with sensitive ecological receptors nearby. Given the setting, the potential ecological risks are perhaps of most concern.
- Ecological Screening Levels (ESLs) for contaminated soil are generally applicable to the top 2m of soil profile, however greater depths should be considered in arid areas such as Glen Helen (NEPM 2013). Hydrocarbon concentrations in all soil samples analysed by the laboratory were such that NEPM ESLs were exceeded for all samples.
- Conclusion – There is fuel contamination of soil immediately surrounding both underground fuel tank systems down to a rocky layer or bedrock at approximately 3m. Lab results indicate that fuel in the soil surrounding the tanks is at sufficient concentration to potentially pose an ecological risk in this area of ecological significance. There are minimal risks to human health from the contaminated soils due to the open location.

2.2.3 Low Ecological Services December 2021 DSI Report

This report appears to be an uncompleted draft version of the March 2022 report, refer Section 2.2.4.

2.2.4 Low Ecological Services March 2022 Investigation and Remediation Report

Key findings of this report are as follows:

- Ngurratjuta Aboriginal Corporation commissioned Territory Electrical and Refrigeration (Territory Electrical) to examine the fuel system for leaks in February 2021. This resulted in Low Ecological Services (LES) being engaged by Territory Electrical to undertake a Preliminary Site Investigation (PSI) of fuel contamination in the soil surrounding the UPSS. The PSI showed hydrocarbon contaminated soils by use of minimally invasive hand auguring around the underground tanks.
- Phase 2 of the DSI with the drilling rig, found bedrock was less than 3.5 mbgl, no water table was present, a levy bank (likely based on rock) formed a geological gully around the tank pits, fuel contaminated soil was localized to the diesel and Opal fuel tank pits and immediate surrounds and the contamination did not extend to drill hole sample points, which were drilled down to bedrock, located 6 m to 90 m downslope of the UST pit area, along the natural drainage line.
- Due to the ecological sensitivity of the area, in July 2021, the NT EPA issued a s48 Notice requiring the investigations, remediation and validation works to be completed under an environmental audit program under the relevant provisions of the Waste Management and Pollution Control Act 1998.
- The WMS soil vapour results indicated that there is no vapour intrusion risk to people occupying the nearby buildings or to invasive maintenance workers and the groundwater sample analysis detected no levels of hydrocarbons above LOR indicating that the hydrocarbon contamination had not migrated into the Finke River.
- The diesel and petrol pits were lined and backfilled with clean imported soil. A perforated vent pipe system, designed by LES and agreed upon by Mr Kirsanovs (Auditor), was installed in both pits to increase aeration and natural remediation of the soil at the bottom of the pits.
- The findings from each phase of this investigation prove that the migration of hydrocarbon contamination off site is not occurring. There is no evidence of contamination beyond the pits, all proximal soil and water samples were uncontaminated. The source of the fuel leak has been removed, pits have been lined, the consistent layer of bedrock at ~2.7 mbgl and the clay soils will limit further migration of the residual hydrocarbon contamination. Hence the ecological risk is negligible. Furthermore, there is no risk to human health from the residual in-situ contaminated soil in the open car park area in which the tank pits are located, given the contaminated soil is deeper than 1.2 m below the ground surface.

- Thus, the findings of this investigation show that the lateral and vertical extent of the residual localized contamination will not pose a risk to human health, the environment, or management of the site, given that the current and proposed medium-term future use of this area within the site as a carpark and lawn area as agreed upon by the new land owners, Discovery Parks.

2.2.5 Low Ecological Services January 2023 Update Report

This report appears to be an uncompleted draft version. A summary of the key points from the draft report is provided below. It should be noted that the final version of this report should be reviewed once its completed.

A review of the draft report found:

- LES installed 4 groundwater monitoring wells in May 2022.
- Soil samples were collected during the drilling of the wells and analysed for TRH, BTEX and metals. Concentrations of TRH were detected in soil sample MW1-6m. TRH was not detected in the lower sample for this well (MW1-10m).
- Groundwater monitoring was undertaken on 11 November 2002 however due to the recent placement of gravel in the area only well MW1 could be found.
- During the site visit on the 11 November sheen was observed on the surface of the Finke River. Black soil in the river was also observed. A sample of the soil was collected and analysed for metals, TRH and BTEX. Results for TRH and BTEX were less than the limits of reporting.
- LES returned to the site on the 15 November and found all four wells. All wells were subsequently sampled and samples analysed for TRH and BTEX. All wells reported concentrations of TRH above the limits of detection with the highest concentrations reported in MW4. BTEX was also detected in MW2 and MW4.
- Another round of monitoring was undertaken in December 2022. Approximately 80L to 100L were bailed from the wells (assuming collectively) before the wells were left to recover and sampled.
- Concentrations of TRH and BTEX were less than the limits of reporting in MW1 and MW3 while concentrations of TRH and BTEX were detected in MW2 and MW4.
- The report concluded that additional development of the wells should be undertaken, sampling should be undertaken using hydra-sleeves and that monitoring should continue biannually (one event in wet season and one in dry season) for the next three years.

2.2.6 Tierra Environment 2023 GME

This report documented the development, sampling and analytical analyses of three existing groundwater wells at the Glen Helen Discovery Park as well as the sampling and analysis of two surface water samples from the nearby Finke River.

As the wells were not developed when originally installed Tierra undertook development prior to purging and sampling activities. Approximately 115L, 80L and 70L of water and sediment were removed from wells MW1, MW3 and MW4 respectively with 6m, 3.1m and 4.3m of sediment removed.

LNAPL was identified in any of the wells during gauging and similarly discolouration, sheen or hydrocarbon odours were not observed during purging and sampling activities. From gauging activities groundwater flow was found to be to the south south-west towards the Finke River which is located approximately 100m to the south.

Laboratory analysis of groundwater and surface water samples did not detect TRH, BTEX or MTBE above the laboratory's limits of reporting. Concentrations of lead were detected in the three groundwater wells exceeding ANZG 99% fresh water criteria and the lead concentration in one well also exceeded ADWG criteria. Lead was not detected above the limits of reporting in the surface water samples.

The CSM identified that it is unlikely that a complete exposure pathway exists between the identified potential chemicals of concern and human receptors, assuming that groundwater is not extracted for use.

