20 October 2023

Bennett Resources Pty Ltd
Level 14, 225 St Georges Terrace
Perth WA 6000

Re: Targeted Soil & Groundwater Works **– Valhalla Gas Exploration & Appraisal Program**

Please see below a summary of targeted soil and groundwater works undertaken by Gemec for the Valhalla Gas Exploration and Appraisal Program (the Proposal) on 25-26 July 2023.

Gemec was engaged by Bennett Resources Pty Ltd (BNR) to undertake down-hole inspection of four groundwater monitoring wells at the Agard 1 and Valhalla North 1 wellsites, and the excavation and sampling of one soil borehole at the Proposed Well 3 location. The sites are located within the petroleum Exploration Permit EP 371, situated in the in the locality of Mount Hardman, Shire of Derby-West Kimberley, Western Australia.

The Proposal is to complete an unconventional exploration and appraisal drilling and Hydraulic Fracture Stimulation (HFS) program within EP 371 in the Canning Basin. A total of 20 exploration wells are proposed to be constructed at 10 well sites (Figure 1) within the Development Envelope. At the time of the works the Proposal is being assessed by the EPA (Assessment 2281).

1. Purpose

The purpose of the works was to determine whether the construction and condition of existing groundwater monitoring wells is appropriate for baseline groundwater assessment purposes, and to establish a baseline soil data set.

2. Scope of Works

The following activities were carried out as part of the scope of work:

- mobilised personnel and equipment to site;
- completed an occupational health and safety plan for the proposed works;
- inspected four groundwater monitoring wells via down-hole camera;
- excavated one soil borehole to a total depth of 2.0 metres below ground surface;
- undertook sufficient quality assurance (QA) and quality control (QC) procedures to ensure the soil assessment was representative;
- collected two representative primary soil samples and two QC samples from the soil borehole, chilled and transported the samples under chain of custody (CoC) protocols to National Association of Testing Authorities (NATA) accredited laboratories for analysis; and
- prepared a report detailing the field activities, analytical results, conclusions and any recommendations.

Field work was undertaken by an experienced Contaminated Land Consultant from Gemec's Perth office in accordance with the various standards and guidelines referenced in s. 5 (References) and Gemec's Protocols.

3. Soil Assessment

The soil borehole SB1 was excavated from the Proposed Well 3 wellsite shown on the attached Figure 1. The location was chosen as its surface geology and soil landscape are each one of the two most widespread throughout the Proposal area.

> Surface geology: 'Dunes' – sandplain with dunes and swales, may include numerous interdune claypans, may be locally gypsiferous (Geoscience Australia, 2023).

> Soil landscape: 'Camelgooda System' – sandplains, swales and linear sand dunes supporting low pindan woodlands of acacias and low woodlands of bauhinia and bloodwood with curly spinifex and ribbon grass (DPIRD, 2023).

> Land type: sandplains and dunes, pindan woodlands and spinifex/tussock grasslands (DPIRD, 2023).

3.1 Methodology

SB1 was excavated using a 75 mm Ø stainless-steel hand auger. A fresh pair of disposable nitrile gloves was worn for each sample collection and the hand auger was decontaminated prior to and post sampling by washing with a laboratory grade phosphate free detergent solution (Quantumclean®) and rinsing with tap water. The soil samples were collected in laboratory supplied sample containers, chilled following collection and sent under CoC documentation to NATA accredited laboratories for testing. The sample containers were marked with an identifying number, depth and date.

The two sample depths aimed to capture variation through the upper soil profile, at depths that are most likely to be exposed to Chemicals of Potential Concern (CoPC) originating from wellsite activities. The samples were collected from the soil surface at 0-0.3 metres below ground surface (m bgs) and at 1.7-2.0 m bgs.

3.2 Sample Analytical Suites

The CoPC selected for assessment are associated with future potential contaminant sources at each wellsite. Additional physical and chemical analyses were used to further define the nature of the soil and to allow for the calculation of site-specific screening levels.

Both primary soil samples were submitted for analysis of the following:

- Petroleum hydrocarbon compounds including benzene, toluene, ethylbenzene, xylenes and naphthalene (BTEXN) and total recoverable hydrocarbon (TRH) fractions in the C6-C40 carbon chain range;
- metals, metalloids and non-metals including aluminium, arsenic, barium, boron, cadmium, chromium, hexavalent chromium, copper, iron, lead, manganese, mercury, nickel, selenium, strontium, thorium, tin, uranium and zinc;
- nutrients including total nitrogen, total Kjeldahl nitrogen (TKN), ammonia, nitrate, nitrite, total phosphorous and phosphate;
- miscellaneous inorganics including sulfur, fluoride and total cyanide; and
- soil characteristics including pH, electrical conductivity (EC), cation exchange capacity (CEC), clay content, total organic carbon (TOC) and organic matter (TOM).

The analytical procedures used by the laboratories undertake determinations in accordance with the following internationally recognised procedures – NEPM, US EPA, APHA and AS.

3.3 Soil Screening Levels

Soil sample concentrations were compared against site screening levels for the protection of ecological and human health as per the 2021 Department of Water and Environmental Regulation (DWER) *Assessment and management of contaminated sites* guideline, which references screening levels detailed in the *National Environment Protection (Assessment of Site Contamination) Measure* (ASC NEPM – NEPC, 2013).

The selected soil screening levels are presented in the attached Tables and were based on the use of the site and surrounds for broad scale agriculture. The screening level guidelines are presented in the References section (s. 5).

3.4 Quality Control

Quality control samples included blind field replicates (Dup and Split), a Rinsate and a Trip Blank sample. The results of each of these are presented in the attached Tables and Appendix A. The absence of analytes detected in the Rinsate and Trip Blank suggest that no cross contamination occurred via equipment, storage or transport. Most relative percentage difference values for the Dup and Split samples were below 50%, and those above 50% weren't considered significant as the value was within 10x the laboratory limit of reporting (LoR). This suggests an adequate level of repeatability of the sampling procedure, and homogeneity of the samples collected.

Laboratory outliers were reported for holding times (pH, EC, phosphate and nitrite) and matrix spike recovery (TKN, sulfur, aluminium, iron, manganese, zinc). The holding times will be taken into consideration for future assessment, whereas the matrix spike recovery wasn't considered applicable due to the high analyte background in the sample and the laboratory control sample being within acceptance criteria. By signing the laboratory reports the laboratories acknowledge that the results satisfy their NATA accreditation.

3.5 Results

Results are discussed in context of the following attachments:

- Soil analytical results: Tables 1-3.
- Laboratory analytical reports: Appendix A.
- Soil sample location: Figure 1.
- Site photographs: Appendix C

The soil was observed as brown, fine to medium grain silty clayey sand at the surface, and with depth it tended toward brownish red, a higher clay content and damp. The observations and soil characteristics were consistent with those expected for the surface geology and soil landscape described above – including a slightly acidic pH (6.2-6.5), low EC (3.3-4.7 µS/cm), CEC (1.1 meq/100 g) and clay content (1-7%).

Concentrations of the nutrients total nitrogen, TKN, ammonia and phosphorus were detected in both samples, with traces of sulfur and fluoride detected only the surface sample (Split). Cyanide was not detected.

Hydrocarbons as BTEXN and TRH were not detected in either soil sample.

The metals signature was dominated by aluminium and iron as expected, with barium, chromium, copper, lead, manganese, nickel, strontium, thorium, uranium and zinc also detected in both the shallow and deeper samples, with the majority of metals higher in concentration at depth.

4. Groundwater Monitoring Well Inspection

A down-hole camera was used to inspect each of the following pairs of nested groundwater monitoring wells, the locations of which are presented on the attached Figures 2 and 3:

- Asgard 1 wellsite: AB1S and AB1D; and
- Valhalla North 1 wellsite: VNB4S and VNB4D.

These groundwater monitoring wells are intended to be used to establish a baseline data set for the Proposal area, due to their up-hydraulic gradient position (inferred) with respect to site contaminant sources, and are therefore not considered to be impacted from historical wellsite activities, as supported by historical groundwater data obtained from these locations. Each groundwater monitoring well is understood to intercept the uppermost aquifer at each location – the Liveringa (Rockwater, 2016).

4.1 Results

Photographs obtained from down-hole camera footage are Attached in Appendix C to support the below observations and resultant construction details.

Field measured groundwater monitoring well construction details.

Site	Asgard 1	Asgard 1	Valhalla North 1	Valhalla North 1
Well reference	AB1S	AB1D	VNB4S	VNB4D
Coordinates (MGA2020 Zone 51)	714813 m N 7981398 m E	714815 m N 7981398 m E	683175 m N 8006123 m E	683177 m N 8006123 m E
Stick up (m ags)	0.5	0.7	0.5	0.7
Screened interval (m btoc)	30.8-36.3	67.0-76.6	36.6-42.3	66.9-78.4
Measured depth of well (m btoc)	36.3	76.6	42.3	78.4
Construction materials [1]	Class 18 uPVC casing, 96 mm ID, 114 mm OD, slotted intervals with 1.0 mm aperture.			
Standing water level (m btoc)	23.070	21.780	30.686	30.956
Head volume (L)	96	397	84	343
Aquifer	Liveringa	Liveringa	Liveringa	Liveringa

Notes: 1 – Construction materials and diameter were observed in the field and confirmed to be in conformance with the Buru conceptual design presented in Appendix B. Refer to the Buru conceptual design for further details such as gravel pack and bentonite seals, the depths of which will be in relation to depth to the top of screen.

'm ags' denotes metres above ground surface.

'm btoc' denotes metres below top of casing.

Based on the recorded down-hole camera footage, the condition of the construction materials of each of the four groundwater monitoring wells was good – there did not appear to be any noteworthy damage to any of the PVC monitor well casings. Some minor scratches were evident.

A partial organic build up was observed within slots in the lower extents of the screened interval of each well, and insect debris was observed on the casing walls of both deep wells (AB1D, VNB4D) – particularly in proximity to the SWL. A film of insect debris was observed on the groundwater surface at each of these two locations and organic debris appears to have settled at the base of each of the four wells.

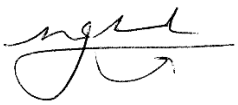
While organic debris may be detected in groundwater samples as trace levels of TRH, and may go on to decompose to form traces of methane, each of these detections are easily discernible from the considerable changes that would occur to groundwater chemistry from gas wellsite contamination. This is supported by groundwater monitoring data obtained from the site to-date. As such, each of the wells are considered appropriate for ongoing representative groundwater monitoring of the surrounding aquifer.

During future wellsite establishment, opportunistic groundwater monitoring bore redevelopment may be undertaken via the use of groundwater abstraction pumps. This would allow for the purging of organic debris from each bore. Additional redevelopment methodology may be applied, however is not consider necessary.

Gemec have appreciated the opportunity to provide our professional services to Bennett Resources for this project.

Please contact me if you require any other information or clarification of the above.

Regards,



Nicolo Jelovsek BSc
Director, Contaminated Land Consultant

5. References

Australian Government, 2022, National Map, Western Australian Government Department map viewer.

CRC CARE, 2011, *Health screening levels for petroleum hydrocarbons in soil and groundwater*, Cooperative Research Centre for Contamination Assessment and Remediation of the Environment.

DPIRD, 2023, Soil Landscape Mapping – Systems (DPIRD-064), data file, Government of Western Australia Department of Primary Industries and Regional Development.

DWER, 2021, *Assessment and management of contaminated sites – Contaminated sites guidelines*, Western Australian Department of Environment Regulation.

Gemec, July 2023, *Baseline Groundwater Monitoring Event Report, Bennett Resources Pty Ltd – Valhalla Gas Exploration and Appraisal Program, November 2022.*

Gemec, October 2023, *Groundwater Monitoring Event Report, Bennett Resources Pty Ltd – Valhalla Gas Exploration and Appraisal Program, July 2023.*

Geoscience Australia, 2023, Surface Geology, data file, Australian Government Geoscience Australia.

Global Alliance on Health and Pollution, December 2013 – *Summary Guidance on Soil Screening Levels Version 1.*

NEPC, 2013, National Environment Protection (Assessment of Site Contamination) Measure 1999, as amended 16 May 2013, Volume 2: Schedule B1 Guideline on Investigation Levels for Soil and Groundwater, National Environment Protection Council.

Rockwater, September 2016, *Hydrogeological Assessment of Paradise-Valhalla-Asgard Project Areas,* Report for Buru Energy, Report No. 416.0/16/04b.

Standards Australia, *Australian Standard AS 4482.1-2005, Guide to the investigation and sampling of sites with potentially contaminated soil, Part 1: Non-volatile and semi-volatile compounds.*

Standards Australia, *Australian Standard AS 4482.2-1999, Guide to sampling and investigation of potentially contaminated soil, Part 2: Volatile substances.*

US EPA, 2005, *Interim Ecological Soil Screening Level Documents*, United States Environmental Protection Agency.

Verbruggen E.M.J. *et a*l, April 2001, *Ecotoxicological Serious Risk Concentrations for soil, sediment and (ground)water: updated proposals for first series of compounds* – RIVM (National Institute of Public Health and the Environment) report 711701 020.

6. Limitations of Report

This report pertains to the Valhalla Project only, as identified herein.

The findings and conclusions given in this report are based on the site conditions and those applicable Government regulations that existed at the time the environmental investigation was conducted, and this report prepared. This report was prepared in accordance with accepted environmental practices used by environmental professionals undertaking projects of a similar nature.

Environmental investigation identifies subsurface conditions only at those locations where samples are taken and at the time they are taken. Decisions should not be made on the basis of this report if adequacy of the report has been affected by time as the report is based on conditions that existed at the time the site was investigated.

Gemec warrant that the environmental investigation and the assessments presented in this report identifies actual subsurface conditions at the location investigated and at the time the investigation was undertaken. No other warranty as to the accuracy and completeness, express or implied, is made as to any advice included in this report. While every effort has been made to ensure accuracy, no liability is accepted for errors of fact or opinion herein.

This report was prepared for use by the client, Bennett Resources Pty Ltd and shall only be used by the client for the purpose or purposes that this report was bought into existence. All third parties rely on this report at their own risk. This report is not intended as a substitute for legal advice which can be given only by a qualified legal practitioner.

Attachments

Tables

Table 1 Soil Analytical Results – BTEXN & TRH

Table 2 Soil Analytical Results – Metals, Metalloids & Non-Metals

Table 3 Soil Analytical Results – Soil Characteristics, Nutrients & Miscellaneous Inorganics

Figures

Figure 1 Regional Site Setting & Wellsite Locations, July 2023

Figure 2 Valhalla North 1 Groundwater Monitoring Locations, July 2023

Figure 3 Asgard 1 Groundwater Monitoring Locations, July 2023

Appendix A – Analytical Results

Chain of Custody Forms and Laboratory Reports

Appendix B – Supporting Data

- Soil Bore Log
- Buru Energy Monitoring Bore Conceptual Design
- Field Equipment Calibration Certificates
- Field Data Sheets
- HSL Application Checklist

Appendix C – Site Photographs

Tables

Table 1: Soil Analytical Results - BTEXN & TRH

Sample ID	Depth (m)	Date	Time	PID	BTEXN						TRH					
					Benzene	Toluene	Ethylbenzene	m+p Xylenes	o- Xylenes	Naphthalene [1]	C6-C10	C6-C10 less BTEX	>C10-C16	>C10-C16 less naphthalene	>C16-C34	>C34-C40
SB1	0-0.3	25.07.23	15:32	0.0	<0.20	<0.50	<1.0	<2.0	<1.0	<1.0	<25	<25	<50	<50	<100	<100
		Dup			*<0.20*	*<0.50*	*<1.0*	*<2.0*	*<1.0*	*<1.0*	*<25*	*<25*	*<50*	*<50*	*<100*	*<100*
		RPD			*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
		Split			*<0.2*	*<0.5*	*<1*	*<2*	*<1*	*<1*	*<25*	*<25*	*<50*	*<50*	*<100*	*<100*
		RPD			*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
	1.7-2.0	25.07.23	15:43	0.0	<0.20	<0.50	<1.0	<2.0	<1.0	<1.0	<25	<25	<50	<50	<100	<100
Trip Blank	-	25.07.23	14:30	-	<0.20	<0.50	<1.0	<2.0	<1.0	<1.0	<25	<25	-	-	-	-
ESL - Urban Residential & Public Open Space [2, 3]					50	85	70	105		170 [4]	NE	180	120	NE	300	2800
HSL C (Vapour Intrusion) - Recreational / Open Space [3]					NL	NL	NL	NL		NL	NE	NL	NE	NL	NE	NE
HSL C (Direct Contact) - Recreational / Open Space					430	99000	27000	81000		11000	26000	NE	20000	NE	27000	38000
Management Limits - Residential, Parkland, Public Open Space [3]					NE	NE	NE	NE		NE	700	NE	1000	NE	2500	10000
SL-A - Agricultural					0.07	120	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Laboratory Limit of Reporting					0.2	0.5	0.5	0.5	0.5	1	10	10	50	50	100	100