Risks to the Finke River are expected to be unlikely as there appears to be only remnant concentrations of lead in the groundwater near the tank locations (now removed). As there has only been one sampling event where lead was analysed it is not clear if it is associated with the tanks or naturally occurring variability.

Recommendations from the report included the development of a groundwater quality monitoring plan and groundwater monitoring over a 12 month period taking into account the climate and expected seasonal variation.

3 SAMPLING, ANALYSIS AND DATA QUALITY OBJECTIVES

3.1 General

The DQO process is used to define the type, quantity and quality of data needed to support decisions relating to the environmental condition of a site. It provides a systematic approach for defining the criteria that a data collection design should satisfy, including when, where and how to collect samples or measurements; determination of tolerable decision error rates; and the number of samples or measurements that should be collected.

This plan has been prepared to clearly document the requirements of the assessment program including:

- quantitative DQOs - including sample location numbers, sample collection frequency, sample analysis frequencies and QA/QC requirements
- a plan to achieve pre-determined DQOs - through describing the site sampling program and procedures, nominated investigation criteria and screening levels
- procedures to be undertaken if the data does not meet the expected DQOs to still achieve the project outcomes

The objective of the investigation for the site is to provide information to allow:

- a comparison to ANZG and ADWG criteria based selected environmental values as per the method detailed in Part 5 Division 2 of the Victorian Government Gazette No S245 dated May 2021
- a comparison to NEPM HSLs to assess the risk of vapour intrusion
- a comparison to previous results and assessment of seasonal variation

The objectives of this SAQP are to provide a detailed description of the key site investigation requirements to be undertaken in order to meet the overall project objective, in accordance with Northern Territory legislative and Amended ASC NEPM guideline requirements, the latter specifically relating to the preparation and implementation of a SAQP.

3.2 Step 1 – State the Problem

As part of a due diligence assessment two underground fuel tanks were identified as having potentially leaked. Previous investigations undertaken by Low Ecological (soil, soil vapour and groundwater) identified TRH and BTEX in the soil in the vicinity of the fuel tanks in groundwater wells MW2 and MW4. Tierra undertook the development of the wells in 2023 and subsequent sampling. Local groundwater flow was identified to be generally to the south, south-west towards the Finke River approximately 100m to the south. TRH and BTEX were not identified in the wells above the limits of reporting however lead was detected and exceeded ANZG and ADWG criteria. Recommendations from the report were to develop a groundwater monitoring plan and undertake additional rounds of monitoring to confirm that chemical concentrations remain low.

3.3 Step 2 – Identify the Decision

The decision will be to assess whether the known hydrocarbon soil contamination in the vicinity of the fuel tanks has resulted in impacts to groundwater. The comparison of results against the screening criteria will form part of that decision process.

Groundwater investigation results are considered required to allow a comparison against, ANZG and ADWG criteria for protected environmental values as specified in Section 3.4.5.

Relevant guidelines to be used as part of the assessment will include:

- Northern Territory of Australia Water Act 1992
- Northern Territory of Australia Water Regulations 1992
- Northern Territory of Australia Waste Management and Pollution Control Act 1998
- Victoria Government Gazette No. S 245

- Australian and New Zealand Guidelines for Fresh and Marine Water Quality, 2018 (ANZG)
- Australian Drinking Water Guidelines 2011 (ADWG)
- Amended National Environment Protection (Assessment of Site Contamination) Measure 1999
- AS5667.1-1998: Water quality – Sampling, Guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples
- AS5667.11-1998: Water quality – Sampling, Guidance on sampling of groundwaters

3.4 Step 3 – Identify Inputs into the Decision

The inputs required to make the decision stated in Step 2 are identified in the DQO process and include:

- Consideration of the site's history
- Consideration of the results of previous site investigations
- Collection of groundwater samples and lab analyses
- Consideration of the site's current condition
- Consideration of the site's future use

3.4.1 Investigation scope considerations

The following considerations apply:

- The scope of investigations is limited to the uppermost groundwater aquifer in the vicinity of the UST's.
- The monitoring event will be limited to existing groundwater wells at the site in the vicinity of the UST's.
- All operational wells will be gauged prior to purging and sampling.
- All operational wells will be purged until field parameters become stable or a well runs dry (although the latter is not desirable).
- All operational wells will be assessed for groundwater sheen, odours and free product (the latter by using an interface probe).
- All operational wells will be sampled for laboratory analysis (refer to Section 3.8.2 for the laboratory program).

3.4.2 Laboratory analysis methodology

Analysis of primary samples, intra-laboratory samples, rinsate, field blank and trip blank samples will be conducted by Eurofins. Analyses of inter-laboratory samples will be undertaken by Envirolab Services. The laboratories hold National Association of Testing Authorities (NATA) registration for the parameters listed in the following table:

Parameter	Analytical Method	Limits of Reporting (mg/L unless otherwise stated)
Metals (Pb)	Eurofins: USEPA 6020A	0.001
	Envirolab: APHA 3120 USEPA 200.8, USEPA 3005A (prep), USEPA 6020A)	0.001
TRH	Eurofins: LTM-ORG-2010 TRH C6-C40	0.02-0.1
	Envirolab: USEPA 8020A, 8260, 8000	0.05-0.1
BTEXN	Eurofins: USEPA 8260	0.001
	Envirolab: USEPA 8260	0.001

Parameter	Analytical Method	Limits of Reporting (mg/L unless otherwise stated)
MTBE	Eurofins: USEPA 8260	0.001
	Envirolab: USEPA 8260	0.001

3.4.3 Internal laboratory quality control

Internal laboratory quality control will include the following: reagent blanks, method blanks, matrix spikes, matrix spike duplicates, surrogate spikes, reference materials and laboratory control samples (refer also to the Amended ASC NEPM, Schedule B3).

3.4.4 Quality assurance/quality control

- Analysis of 1 intra laboratory and 1 inter laboratory duplicate and 1 rinsate for TPH, BTEXN, MTBE and lead.
- Analysis of 1 trip blank sample for BTEXN and TRH C₆ - C₉.

3.4.5 Assessment criteria

Acceptance criteria will be selected based on the environmental values (EVs) applicable to the site.