Notes

All concentrations reported in milligrams per kilogram (mg/kg) on a dry weight basis
'ESL' denotes Ecological Screening Level
'HSL' denotes Health Screening Level
'NA' denotes not applicable - primary and QC sample concentration below laboratory LoR
'NE' denotes screening level not established or is under review
'NL' denotes screening level not limiting
'RPD' denotes relative percentage difference
'-' denotes not tested / parameter not obtained

1. volatile extraction method
2. ESLs apply to top 2 m of soil profile
3. screening level for coarse / sandy soils
4. EIL for fresh naphthalene

Table 2: Soil Analytical Results - Metals, Metalloids & Non-Metals

Sample ID	Depth (m)	Date	Time	Aluminium (Al)	Arsenic (As)	Barium (Ba)	Boron (B)	Cadmium (Cd)	Chromium (Cr)	Hexavalent Chromium (CrVI)	Copper (Cu)	Iron (Fe)	Lead (Pb)	Manganese (Mn)	Mercury (Hg)	Nickel (Ni)	Selenium (Se)	Strontium (Sr)	Thorium (Th)	Tin (Sn)	Uranium (U)	Zinc (Zn)
SB1	0-0.3	25.07.23	15:32	**2000**	<4.0	**14**	<10	<0.40	**17**	<1.0	**1.4**	**5900**	**3**	**69**	<0.10	**1.8**	<2.0	**2.1**	**1.7**	<2.0	**0.17**	**1.6**
		Dup		***2100***	*<4.0*	***14***	*<10*	*<0.40*	***18***	*-*	***1.4***	***5800***	***3***	***68***	*<0.10*	***1.8***	*<2.0*	***2.1***	***1.8***	*<2.0*	***0.21***	***1.6***
		RPD		*5*	*NA*	*0*	*NA*	*NA*	*6*	*-*	*0*	*2*	*0*	*1*	*NA*	*0*	*NA*	*0*	*6*	*NA*	*21*	*0*
		Split		***1400***	*<4*	***13***	*<10*	*<0.4*	***15***	*-*	***2***	***5400***	***2***	***69***	*<0.1*	***2***	*<2*	***2***	***1***	*<2*	*-*	***1***
		RPD		*35*	*NA*	*7*	*NA*	*NA*	*13*	*-*	*35*	*9*	*40*	*0*	*NA*	*11*	*NA*	*5*	*52*	*NA*	*-*	*46*
	1.7-2.0	25.07.23	15:43	**3600**	<4.0	**12**	<10	<0.40	**19**	<1.0	**1.3**	**9600**	**3.8**	**22**	<0.10	**3**	<2.0	**2.1**	**2.5**	<2.0	**0.21**	**5.2**
Rinsate	-	25.07.23	16:15	<10	-	-	-	-	<1.0	-	<1.0	<10	<1.0	<1.0	-	-	-	-	-	-	-	<1.0
EIL - Urban Residential & Public Open Space [1]				NE	100	765 [2]	NE	12 [2]	310 [4,5]	130 [3]	20 [5]	NE	1100	220 [3]	36 [2,6]	4 [5]	4 [3]	NE	NE	NE	NE	60 [5]
HIL C - Recreational / Open Space				NE	300	NE	20000	90	NE	300	17000	NE	600	19000	80 [6]	1200	700	NE	NE	NE	NE	30000
SL-A - Agricultural				NE	12	NE	NE	1.4	64	0.4	NE	NE	70	NE	6.6 [6]	NE	NE	NE	NE	NE	23	NE
Laboratory Limit of Reporting				50	5	10	50	1	2	0.5	5	50	5	5	0.1	2	5	2	10	0.1	5	5

Notes

All soil concentrations reported in milligrams per kilogram (mg/kg) on a dry weight basis, rinsate concentrations reported in micrograms per litre (µg/L)

'EIL' denotes Ecological Investigation Level

'HIL' denotes Health Investigation Level

'NA' denotes not applicable - primary and QC sample concentration below laboratory LoR

'NE' denotes screening level not established or is under review

'RPD' denotes relative percentage difference

'-' denotes not tested / parameter not obtained

1. EILs apply to upper 2 m of soil profile
2. Dutch SRCeco value based on ABC, 4% clay content, 0.54% total organic matter
3. US EPA Eco SSL for Plants, Soil Invertebrates or Mammals
4. screening level for trivalent chromium Cr(III)
5. screening level derived using average ABCs, 4% clay, pH 5.3 & 1.1 meq/100g CEC
6. value for inorganic mercury

Table 3: Soil Analytical Results - Soil Characteristics, Nutrients & Miscellaneous Inorganics

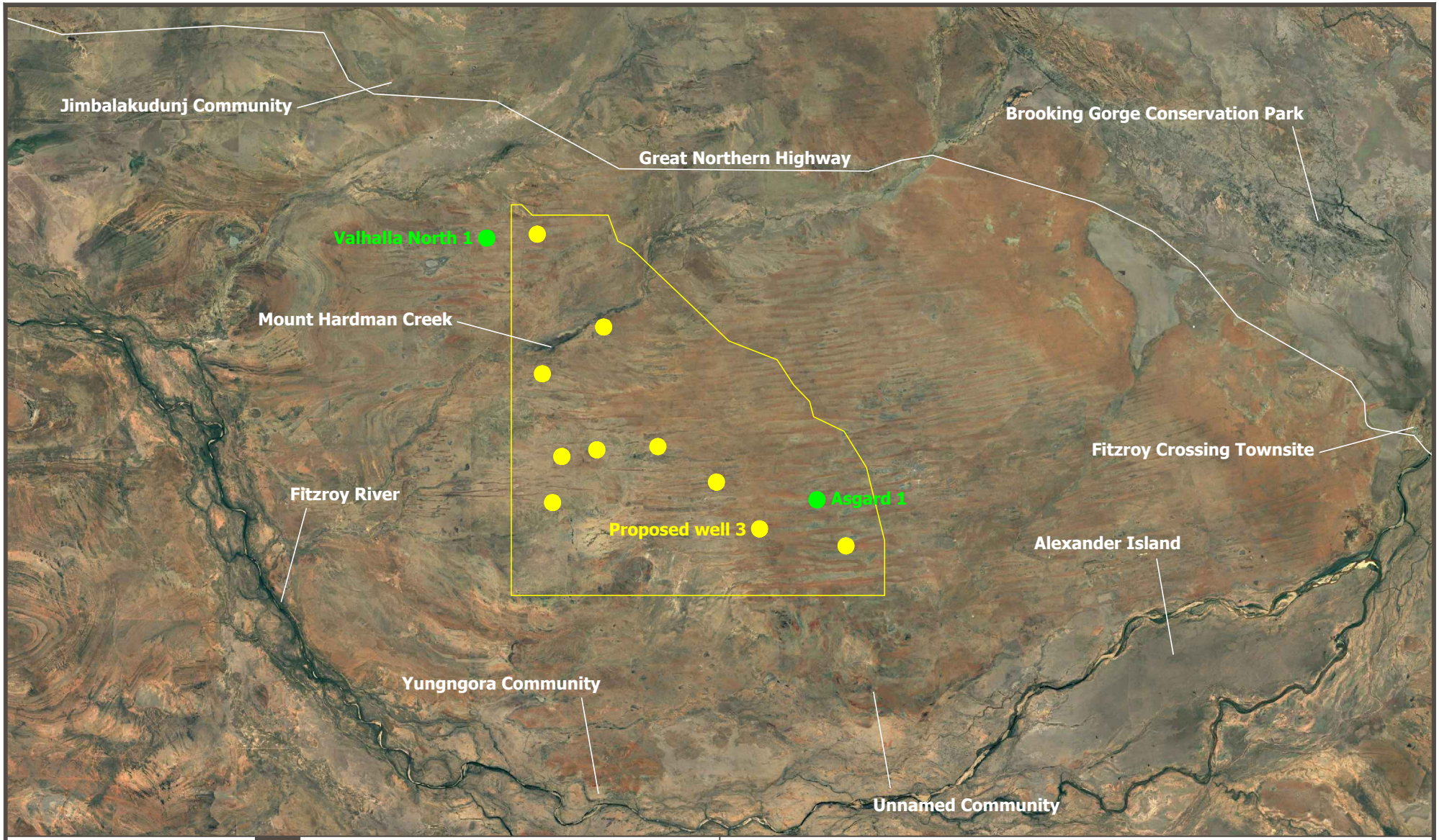
Sample ID	Depth (m)	Date	Time	Soil Characteristics									Nutrients							Miscellaneous		
				Moisture Content (%)	pH	pH ($CaCl_2$ extract)	Electrical Conductivity (µS/cm)	Cation Exchange Capacity (meq/100 g)	Clay (<2 µm) (%)	Soil Particle Density (Clay/Silt/Sand) (g/cm^3)	Total Organic Carbon (%)	Organic Matter (%)	Total Nitrogen (as N)	Total Kjeldahl Nitrogen (as N)	Ammonia (as N)	Nitrate (as N)	Nitrite (as N)	Total Phosphorus (as P)	Phosphate (as P)	Sulfur (S)	Fluoride (F^-)	Total Cyanide (CN^-)
SB1	0-0.3	25.07.23	15:32	**1.6**	**6.2**	**4.9**	**3.3**	**1.1**	**1**	**2.6**	**0.38**	**0.66**	**100**	**100**	**1.4**	<0.50	<0.50	**24**	<0.50	<10	<0.50	<0.50
		Dup		***1.3***	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*<10*	*<0.50*	-
		RPD		*21*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
		Split		***0.9***	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	***10***	***1***	-
		RPD		*56*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
	1.7-2.0	25.07.23	15:43	**2.6**	**6.5**	**5.7**	**4.7**	**1.1**	**7**	**2.6**	**0.25**	**0.42**	**96**	**96**	**1.1**	<0.50	<0.50	**17**	<0.50	<10	<0.50	<0.50
EIL - Urban Residential & Public Open Space [1]				NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	2000 [2]	NE	NE	NE	NE
HIL C - Recreational / Open Space				NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	240
SL-A - Agricultural				NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	200	NE
Laboratory Limit of Reporting				0.1	0.1	0.1	2	0.1	1	0.1	0.01	0.01	10	10	0.5	0.5	0.5	10	0.5	10	0.5	0.5

Notes

All concentrations reported in milligrams per kilogram (mg/kg) on a dry weight basis, unless stated otherwise
'EIL' denotes Ecological Investigation Level
'HIL' denotes Health Investigation Level
'NA' denotes not applicable - primary and QC sample concentration below laboratory LoR
'NE' denotes screening level not established or is under review
'RPD' denotes relative percentage difference
'-' denotes not tested / parameter not obtained

1. EILs apply to top 2 m of soil profile
2. 1999 NEPM Interim Urban value

Figures



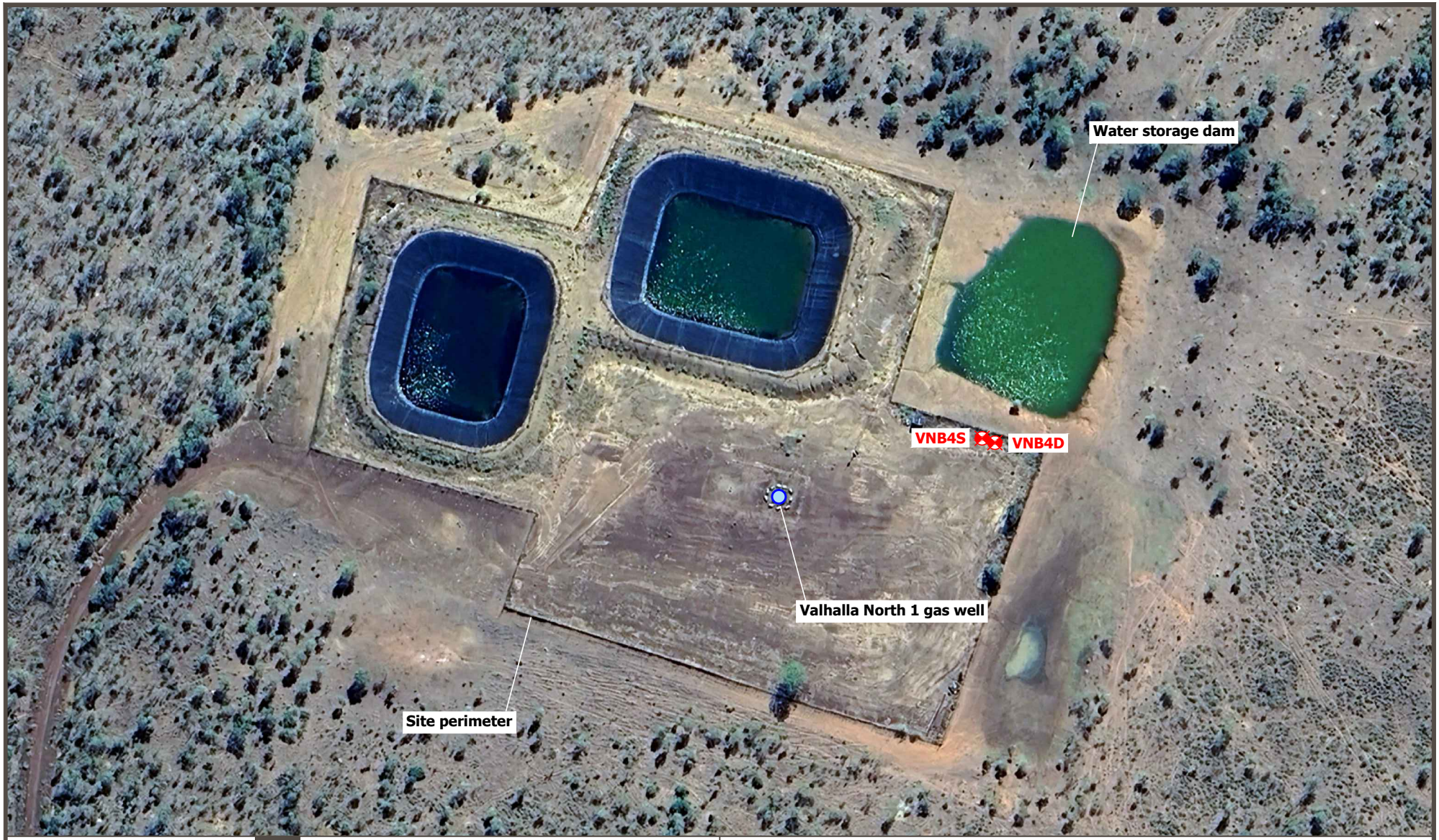
gemec
ENVIRONMENTAL CONSULTANTS
PO Box 89
Melville W.A. 6956
T: +61 8 9339 8449
E: info@gemec.com.au
W: www.gemec.com.au

Development Envelope
Proposed well site
Existing / former well site

0 20
Scale (km), approx.

Regional Site Setting & Wellsite Locations, July 2023
Valhalla Gas Exploration & Appraisal Program
Shire of Derby-West Kimberley, Western Australia

Drawn: DB	Date: 08.08.2022	Checked	Approved	Dwg No.	Figure 1
Source: Nearmap, May 2022		NJ	NJ		



GEMEC
ENVIRONMENTAL CONSULTANTS
PO Box 89
Melville W.A. 6956
T: +61 8 9339 8449
E: info@gemec.com.au
W: www.gemec.com.au

Gas well
Groundwater sample location

0 50
Scale (m), approx.