The NT contaminated Land Guideline (section 11.5) requires that environmental audits be completed in accordance with the State where the Auditor is accredited, in this case Victoria. On this basis the selection of the EVs was undertaken as per the method detailed in Part 5 Division 2 of the Victorian Government Gazette No S245 dated May 2021. The document specifies that EVs should be based on the TDS (Table 5.3) and then indicators and objectives are based on selected EVs (Table 5.4).

Therefore for the Glen Helen site TDS was based on the TDS level in one of the wells on site and reported TDS levels of nearby production wells which ranged from 1,220ppm to 3,200ppm. Based on this Groundwater Segment B with a TDS range of 1,201mg/L – 3,100mg/L was selected as the most representative. For Segment B the following environmental values apply:

- Water dependent ecosystems and species
- Potable mineral water supply
- Irrigation
- Stock Watering
- Industrial and commercial use
- Primary contact recreation
- Traditional Owner cultural values
- Buildings and structures
- Geothermal properties

Based on the selected environmental values and in consideration of the limited scope of analysis (analysing for lead, TRH, BTEXN, MTBE), groundwater results will be compared to the following indicators as specified in Table 5.4:

- Aquatic ecosystems default guideline values for 99% species protection for freshwater from the 2018 Australian and New Zealand Guidelines for Fresh & Marine Water Quality (ANZG)
- Health and aesthetic guideline values provided in Table 10.6 of the 2011 Australian Drinking Water Guidelines (ADWG)

Results will be compared to the lowest recognised criterion for each analyte (shown in bold in the results summary table).

For a Tier 1 risk assessment of vapour intrusion, health screening levels are provided in Schedule B1 of the ASC NEPM. The health screening levels (HSLs) considered most appropriate is "Groundwater HSL for

Vapour Intrusion, HSL A/B, 8m+, Clay Soils", on the basis of the most conservative soil type, the land use scenario and the depth to groundwater.

3.4.6 Presence of LNAPL

During well gauging a Solinst 122 Interface Meter will be used to check for the presence of LNAPL in each well. Where LNAPL is detected the thickness will be determined and the well will not be sampled. In addition during purging and sampling recovered water will be inspected for the presence of LNAPL.

3.4.7 Presence of odour and sheen

During purging and sampling activities the purged water will be observed for the presence of odour and sheen.

3.5 Step 4 – Define the Study Boundaries

The site is defined on the plan provided in Appendix A.

3.6 Step 5 – Develop a Decision Rule

The results of the groundwater analytical testing will be compared to adopted assessment criteria.

Data Quality Objectives (DQOs) for the site will be in accordance with the Amended ASC NEPM.

Data Quality Indicators (DQIs) to be adopted to assess the precision, accuracy, documentation, completeness, representativeness and comparability of the data are summarised in Appendix B.

3.7 Step 6 – Specify Limits on Decision Errors

3.7.1 General

To validate the quality and quantity of both the field and laboratory data being used in the decision making process, Quality Assurance/Quality Control (QA/QC) objectives have been developed. QA/QC procedures will be implemented in accordance with Australian Standard AS4482.1.

The accepted probability of making a Type II error (false negative) for this investigation has been set at 5%.

3.7.2 Decision error protocol

The decision error protocols adopted for the QA/QC program are as identified in Appendix B.

3.7.3 Rectifying non-conformances

Where non-conformances in the decision error protocols are identified the reason for the non-conformance will be investigated and clearly identified within the assessment report. The discussion will also state whether the identified non-conformance is likely to impact the quality of the data obtained for the investigation of the site.

Where a non-conformance is reported by the analytical laboratories, the laboratory will be contacted to identify the reason for the non-conformance and affected samples may be re-analysed to ensure the representativeness of the results.

In the event that the stated level of confidence in the decision cannot be achieved (in this case 95%) during the hypothesis testing approach, additional collection of samples and/or analysis of additional samples may be required. Any recommended additional works would be outlined in a proposal to be considered for approval by the Client.

3.7.4 Laboratory analytical procedures

Laboratories used for the investigation will be NATA accredited and will use NATA endorsed analytical methods (where available).

3.8 Step 7 – Optimise the Design for Obtaining Data

The condition of the wells and the site will be reviewed prior to sampling and during gauging to ensure the most appropriate sampling technique is used and to identify sampling constraints (if any) posed by site

conditions. At this stage the proposed method is using a low follow bladder pump with dedicated twin tubing and dedicated disposal bladder for each well.

3.8.1 Sampling methodology

The sampling methodology to be adopted for the investigation will be undertaken in accordance with the Amended ASC NEPM. A brief description of the proposed methodology is provided in Section 3.8.6 of this report.

3.8.2 Sampling pattern, frequency and analysis

Samples will be collected from the 4 groundwater wells MW1, MW2 (if able to be located), MW3 and MW4. A plan showing the locations of the groundwater wells is presented in Appendix A.

Field parameters will be measures as follows:

- pH, conductivity, redox, temperature, dissolved oxygen

The proposed laboratory scope is as follows:

- Analysis of samples from MW1 to MW4 for TRH, BTEXN, MTBE, lead

3.8.3 Sampling team

The Project Team will include the following members and responsibilities as outlined below.

Role	Team Member	Contact Details
Client Contact	Amy Driver	08 8951 1911 amyd@ngur.com.au
Reporting Manager	Daryl Burrows	0402 097 295 daryl@tierra.com.au
Project Manager and Client Liaison	Daryl Burrows	0402 097 295 daryl@tierra.com.au
Peer Review	Tom Dolling	08 8373 2512 tom@tierra.com.au
Field Program Manager and OH&S Manager	Daryl Burrows	0402 097 295 daryl@tierra.com.au
Field Team	Daryl Burrows/ Lauren Harvey (if Daryl is unavailable)	08 8373 2512
Reporting	Daryl Burrows/ Lauren Harvey	08 8373 2512

3.8.4 Field instrument calibration and maintenance

The water quality meter used during purging activities will be sourced from Kennards. The unit will be calibrated by Kennards prior to issue.

3.8.5 Field data and record keeping

Sampling sheets will be completed in the field and contain information regarding the depth to groundwater, weather, purging method and equipment, litres purged, temperature, dissolved oxygen concentration, conductivity, pH, redox, appearance of the water and other information or observations made.

Groundwater well locations will be placed on a plan and contours from groundwater gauging data will be generated.