Valhalla North 1 Groundwater Monitoring Locations, July 2023
Valhalla Gas Exploration & Appraisal Program
Shire of Derby-West Kimberley, Western Australia

Drawn: DB	Date: 08.08.2022	Checked	Approved	Dwg No.	Figure 2
Source: Nearmap, 23 May 2023		NJ	NJ		

Gemec
ENVIRONMENTAL CONSULTANTS
PO Box 89
Melville W.A. 6956
T: +61 8 9339 8449
E: info@gemec.com.au
W: www.gemec.com.au

Gas well
Groundwater sample location

Asgard 1 Baseline Groundwater Monitoring Locations, July 2023
Valhalla Gas Exploration & Appraisal Program
Shire of Derby-West Kimberley, Western Australia

0 50
Scale (m), approx.

Drawn: DB	Date: 08.08.2022	Checked	Approved	Dwg No.	Figure 3
Source: Nearmap, 23 May 2023		NJ	NJ		

Appendix A – Analytical Results

CHAIN OF CUSTODY - Client

Client: Gemec
Project Mgr: Nicolo Jelovsek
Sampler: Nicolo Jelovsek
Address: 1/25 Foss St Palmyra 6157
Email: nicolo@gemec.com.au
Phone: 08 9339 8449 / 0439 093 980

gemec ENVIRONMENTAL CONSULTANTS

Client Project Name and Number: BME - Valhalla
Location: Valhalla Proposed Well 3
MPL Quote No: 22PE483
Date results required:
Or choose: standard ~~/ 1 day / 2 day / 3 day~~
Note: Inform lab in advance if urgent turnaround is required - surcharge applies

MPL Laboratories
Address: 16-18 Hayden Crt
Myaree 6154
Phone: 08 9317 2505
Fax: 08 9317 4163
E-mail: lab@mpl.com.au

mpl Laboratories

Sample information / **Analyses Required**

MPL Sample ID	Client Sample ID	Depth (m)	Date sampled	Time	Type of sample	CS001_M: BTEXN, TRH, 8 metals (As, Cd, Cr, Cu, Hg, Ni, Pb, Zn)	Extra metals: Al, Ba, B, Fe, Mn, S, Se, Sn, Sr, Th, U, Zn	Hexavalent chromium	Cyanide (total)	Fluoride	E010302: Nutrient suite	pH & EC	vTRH (C6-C9) + BTEXN	8 metals: Al Cu Cr Fe Pb Mn S Zn (total) - excl. CrVI	SS350: NEPM2013 Soil Characteristics EIL			
1	SB1	0-0.3	25.07.23	15:32	Soil	X	X	X	X	X	X	X			X			
2	SB1	1.7-2.0	25.07.23	15:43	Soil	X	X	X	X	X	X	X			X			
3	Dup	-	25.07.23	-	Soil	X	X			X								
4	Trip Blank	-	25.07.23	14:30	Soil								X					
5	Rinsate	-	25.07.23	16:15	Water									X				

Comments
Email CoC with report also please
Sample containers labelled VDE

mpl Laboratories ENVIROLAB GROUP
Job No.- PE Global
Date Rec - 28 JUL 2023
Time Rec - 1135
Rec By - SJM
TAT Req - SAME 1 / 2 / 3 / (STD)
Temp - (cool) / ambient 8°C
Cooling - Ice / (Ice pack) / None
Security Seal - Yes / (No)

Relinquished by (company): Gemec
Print Name: Nicolo Jelovsek
Date & Time: 28.07.23, 10:00
Signature:

Received by (company): MPL
Print Name: SJM
Date & Time: 28 JUL 2023 - 1135
Signature: SJM

Laboratory Use Only:
Samples Received: (Cool) / ambient
Temperature Received at: 8°C (if applicable)
Transported by: Hand delivered / courier

Envirolab Services (WA) Pty Ltd trading as MPL Laboratories
ABN 53 140 099 207
16-18 Hayden Court Myaree WA 6154
ph +61 8 9317 2505 fax +61 8 9317 4163
lab@mpl.com.au
www.mpl.com.au

Sample Receipt Advice PEG1691

Client Details

Client	Gemec
Attention	Nicolo Jelovsek

Sample Login Details

Your Reference	BME - Valhalla - Valhalla Proposed Well 3
Envirolab Reference	PEG1691
Date Sample Received	28/07/2023
Date Instructions Received	28/07/2023
Date Final Results Expected	04/08/2023

Sample Condition

Samples received in appropriate condition for analysis	See Comments
Number of Samples	4 Soil, 1 Water
Turnaround Time	5 Days
Temperatures / Cooling Methods	8.0°C Ice Pack

Additional Info

Sample storage - waters are routinely disposed at approximately 1 month and soils approximately 2 months from receipt.

Requests for longer term sample storage must be received in writing.

Where no sampling date has been supplied for some or all samples, the date of sample receipt has been used as the associated sampling date. The sampling dates are used to assess compliance to recommended Technical Holding Times.

Please contact the laboratory immediately if observed settled sediment present in water samples is to be included in the extraction and/or analysis (exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, Total Recoverable metals and PFAS analysis where solids are included by default.

Please direct any queries to:

Heram Halim

Phone	08 9317 2505
Fax	08 9317 4163
Email	hhalim@mpl.com.au

Meredith Conroy

Phone	08 9317 2505
Fax	08 9317 4163
Email	mconroy@mpl.com.au

Analysis underway, details on the following page

Sample Receipt Advice PEG1691

Analysis Grid

The • indicates the testing you have requested. ***THIS IS NOT A REPORT OF THE RESULTS.***

	Nutrient Suite	NEPM2013 EIL	Suite 1 - Soil	vTRH&MBTEXN	Metals	Total Metals	Metals (LL)	Total Metals (LL)	EC	pH	Cr6+	Fluoride	Moisture	Cyanide - Total	1:5 Soil:Water Extraction
PEG1691-01 Soil | 25/07/2023 SB1 | 0.0m-0.3m	•	•	•		•		•		•	•	•	•	•	•	
PEG1691-02 Soil | 25/07/2023 SB1 | 1.7m-2m	•	•	•		•		•		•	•	•	•	•	•	
PEG1691-03 Soil | 25/07/2023 Dup			•		•		•					•	•		•
PEG1691-04 Soil | 25/07/2023 Trip Blank				•									•		
PEG1691-05 Water | 25/07/2023 Rinsate						•		•							

Suite Details

Suite Name	Suite Analyses
Nutrient Suite|Soil	P, 1:5 Soil:KCl Extraction, 1:5 Soil:Water Extraction, Phosphate as P, Nitrogen - Ammonia, Nitrogen - Nitrate, Nitrogen - Nitrite, Nitrogen - NOx, Nitrogen - TKN, Organic Nitrogen, Total Nitrogen - calc
NEPM2013 EIL|Soil	Fe, CEC, Exchangeable Cations, CaCl2 Soil Extraction, OC Walkley Black, TOC Walkley Black, TOM Walkley Black, Clay Content, Particle Density, pH CaCl2
Suite 1 - Soil|Soil	vTRH&MBTEXN, sTRH, As, Cd, Cr, Cu, Hg, Ni, Pb, Zn

Envirolab Services (WA) Pty Ltd trading as MPL Laboratories
ABN 53 140 099 207
16-18 Hayden Court Myaree WA 6154
ph +61 8 9317 2505 fax +61 8 9317 4163
lab@mpl.com.au
www.mpl.com.au

Certificate of Analysis PEG1691

Client Details

Client	Gemec
Contact	Nicolo Jelovsek
Address	1/25 Foss St, PALMYRA, WA, 6157

Sample Details

Your Reference	BME - Valhalla - Valhalla Proposed Well 3
Number of Samples	4 Soil, 1 Water
Date Samples Received	28/07/2023
Date Samples Registered	28/07/2023

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date Results Requested by	04/08/2023
Date of Issue	04/08/2023

Accredited for compliance with ISO/IEC 17025. Tests not covered by NATA are denoted with *.