3.8.6 Sample collection and preservation

Sampling will be undertaken in accordance with Schedule B2 of the ASC NEPM.

The primary laboratory will supply appropriate sample bottles for the type of analysis that is to be undertaken. Bottles will be labelled prior to going on site. Sample bottles for individual wells will be removed from the site vehicle immediately after purging and prior to sampling. Bottles will be labelled with the appropriate location designation.

It has been assumed that laminar flow and therefore low flow is able to be achieved in the wells during the monitoring event. If this is not the case in any particular well the well will be purged with drawdown until either the field readings are stable or the well runs dry. In the event the well runs dry the well will be left until the water level has recovered to at least 75% of its original level and then sampled.

During this event groundwater wells are to be purged and sampled using a low flow bladder pump.

All wells will be purged prior to sampling until dissolved oxygen, redox potential, conductivity, pH and temperature readings, measured in the field using a multi parameter water quality meter, have stabilised. Purged water will be stored in 200L drums and disposed of at a licenced liquid waste facility.

3.8.7 Sample preservation and transport

Samples will be stored in an esky with ice prior to transportation to the laboratory to ensure that acceptable storage conditions are achieved as relevant to the type of analyses to be undertaken. Samples will be shipped to the laboratory within 48 hours of sampling under Chain of Custody documentation.

3.8.8 Decontamination

Disposable gloves will be worn during all sampling activities to prevent contact with potentially toxic compounds and changed between samples to prevent cross contamination.

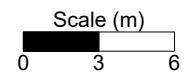
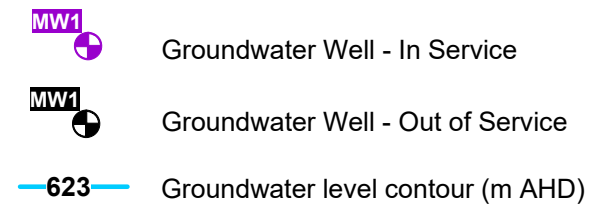
A new disposable bladder pump and dedicated twin tubing will be used for each well to minimise the potential for cross contamination.

The Solinst Interface meter used during groundwater gauging and the body of the bladder pump will be decontaminated by washing in detergent (e.g. Decon 90) and water and subsequent rinsing with water prior to the commencement of field work, between each groundwater well and at the completion of field work. This will be undertaken to minimise the potential for cross contamination of samples. The water quality meter will not be decontaminated as it will be located after the sampling position and as such sampled water will not come in contact with the meter.

3.8.9 Reporting

A report will be prepared based on reporting guidelines in the Amended ASC NEPM.

APPENDIX A
SITE PLAN



Notes:

1. The extent of the former tank pits are approximate based on a plan provided by Low Ecological Services.
2. The position of MW1, MW3 and MW4 is based on a survey. The position of MW2 is approximate and based on a plan provided by Low Ecological Services.
3. Groundwater contours generated by Surfer software with a grid generated using triangulation with linear interpolation.

Figure 1 - Groundwater Well Locations
Glen Helen Discovery Park
Groundwater Monitoring Event, May 2023

APPENDIX B
DATA QUALITY INDICATORS

DQI - Completeness <i>A measure of the amount of useable data (expressed as %) from a data collection activity</i>			
<i>Field considerations</i>	<i>Laboratory considerations</i>	<i>Comments</i>	<i>Completeness DQIs adopted for this program</i>
<p>All critical locations sampled All samples collected SOPs appropriate and complied with Experienced sampler Documentation correct</p>	<p>All critical samples analysed according to SAQP All analytes analysed according to SAQP Appropriate methods and PQLs Sample documentation complete Sample holding times complied with</p>	<p>The required percentage completeness should be specified in the SAQP. All required data must be obtained for critical samples and chemicals of concern. Incompleteness is influenced by:</p> <ul style="list-style-type: none"> • field performance problems (access problems, difficulties on site, damage) • laboratory performance problems (matrix interference, invalid holding times) • matrix problems 	<ul style="list-style-type: none"> ▪ All field work to be completed in accordance with the SAQP. Where this cannot be achieved, alternative sampling approaches / locations will be undertaken where possible. An acceptance level of 95% has been considered appropriate. ▪ Samples to be collected from each well ▪ Field engineer / scientist to be adequately experienced/trained in each task to be undertaken or supervised by an adequately experienced/trained person ▪ Field sampling sheets to be completed ▪ Samples to be analysed within laboratory specified holding times ▪ Primary and secondary laboratory methods are as listed in the SAQP
DQI - Comparability <i>The confidence (expressed qualitatively) that data may be considered to be equivalent for each sampling and analytical event</i>			
<i>Field considerations</i>	<i>Laboratory considerations</i>	<i>Comments</i>	<i>Comparability DQIs adopted for this program</i>
<p>Same SOPs used on each occasion Experienced sampler Climatic conditions (temperature, rainfall, wind, ...)</p>	<p>Sample analytical methods used (including clean-up) Sample PQLs (justify/quantify if different) Same laboratories (justify/quantify if different) Same units (justify/quantify if different)</p>	<p>Same approach to sampling (SOPs, holding times...) Quantify influence from climatic or physical conditions Samples collected, preserved, handled in same manner (filtered, same containers)</p>	<ul style="list-style-type: none"> ▪ Field work to be completed in accordance with the SAQP ▪ Field engineer / scientist to be adequately experienced/trained in each task to be undertaken or supervised by an adequately experienced/trained person ▪ Groundwater samples to be collected using the same method, i.e. low flow bladder pump ▪ Refer SAQP for primary laboratory methods ▪ Same media to be reported with same units (mg/L or ug/L for water) ▪ Samples to be stored in laboratory supplied containers, in a chilled cool box and transported to laboratory under chain of custody documentation