Authorisation Details

Results Approved By	Diego Bigolin, Supervisor, Inorganics Heram Halim, Operations Manager Lien Tang, Assistant Operations Manager Michael Mowle, Inorganics Supervisor Stacey Hawkins, ASS/AMD Supervisor Todd Lee, Group Operations Manager Travis Carey, Organics Supervisor
Laboratory Manager	Michael Kubiak

Certificate of Analysis PEG1691

Samples in this Report

Envirolab ID	Sample ID	Depth	Matrix	Date Sampled	Date Received
PEG1691-01	SB1	0.00-0.30Meters	Soil	25/07/2023	28/07/2023
PEG1691-02	SB1	1.70-2.00Meters	Soil	25/07/2023	28/07/2023
PEG1691-03	Dup		Soil	25/07/2023	28/07/2023
PEG1691-04	Trip Blank		Soil	25/07/2023	28/07/2023
PEG1691-05	Rinsate		Water	25/07/2023	28/07/2023

Volatile TRH and BTEX (Soil)

Envirolab ID	Units	PQL	ADWG	PEG1691-01	PEG1691-02	PEG1691-03	PEG1691-04
Your Reference			Health	SB1	SB1	Dup	Trip Blank
Date Sampled			Value	25/07/2023	25/07/2023	25/07/2023	25/07/2023
Depth				0.00-0.30	1.70-2.00		
TRH C6-C9	mg/kg	25		<25	<25	<25	<25
TRH C6-C10	mg/kg	25		<25	<25	<25	<25
TRH C6-C10 less BTEX (F1)	mg/kg	25		<25	<25	<25	<25
Methyl tert butyl ether (MTBE)	mg/kg	0.50		<0.50	<0.50	<0.50	<0.50
Benzene	mg/kg	0.20		<0.20	<0.20	<0.20	<0.20
Toluene	mg/kg	0.50		<0.50	<0.50	<0.50	<0.50
Ethylbenzene	mg/kg	1.0		<1.0	<1.0	<1.0	<1.0
meta+para Xylene	mg/kg	2.0		<2.0	<2.0	<2.0	<2.0
ortho-Xylene	mg/kg	1.0		<1.0	<1.0	<1.0	<1.0
Total Xylene	mg/kg	3.0	600	<3.0	<3.0	<3.0	<3.0
Naphthalene (value used in F2 calc)	mg/kg	1.0		<1.0	<1.0	<1.0	<1.0
Surrogate aaa-Trifluorotoluene	%			90.3	102	104	98.7

Semi-volatile TRH (Soil)

Envirolab ID	Units	PQL	PEG1691-01	PEG1691-02	PEG1691-03
Your Reference			SB1	SB1	Dup
Date Sampled			25/07/2023	25/07/2023	25/07/2023
Depth			0.00-0.30	1.70-2.00	
TRH C10-C14	mg/kg	50	<50	<50	<50
TRH C15-C28	mg/kg	100	<100	<100	<100
TRH C29-C36	mg/kg	100	<100	<100	<100
Total +ve TRH C10-C36	mg/kg	50	<50	<50	<50
TRH >C10-C16	mg/kg	50	<50	<50	<50
TRH >C10-C16 less Naphthalene F2	mg/kg	50	<50	<50	<50
TRH >C16-C34 (F3)	mg/kg	100	<100	<100	<100
TRH >C34-C40 (F4)	mg/kg	100	<100	<100	<100
Total +ve TRH >C10-C40	mg/kg	50	<50	<50	<50
Surrogate o-Terphenyl	%		101	94.7	94.7

Acid Extractable Metals (Soil)

Envirolab ID	Units	PQL	PEG1691-01	PEG1691-02	PEG1691-03
Your Reference			SB1	SB1	Dup
Date Sampled			25/07/2023	25/07/2023	25/07/2023
Depth			0.00-0.30	1.70-2.00	
Aluminium	mg/kg	10	2000	3600	2100
Arsenic	mg/kg	4.0	<4.0	<4.0	<4.0
Boron	mg/kg	10	<10	<10	<10
Barium	mg/kg	1.0	14	12	14
Cadmium	mg/kg	0.40	<0.40	<0.40	<0.40
Chromium	mg/kg	1.0	17	19	18
Copper	mg/kg	1.0	1.4	1.3	1.4
Iron	mg/kg	10	5900	9600	5800
Mercury	mg/kg	0.10	<0.10	<0.10	<0.10
Manganese	mg/kg	1.0	69	22	68
Nickel	mg/kg	1.0	1.8	3.2	1.8
Phosphorus	mg/kg	10	24	17	[NA]
Lead	mg/kg	1.0	3.0	3.8	3.0
Sulfur	mg/kg	10	<10	<10	<10
Selenium	mg/kg	2.0	<2.0	<2.0	<2.0
Tin	mg/kg	2.0	<2.0	<2.0	<2.0
Strontium*	mg/kg	1.0	2.1	2.1	2.1
Zinc	mg/kg	1.0	1.6	5.2	1.6

Acid Extractable Metals (Water)

Envirolab ID	Units	PQL	PEG1691-05
Your Reference			Rinsate
Date Sampled			25/07/2023
Sulfur	mg/L	0.50	<0.50

Acid Extractable Low Level Metals (Soil)

Envirolab ID	Units	PQL	PEG1691-01	PEG1691-02	PEG1691-03
Your Reference			SB1	SB1	Dup
Date Sampled			25/07/2023	25/07/2023	25/07/2023
Depth			0.00-0.30	1.70-2.00	
Thorium	mg/kg	0.50	1.7	2.5	1.8
Uranium	mg/kg	0.10	0.17	0.21	0.21

Acid Extractable Low Level Metals (Water)

Envirolab ID	Units	PQL	ADWG	PEG1691-05
Your Reference			Health	Rinsate
Date Sampled			Value	25/07/2023
Aluminium	µg/L	10		<10
Chromium	µg/L	1.0		<1.0
Copper	µg/L	1.0	2000	<1.0
Iron	µg/L	10		<10
Manganese	µg/L	1.0	500	<1.0
Lead	µg/L	1.0	10	<1.0
Zinc	µg/L	1.0		<1.0

Exchangeable Cations (Soil)

Envirolab ID	Units	PQL	PEG1691-01	PEG1691-02
Your Reference			SB1	SB1
Date Sampled			25/07/2023	25/07/2023
Depth			0.00-0.30	1.70-2.00
Calcium	meq/100g	0.10	0.82	0.71
Potassium	meq/100g	0.10	<0.10	<0.10
Magnesium	meq/100g	0.10	0.19	0.31
Sodium	meq/100g	0.10	<0.10	<0.10
Cation Exchange Capacity (CEC)	meq/100g	0.10	1.1	1.1

Inorganics - General Physical Parameters (Soil)

Envirolab ID	Units	PQL	PEG1691-01	PEG1691-02
Your Reference			SB1	SB1
Date Sampled			25/07/2023	25/07/2023
Depth			0.00-0.30	1.70-2.00
pH	pH units		6.2	6.5
Electrical Conductivity	µS/cm	2.0	3.3	4.7

Inorganics - General Chemical Parameters (Soil)

Envirolab ID	Units	PQL	PEG1691-01	PEG1691-02	PEG1691-03
Your Reference			SB1	SB1	Dup
Date Sampled			25/07/2023	25/07/2023	25/07/2023
Depth			0.00-0.30	1.70-2.00	
Fluoride	mg/kg	0.50	<0.50	<0.50	<0.50
Phosphate as P	mg/kg	0.50	<0.50	<0.50	[NA]
Hexavalent Chromium	mg/kg	1.0	<1.0	<1.0	[NA]

Inorganics - Moisture (Soil)

Envirolab ID	Units	PQL	PEG1691-01	PEG1691-02	PEG1691-03	PEG1691-04
Your Reference			SB1	SB1	Dup	Trip Blank
Date Sampled			25/07/2023	25/07/2023	25/07/2023	25/07/2023
Depth			0.00-0.30	1.70-2.00		
Moisture	%	0.10	1.6	2.6	1.3	<0.10

Inorganics - Carbons, Nitrogen Species, Sulfur Species (Soil)

Envirolab ID	Units	PQL	PEG1691-01	PEG1691-02
Your Reference			SB1	SB1
Date Sampled			25/07/2023	25/07/2023
Depth			0.00-0.30	1.70-2.00
Organic Carbon (Walkley Black)	mg/kg	1000	2900	1800
Total Organic Carbon (Walkley Black)	mg/kg	1000	3800	2500
Total Organic Matter (Walkley Black)	mg/kg	1000	6600	4200
Ammonia as N	mg/kg	0.50	1.4	1.1
Nitrate as N	mg/kg	0.50	<0.50	<0.50
Nitrate as NO3 by calculation	mg/kg	3.0	<3.0	<3.0
Nitrite as N	mg/kg	0.50	<0.50	<0.50
Nitrite as NO2 by calculation*	mg/kg	2.0	<2.0	<2.0
NOx as N	mg/kg	0.50	<0.50	<0.50
TKN as N	mg/kg	10	100	96
Organic Nitrogen by calc	mg/kg	10	100	95
Total Nitrogen as N by calculation	mg/kg	10	100	96