Glen Helen Discovery Park
Groundwater Monitoring Plan

<i>DQI - Representativeness</i>			
<i>The confidence (expressed qualitatively) that data are representative of each media present on the site</i>			
<i>Field considerations</i>	<i>Laboratory considerations</i>	<i>Comments</i>	<i>Representativeness DQIs adopted for this program</i>
<i>Appropriate media sampled according to SAQP All media identified in SAQP sampled</i>	<i>All samples analysed according to SAQP</i>	<i>Samples must be collected to reflect the characteristics of each media Sample analyses must reflect properties of field samples Homogeneity of the samples Appropriate collection, handling, storage and preservation Detection of laboratory artefacts, e.g. contamination blanks</i>	<ul style="list-style-type: none"> ▪ <i>Groundwater only to be sampled as specified in the SAQP</i> ▪ <i>Groundwater samples to be collected in accordance with AS4482.1 in appropriately preserved bottles and stored in chilled cool box for transport to the laboratory to minimise volatile losses</i> ▪ <i>Refer accuracy (bias) for laboratory blank info</i>
<i>DQI - Precision</i>			
<i>A quantitative measure of the variability (or reproducibility) of data</i>			
<i>Field considerations</i>	<i>Laboratory considerations</i>	<i>Comments</i>	<i>Precision DQI's adopted for this program</i>
<i>SOPs appropriate and complied with</i>	<i>Analysis of:</i> <ul style="list-style-type: none"> • <i>laboratory and interlaboratory duplicates</i> • <i>field duplicates</i> • <i>laboratory-prepared volatile trip spikes</i> 	<i>Measured by the coefficient of variance or standard deviation of the mean or by RPDs Field duplicates measure field and laboratory precision Laboratory duplicates measure analytical precision</i>	<ul style="list-style-type: none"> ▪ <i>All field work to be completed in accordance with the SAQP.</i> ▪ <i>Field duplicates (inter and intra laboratory) to be collected and analysed as indicated in the SAQP. RPDs to be calculated for inter and intra laboratory duplicates, with the objective of all RPDs calculated being 0% to 50% for concentrations 10 to 30 times the limits of reporting and 0% to 30% for concentrations 30 times greater than the limits of reporting. Where exceedances greater than these tolerances occur, the reason for the high RPD value will be investigated and further action will be taken if necessary. These reasons may be related to low sample concentrations where a small actual difference in concentration results in a large RPD value, in which case no further action will be required.</i> ▪ <i>Laboratory internal QC to include duplicate samples for each analyte and will conform with the following:</i> <ul style="list-style-type: none"> ○ <i>Surrogate spike recoveries to be between the laboratories stated criteria (varies per analytes);</i> ○ <i>Matrix spike recoveries to be between the laboratories stated criteria (varies per analytes);</i> ○ <i>Contaminants below detection limits for field blank samples and rinsate and trip blank samples;</i> ○ <i>Matrix duplicate/laboratory duplicate RPDs to be less than 30%.</i>

<i>DQI - Accuracy (bias)</i> <i>A quantitative measure of the closeness of reported data to the true value</i>			
<i>Field considerations</i>	<i>Laboratory considerations</i>	<i>Comments</i>	<i>Accuracy (bias) DQIs adopted for this program</i>
<i>SOPs appropriate and complied with</i>	<i>Analysis of:</i> <ul style="list-style-type: none"> • <i>field blanks</i> • <i>rinsate blanks</i> • <i>reagent blanks</i> • <i>method blanks</i> • <i>matrix spikes</i> • <i>matrix spike duplicates</i> • <i>surrogate spikes</i> • <i>reference materials</i> • <i>laboratory control samples</i> 	<i>Bias introduced:</i> <ul style="list-style-type: none"> • <i>by chemicals during handling or transport</i> • <i>from contaminated equipment</i> • <i>from contaminated reagents</i> • <i>during laboratory analysis</i> • <i>during laboratory preparation and analysis (may be high or low)</i> • <i>precision of preparation and analytical method</i> 	<ul style="list-style-type: none"> ▪ <i>All field work to be completed in accordance with this SAQP.</i> ▪ <i>Laboratories to be National Association of Testing Authorities (NATA) accredited for the analyses performed (where available)</i> ▪ <i>The frequency of duplicate, trip blank, and rinsate sampling and testing will be as listed in the SAQP.</i> ▪ <i>Laboratory internal QC to include as outlined in NEPM Schedule B(3):</i> <ul style="list-style-type: none"> ○ <i>reagent blanks</i> ○ <i>method blanks</i> ○ <i>matrix spikes</i> ○ <i>matrix spike duplicates</i> ○ <i>surrogate spikes</i> ○ <i>reference materials</i> ○ <i>laboratory control samples</i>

TABLES



Soil Results - All Data



APPENDIX C - SUMMARY LABORATORY ANALYSIS RESULTS FOR SOIL SAMPLES 23/03/2021

Section 1: 1-12 analytes

			Sample ID: Glen Helen 23/03/2021											
Analyte grouping/Analyte	Unit	LOR	P6 0.5m	B1 above	B3 above	B5 above	B7 above	B9 above	P9 0.5m filler sand	D11 south of tank	B10	D1 0.1m	D5 0.1m	D0 0.1m
<i>PID Reading (Non-Lab Field Measurement)</i>														
PID Vapour Reading	ppm	0.1												
Moisture Content	%	1	4.5	8.6	10.4	9.7	7.6	8.7	5.8	5.5	7.9	13.2	6.6	18.8
EG005(ED093) T: Total Metals by ICP-AES														
Arsenic	mg/kg	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Cadmium	mg/kg	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Chromium	mg/kg	2	18	11	11	10	10	16	4	16	15	15	7	13
Copper	mg/kg	5	13	8	8	6	6	10	<5	10	10	10	9	10
Lead	mg/kg	5	9	19	21	6	<5	10	<5	8	6	7	7	12
Nickel	mg/kg	2	10	7	7	6	6	9	3	9	9	9	5	8
Zinc	mg/kg	5	27	32	30	23	74	28	9	23	21	40	18	37
EG035T: Total Recoverable Mercury by FIMS														
Mercury	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
EP080/071: Total Petroleum Hydrocarbons														
C6 - C9 Fraction	mg/kg	10	<10	<10	<10	<10	<10	<10	<10	44	286	<10	<10	<10
C10 - C14 Fraction	mg/kg	50	110	250	450	<50	<50	1910	<50	5220	9170	<50	<50	1920
C15 - C28 Fraction	mg/kg	100	<100	2100	3280	<100	<100	8920	<100	15300	17700	<100	120	13400
C29 - C36 Fraction	mg/kg	100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
C10 - C36 Fraction (sum)	mg/kg	50	110	2350	3730	<50	<50	10800	<50	20500	26900	<50	120	15300
EP080S: TPH(V)/BTEX Surrogates														
1,2-Dichloroethane-D4	%	0.2	113	105	111	100	101	110	114	117	104	109	114	100
Toluene-D8	%	0.2	105	98.8	106	98.0	84.1	107	110	116	108	113	108	92.4

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			Sample ID: Glen Helen 23/03/2021											
Analyte grouping/Analyte	Unit	LOR	P6 0.5m	B1 above	B3 above	B5 above	B7 above	B9 above	P9 0.5m filler sand	D11 south of tank	B10	D1 0.1m	D5 0.1m	D0 0.1m
4-Bromofluorobenzene	%	0.2	107	95.3	104	99.2	93.5	102	111	108	106	112	107	88.1
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions														
C6 - C10 Fraction	mg/kg	<10	<10	23	<10	117	435	<10	<10	<10	<10	<10	<10	<10
C6 - C10 Fraction minus BTEX (F1)	mg/kg	10	<10	<10	<10	<10	<10	23	<10	117	435	<10	<10	<10
>C10 - C16 Fraction minus Naphthalene (F2)	mg/kg	50	<10	<10	<10	<10	<10	23	<10	114	415	<10	<10	<10
>C16 - C34 Fraction (F3)	mg/kg	100	80	790	1090	<50	<50	4960	<50	9580	15800	<50	<50	4920
>C34 - C40 Fraction (F4)	mg/kg	100	<100	1640	2740	<100	<100	6040	<100	11000	11000	<100	<100	10600
>C10 - C40 Fraction (sum)	mg/kg	50	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
>C10 - C16 Fraction minus Naphthalene (F2)	mg/kg	50	80	2430	3830	<50	<50	11000	<50	20600	26800	<50	<50	15500
EP080: BTEXN														
Benzene	mg/kg	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Toluene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	1.4	<0.5	<0.5	<0.5
Ethylbenzene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	1.8	<0.5	<0.5	<0.5
meta- & para-Xylene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	1.1	8.4	<0.5	<0.5	<0.5
ortho-Xylene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	1.7	8.2	<0.5	<0.5	<0.5
Total Xylenes	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	2.8	16.6	<0.5	<0.5	<0.5
Sum of BTEX	mg/kg	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	2.8	19.8	<0.2	<0.2	<0.2
Naphthalene	mg/kg	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

Section 2: 13-24 analytes

			Sample ID: Glen Helen 23/03/2021											
Analyte grouping/Analyte	Unit	LOR	D9 1.0m	P17 surface	B20	B15	P11 2.5m	P13 2.3m	P14 2.3m	P29 3.5m	P30 3.5m	P31 3.7m	B13	D17 0.5m below tank
PID Reading (Non-Lab Field Measurement)														
PID Vapour Reading	ppm	0.1												
Moisture Content	%	1	8.0	6.1	6.9	6.8	9.5	7.7	8.0	7.4	7.7	7.4	10.8	4.3
EG005(ED093) T: Total Metals by ICP-AES														
Arsenic	mg/kg	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Cadmium	mg/kg	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Chromium	mg/kg	2	11	15	17	14	15	14	8	9	8	15	10	17
Copper	mg/kg	5	7	8	12	10	10	9	6	9	6	10	7	12
Lead	mg/kg	5	8	24	9	34	6	27	<5	<5	<5	8	6	12
Nickel	mg/kg	2	7	9	11	8	9	8	5	6	5	9	6	10
Zinc	mg/kg	5	39	23	27	25	21	17	10	13	9	26	12	32
EG035T: Total Recoverable Mercury by FIMS														
Mercury	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
EP080/071: Total Petroleum Hydrocarbons														
C6 - C9 Fraction	mg/kg	10	<10	<10	<10	<10	<10	<10	395	61	490	185	223	<10
C10 - C14 Fraction	mg/kg	50	<50	290	110	<50	<50	<50	80	160	340	8360	9840	150
C15 - C28 Fraction	mg/kg	100	<100	2900	610	<100	<100	<100	<100	<100	110	17700	18600	100
C29 - C36 Fraction	mg/kg	100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
C10 - C36 Fraction (sum)	mg/kg	50	<50	3190	720	<50	<50	<50	80	160	450	26100	28400	250
EP080S: TPH(V)/BTEX Surrogates														
1,2-Dichloroethane-D4	%	0.2	102	101	110	120	88.7	97.4	108	98.0	90.9	93.6	84.0	95.1
Toluene-D8	%	0.2	95.9	95.9	110	111	89.4	102	113	104	109	115	102	112
4-Bromofluorobenzene	%	0.2	97.0	93.2	107	116	86.5	96.8	112	105	114	117	99.1	113

			Sample ID: Glen Helen 23/03/2021											
Analyte grouping/Analyte	Unit	LOR	D9 1.0m	P17 surface	B20	B15	P11 2.5m	P13 2.3m	P14 2.3m	P29 3.5m	P30 3.5m	P31 3.7m	B13	D17 0.5m below tank
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions														
C6 - C10 Fraction	mg/kg	10	<10	<10	<10	<10	<10	<10	<10	489	97	592	421	420
C6 - C10 Fraction minus BTEX (F1)	mg/kg	10	<10	<10	<10	<10	<10	<10	<10	469	93	569	403	370
>C10 - C16 Fraction minus Naphthalene (F2)	mg/kg	50	1070	<50	1030	240	<50	<50	<50	60	130	270	15000	14900
>C16 - C34 Fraction (F3)	mg/kg	100	3130	<100	2260	500	<100	<100	<100	<100	<100	<100	10900	13100
>C34 - C40 Fraction (F4)	mg/kg	100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
>C10 - C40 Fraction (sum)	mg/kg	50	4200	<50	3290	740	<50	<50	<50	60	130	270	25900	28000
>C10 - C16 Fraction minus Naphthalene (F2)	mg/kg	50	1070	<50	1030	240	<50	<50	<50	60	130	270	15000	14900
EP080: BTEXN														
Benzene	mg/kg	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.2	<0.2	<0.2
Toluene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	3.3	<0.5	4.9	1.2	6.7
Ethylbenzene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	3.3	0.8	4.7	1.8	7.2
meta- & para-Xylene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	8.6	1.7	8.6	8.2	22.4
ortho-Xylene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	4.9	1.1	4.8	6.8	14.1
Total Xylenes	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	13.5	2.8	13.4	15.0	36.5
Sum of BTEX	mg/kg	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	20.1	3.6	23.2	18.0	50.4
Naphthalene	mg/kg	1	<1	<1	<1	<1	<1	<1	<1	1	2	1	1	1