Inorganics - Cyanide Species and Similar (Soil)

Envirolab ID	Units	PQL	PEG1691-01	PEG1691-02
Your Reference			SB1	SB1
Date Sampled			25/07/2023	25/07/2023
Depth			0.00-0.30	1.70-2.00
Total Cyanide	mg/kg	0.50	<0.50	<0.50

Inorganics - Miscellaneous (Soil)

Envirolab ID	Units	PQL	PEG1691-01	PEG1691-02
Your Reference			SB1	SB1
Date Sampled			25/07/2023	25/07/2023
Depth			0.00-0.30	1.70-2.00
2 µm Clay	% passing	1.0	1.0	7.0

Inorganics - Miscellaneous (Soil) - Analysed By Envirolab Services Sydney

Envirolab ID	Units	PQL	PEG1691-01	PEG1691-02
Your Reference			SB1	SB1
Date Sampled			25/07/2023	25/07/2023
Depth			0.00-0.30	1.70-2.00
Particle Density*	g/cm3		2.6	2.6

Inorganics (CaCl2 extraction) (Soil)

Envirolab ID	Units	PQL	PEG1691-01	PEG1691-02
Your Reference			SB1	SB1
Date Sampled			25/07/2023	25/07/2023
Depth			0.00-0.30	1.70-2.00
pH (1:5 soil:CaCl2)	pH units		4.9	5.7

Method Summary

Method ID	Methodology Summary
Calc	Calculation
INORG-001	pH - Measured using pH meter and electrode based on APHA latest edition, Method 4500-H+. Please note that the results for water analyses are indicative only, as analysis can be completed outside of the APHA recommended holding times. Solids are reported from a 1:5 water extract unless otherwise specified. Alternatively, pH is determined in a 1:5 extract using 0.01M calcium chloride or a solid is extracted at a ratio of 1:2.5 (AS1289.4.3.1), pH is measured in the extract.
INORG-001_CACL2	pH - Measured using pH meter and electrode based on APHA latest edition, Method 4500-H+. Solids are reported from a 1:5 extract using 0.01M calcium chloride.
INORG-002	Conductivity and Salinity - measured using a conductivity cell at 25°C based on APHA latest edition Method 2510. Soil results reported from a 1:5 Soil:Water extract unless otherwise specified. Please note Resistivity is estimated by calculation and may not correlate with results otherwise obtained using the Resistivity current method (based on AS 1289.4.4.1), depending on the nature of the soil being analysed.
INORG-008	Moisture content determined by heating at 105+/-5 °C for a minimum of 12 hours.
INORG-014	Cyanide - free, total, weak acid dissociable by segmented flow analyser (in line dialysis with colourimetric finish). Solids/Filters and sorbents are extracted in a caustic media prior to analysis. Impingers are pH adjusted as required prior to analysis. Cyanides amenable to Chlorination - samples are analysed untreated and treated with hypochlorite to assess the potential for chlorination of cyanide forms.
INORG-026	Fluoride determined by ion selective electrode (ISE) based on APHA latest edition, 4500-F-C. Solids are reported from a 1:5 water extract unless otherwise specified.
INORG-036	Total Organic Carbon and/or Matter - A titrimetric method that measures the oxidisable organic content of soils.
INORG-055	Nitrate/Nitrite/NOx/TKN - determined colourimetrically. Waters samples are filtered on receipt prior to analysis. Soils/solids are analysed following a water extraction.
INORG-057	Ammonia - determined colourimetrically. Water samples are filtered on receipt prior to analysis. Soils and OHS media are analysed following a water extraction. Alternatively, Ammonia can be extracted from soil using 1M KCl.
INORG-060	Phosphate - determined colourimetrically using APHA latest edition 4500 P E. Water samples are filtered on receipt prior to analysis. Soils are analysed from a water extract.
INORG-062	TKN - determined colourimetrically. Alternatively, TKN can be derived from calculation (Total N - NOx).
INORG-107	Particle Size Distribution using in house method INORG-107 (sieves and hydrometer).
INORG-118	Hexavalent Chromium by Ion Chromatographic separation and colourimetric determination. Waters samples are filtered prior to analysis. Solids are extracted with an alkaline buffered solution, for air sampling media the same alkali extraction can be used or alternatives from NIOSH/OSHA. For aqueous samples, Total Hexavalent Chromium includes the dissolved Hexavalent Chromium and any Hexavalent Chromium solubilised by the preservative i.e. Sodium Hydroxide from any particulate that may be present.
INORG-122	Soil Density using gas pycnometer
METALS-020	Determination of various metals by ICP-OES.
METALS-020_008A	Determination of exchangeable cations and cation exchange capacity in soils using 1M Ammonium Chloride exchange and ICP-OES analytical finish.
METALS-021	Determination of Mercury by Cold Vapour AAS.
METALS-022	Determination of various metals by ICP-MS. Please note for Bromine and Iodine, any forms of these elements that are present are included together in the one result reported for each of these two elements.
ORG-020	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-FID. F2 = (>C10-C16)-Naphthalene as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater (HSLs Tables 1A (3, 4)). Note Naphthalene is determined from the VOC analysis. Note, the Total +ve TRH PQL is reflective of the lowest individual PQL and is therefore "Total +ve TRH" is simply a sum of the positive individual TRH fractions (>C10-C40).
ORG-023_F1_TOT	Determination of volatile organic compounds (VOCs) by P&T-GC-MS. Water samples are analysed directly by purge and trap GC-MS. Solids are extracted with Methanol, diluted and analysed by purge and trap GC-MS. F1 = (C6-C10)-BTEX as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater. Note, the Total +ve Xylene PQL is reflective of the lowest individual PQL and is therefore "Total +ve Xylenes" is simply a sum of the positive individual Xylenes.

Result Definitions

Identifier	Description
NR	Not reported
NEPM	National Environment Protection Measure
NS	Not specified
LCS	Laboratory Control Sample
RPD	Relative Percent Difference
>	Greater than
<	Less than
PQL	Practical Quantitation Limit
INS	Insufficient sample for this test
NA	Test not required
NT	Not tested
DOL	Samples rejected due to particulate overload (air filters only)
RFD	Samples rejected due to filter damage (air filters only)
RUD	Samples rejected due to uneven deposition (air filters only)
##	Indicates a laboratory acceptance criteria outlier, for further details, see Result Comments and/or QC Comments

Quality Control Definitions

Blank

This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, and is determined by processing solvents and reagents in exactly the same manner as for samples.

Surrogate Spike

Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

LCS (Laboratory Control Sample)

This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.

Matrix Spike

A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.

Duplicate

This is the complete duplicate analysis of a sample from the process batch. The sample selected should be one where the analyte concentration is easily measurable.

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria. Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction. Spikes for Physical and Aggregate Tests are not applicable. For VOCs in water samples, three vials are required for duplicate or spike analysis.

General Acceptance Criteria (GAC) - Analyte specific criteria applies for some analytes and is reflected in QC recovery tables.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% - see ELN-P05 QAQC tables for details (available on request); <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase. Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was typically insufficient in order to satisfy laboratory QA/QC protocols.

Miscellaneous Information

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached. We have taken the sampling date as being the date received at the laboratory.

Two significant figures are reported for the majority of tests and with a high degree of confidence, for results <10*PQL, the second significant figure may be in doubt i.e. has a relatively high degree of uncertainty and is provided for information only.

Measurement Uncertainty estimates are available for most tests upon request.

Analysis of aqueous samples typically involves the extraction/digestion and/or analysis of the liquid phase only (i.e. NOT any settled sediment phase but inclusive of suspended particles if present), unless stipulated on the Envirolab COC or by correspondence. Notable exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, Total Recoverable metals and PFAS where sediment/solids are included by default.

Urine Analysis - The BEI values listed are taken from the 2022 edition of *TLVs and BEIs Threshold Limits by ACGIH*.