APPENDIX D - FULL LABORATORY ANALYSIS RESULTS FOR SOIL SAMPLES 28/04/2021

Analyte grouping/Analyte	Unit	LOR	Sample ID: Glen Helen 28/04/2021											
			D3 – 0.1m	P2 - 0.1m	H1 - 2.3m	H2 - 2.6m	H3 - 0.0m	H3 - 2.2-2.7m	H4 - 1.0m	H5 - 3.0m	H6 - 0.0	H6 - 2.0	H7 - 2.0	H8 - 1.0
<i>PID Reading (Non-Lab Field Measurement)</i>														
PID Vapour Reading	ppm	0.1	389	1863	0.1	5.6	4.2	3.5	4.8	10.6	4.5	5.5	5.1	11.4
Moisture Content	%	1	6.9	7.8	10.3	5.1	1.6	9.8	4.2	3.6	6.4	9.1	9.2	8.4
EG005(ED093) T: Total Metals by ICP-AES														
Arsenic	mg/kg	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Cadmium	mg/kg	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Chromium	mg/kg	2	12	16	12	12	6	17	5	12	10	12	17	12
Copper	mg/kg	5	9	10	8	10	<5	12	<5	8	7	9	12	9
Lead	mg/kg	5	6	8	<5	7	<5	8	<5	6	<5	5	7	6
Nickel	mg/kg	2	7	9	7	10	4	10	3	8	6	8	10	7
Zinc	mg/kg	5	17	21	13	22	8	26	6	20	14	17	26	17
EG035T: Total Recoverable Mercury by FIMS														
Mercury	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
EP080/071: Total Petroleum Hydrocarbons														
C6 - C9 Fraction	mg/kg	10	274	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
C10 - C14 Fraction	mg/kg	50	16900	90	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
C15 - C28 Fraction	mg/kg	100	45400	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
C29 - C36 Fraction	mg/kg	100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
C10 - C36 Fraction (sum)	mg/kg	50	62300	90	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
EP080S: TPH(V)/BTEX Surrogates														
1,2-Dichloroethane-D4	%	0.2	127	106	92.3	99.2	106	103	102	103	102	90.9	94.6	113
Toluene-D8	%	0.2	120	119	99.9	94.1	118	114	112	114	117	99.2	108	128
4-Bromofluorobenzene	%	0.2	117	120	101	108	119	118	110	115	112	103	109	124
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions														
C6 - C10 Fraction	mg/kg	10	703	42	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10

Analyte grouping/Analyte	Unit	LOR	Sample ID: Glen Helen 28/04/2021											
			D3 – 0.1m	P2 - 0.1m	H1 - 2.3m	H2 - 2.6m	H3 - 0.0m	H3 - 2.2-2.7m	H4 - 1.0m	H5 - 3.0m	H6 - 0.0	H6 - 2.0	H7 - 2.0	H8 - 1.0
C6 - C10 Fraction minus BTEX (F1)	mg/kg	10	660	42	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
>C10 - C16 Fraction minus Naphthalene (F2)	mg/kg	50	32000	110	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
>C16 - C34 Fraction (F3)	mg/kg	100	30500	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
>C34 - C40 Fraction (F4)	mg/kg	100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
>C10 - C40 Fraction (sum)	mg/kg	50	62500	110	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
>C10 - C16 Fraction minus Naphthalene (F2)	mg/kg	50	32000	110	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
EP080: BTEXN														
Benzene	mg/kg	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Toluene	mg/kg	0.5	1.9	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Ethylbenzene	mg/kg	0.5	5.2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
meta- & para-Xylene	mg/kg	0.5	21.6	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
ortho-Xylene	mg/kg	0.5	14.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Total Xylenes	mg/kg	0.5	35.7	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Sum of BTEX	mg/kg	0.2	42.8	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Naphthalene	mg/kg	1	6	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

4.2. LABORATORY RESULTS MAY 2022

Table 2: ALS Laboratory Results for the Soil Samples taken in May 2022.

SUMMARY LABORATORY ANALYSIS RESULTS FOR SOIL SAMPLES 27/05/2022

Analyte grouping/Analyte	Unit	LOR	Sample ID: Glen Helen 27/05/2022									
			MW1 6m	MW1 10m	MW1 13m	MW2 6m	MW2 13m	MW3 5m	MW3 15m	MW4 5m	MW4 6m	MW4 10m
Moisture Content	%	1	4.0	11.0	12.5	6.6	9.1	5.2	16.0	3.9	---	7.0
EG005(ED093) T: Total Metals by ICP-AES												
Arsenic	mg/kg	5	128	<5	7	97	<5	94	<5	57	31	<5
Cadmium	mg/kg	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Chromium	mg/kg	2	5	7	8	10	11	4	2	6	4	12
Copper	mg/kg	5	<5	9	12	6	<5	<5	<5	5	<5	<5
Lead	mg/kg	5	8	9	14	6	<5	5	7	<5	5	<5
Nickel	mg/kg	2	14	8	13	8	49	10	4	10	10	35
Zinc	mg/kg	5	15	30	49	16	153	10	15	10	14	87
EG035T: Total Recoverable Mercury by FIMS												
Mercury	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
EP080/071: Total Petroleum Hydrocarbons												
C6 - C9 Fraction	mg/kg	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
C10 - C14 Fraction	mg/kg	50	130	<50	<50	<50	<50	<50	<50	<50	<50	<50
C15 - C28 Fraction	mg/kg	100	910	<100	<100	<100	<100	<100	<100	<100	<100	<100
C29 - C36 Fraction	mg/kg	100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
C10 - C36 Fraction (sum)	mg/kg	50	1040	<50	<50	<50	<50	<50	<50	<50	<50	<50
EP080S: TPH(V)/BTEX Surrogates												
1,2-Dichloroethane-D4	%	0.2	96.2	97.1	96.2	100	98.3	108	97.4	101	86.3	92.8
Toluene-D8	%	0.2	103	98.8	98.8	100	100	110	102	109	104	107
4-Bromofluorobenzene	%	0.2	93.8	93.8	90.9	96.2	94.6	103	92.4	101	87.7	93.2
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions												
C6 - C10 Fraction	mg/kg	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
C6 - C10 Fraction minus BTEX (F1)	mg/kg	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
>C10 - C16 Fraction	mg/kg	50	360	<10	<10	<10	<10	<10	<10	<10	<10	<10
>C16 - C34 Fraction (F3)	mg/kg	100	700	<50	<50	<50	<50	<50	<50	<50	<50	<50

Table 2 continued:

Analyte grouping/Analyte	Unit	LOR	Sample ID: Glen Helen 27/05/2022									
			MW1 6m	MW1 10m	MW1 13m	MW2 6m	MW2 13m	MW3 5m	MW3 15m	MW4 5m	MW4 6m	MW4 10m
>C34 - C40 Fraction (F4)	mg/kg	100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
>C10 - C40 Fraction (sum)	mg/kg	50	1060	<100	<100	<100	<100	<100	<100	<100	<100	<100
>C10 - C16 Fraction minus Naphthalene (F2)	mg/kg	50	360	<50	<50	<50	<50	<50	<50	<50	<50	<50
EP080: BTEXN												
Benzene	mg/kg	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Toluene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Ethylbenzene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
meta- & para-Xylene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
ortho-Xylene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Total Xylenes	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Sum of BTEX	mg/kg	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Naphthalene	mg/kg	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

Groundwater Results — Most Recent Data



	Metals	PAH	BTEX						TRH											Solvents	
	Lead	Naphthalene	Benzene	Ethylbenzene	Toluene	Xylene (m & p)	Xylene (o)	Xylene Total	C6-C10	C6-C10 less BTEX (F1)	C10-C16	C10-C16 less NAPHTHALENE (F2)	C16-C34	C34-C40	C10 - C40 (Sum of total)	C6 - C9	C10 - C14	C15 - C28	C29-C36	+C10 - C36 (Sum of total)	MTBE
	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	mg/L	mg/L	mg/L	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L
EQL	0.001	10	1	1	1	2	1	3	0.02	0.02	0.05	0.05	0.1	0.1	100	20	50	100	100	100	0.001
ADWG 2015 Aesthetic			3	25				20													
ADWG 2015 Health	0.01		1	300	800			600													
ANZG (2018) Freshwater 99%	0.001	2.5	600				200														
NEPM GW HSL A/B Vapour Intrusion, 4m-8m, Sand		NL	800	NL	NL			NL		1		1									
Location	Sample Date																				
FR1	31/05/2023	<0.001	<10	<1	<1	<1	<2	<1	<3	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1	<100	<20	<50	<100	<100	<100
FR2	31/05/2023	<0.001	<10	<1	<1	<1	<2	<1	<3	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1	<100	<20	<50	<100	<100	<100
MW1	31/05/2023	0.01	<10	<1	<1	<1	<2	<1	<3	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1	<100	<20	<50	<100	<100	<100
MW3	31/05/2023	0.056	<10	<1	<1	<1	<2	<1	<3	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1	<100	<20	<50	<100	<100	<100
MW4	31/05/2023	0.002	<10	<1	<1	<1	<2	<1	<3	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1	<100	<20	<50	<100	<100	<100

	Metals	PAH	BTEX						TRH											Solvents		
	Lead	Naphthalene	Benzene	Ethylbenzene	Toluene	Xylene (m & p)	Xylene (o)	Xylene Total	C6-C10	C6-C10 less BTEX (F1)	C10-C16	C10-C16 less NAPHTHALENE (F2)	C16-C34	C34-C40	C10 - C40 (Sum of total)	C6 - C9	C10 - C14	C15 - C28	C29-C36	+C10 - C36 (Sum of total)	MTBE	
	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	
EQL	0.001	10	1	1	1	2	1	3	0.02	0.02	0.05	0.05	0.1	0.1	100	20	50	100	100	100	0.001	
ADWG 2015 Aesthetic				3	25			20														
ADWG 2015 Health	0.01		1	300	800			600														
ANZG (2018) Freshwater 99%	0.001	2.5	600				200															
NEPM GW HSL A/B Vapour Intrusion, 4m-8m, Sand		NL	800	NL	NL			NL		1		1										
Location	Sample Date																					
MW1	15/11/2022	-	<5	<1	<2	<2	<2	<2	0.04	0.04	<0.1	<0.1	<0.1	<0.1	<0.1	<100	40	<50	<100	<50	<50	-
MW1	13/12/2022	-	<5	<1	<2	<2	<2	<2	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1	<0.1	<20	<50	<100	<50	<50	-	
MW1	31/05/2023	0.01	<10	<1	<1	<1	<2	<1	<3	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1	<100	<20	<50	<100	<100	<100	<0.001
MW2	15/11/2022	-	6	4	2	<2	<2	<2	0.1	0.09	0.15	0.14	0.11	<100	0.26	110	140	110	<50	250	-	
MW2	13/12/2022	-	6	4	-	-	-	-	0.06	-	-	-	-	-	-	60	-	-	-	-	-	
MW2	31/05/2023								Not Located													
MW3	15/11/2022	-	<5	<1	<2	<2	<2	<2	0.03	0.03	<0.1	<0.1	<0.1	<0.1	<0.1	<100	30	<50	<100	<50	<50	-
MW3	13/12/2022	-	<5	<1	<2	<2	<2	<2	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1	<0.1	<20	<50	<100	<50	<50	-	
MW3	31/05/2023	0.056	<10	<1	<1	<1	<2	<1	<3	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1	<100	<20	<50	<100	<100	<100	<0.001
MW4	15/11/2022	-	<5	<1	<2	3	<2	<2	<3	0.73	0.73	<0.1	<0.1	<0.1	<0.1	<0.1	740	60	<100	<50	60	-
MW4	13/12/2022	-	-	-	-	-	-	-	0.03	-	-	-	-	-	-	30	-	-	-	-	-	
MW4	31/05/2023	0.002	<10	<1	<1	<1	<2	<1	<3	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1	<100	<20	<50	<100	<100	<100	<0.001