Air volume measurements are not covered by Envirolab's NATA accreditation.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from the latest "Australian Drinking Water Guidelines", published by NHMRC. No guideline values have been set for Total Coliforms in drinking water. Increased concentrations should be investigated. Total Coliforms are not considered useful as indicators of the presence of faecal contamination.

Where we have provided guideline values eg. ADWG Health Value, it is the responsiblity of the reader to decide if the water is fit for consumption. Please note that the tests we have conducted are just a selection of common tests to give you a general idea of drinking water quality. There are many other tests included in the ADWG that we have not tested for.

Data Quality Assessment Summary PEG1691

Client Details

Client	Gemec
Your Reference	BME - Valhalla - Valhalla Proposed Well 3
Date Issued	04/08/2023

Recommended Holding Time Compliance

Recommended holding time exceedances exist - See detailed list below

Quality Control and QC Frequency

QC Type	Compliant	Details
Blank	Yes	No Outliers
LCS	Yes	No Outliers
Duplicates	Yes	No Outliers
Matrix Spike	No	Matrix Spike Outliers Exist - See detailed list below
Surrogates / Extracted Internal Standards	Yes	No Outliers
QC Frequency	Yes	No Outliers

Surrogates/Extracted Internal Standards, Duplicates and/or Matrix Spikes are not always relevant/applicable to certain analyses and matrices. Therefore, said QC measures are deemed compliant in these situations by default. See Laboratory Acceptance Criteria for more information

Data Quality Assessment Summary PEG1691

Recommended Holding Time Compliance

Analysis	Sample Number(s)	Date Sampled	Date Extracted	Date Analysed	Compliant
vTRH&MBTEXN | Soil	1-4	25/07/2023	03/08/2023	03/08/2023	Yes
sTRH | Soil	1-3	25/07/2023	03/08/2023	04/08/2023	Yes
Metals | Soil	1-3	25/07/2023	03/08/2023	03/08/2023	Yes
Metals-Hg | Soil	1-3	25/07/2023	03/08/2023	04/08/2023	Yes
Total Metals | Water	5	25/07/2023	01/08/2023	03/08/2023	Yes
Metals (LL) | Soil	1-3	25/07/2023	03/08/2023	03/08/2023	Yes
Total Metals (LL) | Water	5	25/07/2023	01/08/2023	03/08/2023	Yes
CEC | Soil	1-2	25/07/2023	03/08/2023	03/08/2023	Yes
Exchangeable Cations | Soil	1-2	25/07/2023	03/08/2023	03/08/2023	Yes
EC | Soil	1-2	25/07/2023	03/08/2023	04/08/2023	No
pH | Soil	1-2	25/07/2023	03/08/2023	04/08/2023	No
Cr6+ | Soil	1-2	25/07/2023	03/08/2023	04/08/2023	Yes
Fluoride | Soil	1-3	25/07/2023	03/08/2023	04/08/2023	Yes
Phosphate as P | Soil	1-2	25/07/2023	03/08/2023	04/08/2023	No
Moisture | Soil	1-4	25/07/2023	03/08/2023	04/08/2023	Yes
Nitrogen - Ammonia | Soil	1-2	25/07/2023	03/08/2023	04/08/2023	Yes
Nitrogen - Nitrate | Soil	1-2	25/07/2023	03/08/2023	04/08/2023	Yes
Nitrogen - Nitrite | Soil	1-2	25/07/2023	03/08/2023	04/08/2023	No
Nitrogen - NOx | Soil	1-2	25/07/2023	03/08/2023	04/08/2023	No
Nitrogen - TKN | Soil	1-2	25/07/2023	27/07/2023	01/08/2023	Yes
OC Walkley Black | Soil	1-2	25/07/2023	03/08/2023	04/08/2023	Yes
TOC Walkley Black | Soil	1-2	25/07/2023	03/08/2023	04/08/2023	Yes
TOM Walkley Black | Soil	1-2	25/07/2023	03/08/2023	04/08/2023	Yes
Cyanide - Total | Soil	1-2	25/07/2023	03/08/2023	03/08/2023	Yes
Clay Content | Soil	1-2	25/07/2023	04/08/2023	04/08/2023	Yes
Particle Density | Soil	1-2	25/07/2023	02/08/2023	02/08/2023	Yes
pH CaCl2 | Soil	1-2	25/07/2023	03/08/2023	04/08/2023	No

Data Quality Assessment Summary PEG1691

Outliers: Matrix Spike

INORG-062|Inorganics - Carbons, Nitrogen Species, Sulfur Species (Soil)| Batch BEG2895

Sample ID	Analyte	% Limits	% Recovery
BEG2895-MS1#	TKN as N	70 - 130	##[1]

METALS-020|Acid Extractable Metals (Water)| Batch BEH0094

Sample ID	Analyte	% Limits	% Recovery
BEH0094-MS1#	Sulfur	70 - 130	##[1]

METALS-020|Acid Extractable Metals (Soil)| Batch BEH0291

Sample ID	Analyte	% Limits	% Recovery
PEG1691-02	Aluminium	70 - 130	##[1]
PEG1691-02	Iron	70 - 130	##[1]

METALS-022|Acid Extractable Low Level Metals (Water)| Batch BEH0093

Sample ID	Analyte	% Limits	% Recovery
BEH0093-MS1#	Aluminium	70 - 130	##[1]
BEH0093-MS1#	Manganese	70 - 130	##[1]
BEH0093-MS1#	Zinc	70 - 130	##[1]

Quality Control PEG1691

ORG-023_F1_TOT|Volatile TRH and BTEX (Soil) | Batch BEH0292

Analyte	Units	PQL	Blank	DUP1 PEG1691-01 Samp | QC | RPD %	DUP2 BEH0292-DUP2# Samp | QC | RPD %	LCS %	Spike % PEG1691-02
TRH C6-C9	mg/kg	25	<25	<25 | <25 | [NA]	<25 | <25 | [NA]	107	115
TRH C6-C10	mg/kg	25	<25	<25 | <25 | [NA]	<25 | <25 | [NA]	107	114
TRH C6-C10 less BTEX (F1)	mg/kg	25	<25	<25 | <25 | [NA]	<25 | <25 | [NA]	[NA]	[NA]
Methyl tert butyl ether (MTBE)	mg/kg	0.50	<0.50			[NA]	[NA]
Benzene	mg/kg	0.20	<0.20	<0.20 | <0.20 | [NA]	<0.20 | <0.20 | [NA]	106	112
Toluene	mg/kg	0.50	<0.50	<0.50 | <0.50 | [NA]	<0.50 | <0.50 | [NA]	95.6	103
Ethylbenzene	mg/kg	1.0	<1.0	<1.0 | <1.0 | [NA]	<1.0 | <1.0 | [NA]	99.2	106
meta+para Xylene	mg/kg	2.0	<2.0	<2.0 | <2.0 | [NA]	<2.0 | <2.0 | [NA]	89.1	95.6
ortho-Xylene	mg/kg	1.0	<1.0	<1.0 | <1.0 | [NA]	<1.0 | <1.0 | [NA]	97.0	103
Total Xylene	mg/kg	3.0	<3.0	<3.0 | <3.0 | [NA]	<3.0 | <3.0 | [NA]	[NA]	[NA]
Naphthalene (value used in F2 calc)	mg/kg	1.0	<1.0	<1.0 | <1.0 | [NA]	<1.0 | <1.0 | [NA]	[NA]	[NA]
Surrogate aaa-Trifluorotoluene	*%*		*95.9*	*90.3 / 93.3*	*87.2 / 84.4*	*93.6*	*94.8*

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

ORG-020|Semi-volatile TRH (Soil) | Batch BEH0294

Analyte	Units	PQL	Blank	DUP1 PEG1691-01 Samp | QC | RPD %	DUP2 BEH0294-DUP2# Samp | QC | RPD %	LCS %	Spike % PEG1691-02
TRH C10-C14	mg/kg	50	<50	<50 | <50 | [NA]	<50 | <50 | [NA]	88.9	92.6
TRH C15-C28	mg/kg	100	<100	<100 | <100 | [NA]	<100 | <100 | [NA]	89.2	94.7
TRH C29-C36	mg/kg	100	<100	<100 | <100 | [NA]	<100 | <100 | [NA]	88.6	92.9
TRH >C10-C16	mg/kg	50	<50	<50 | <50 | [NA]	<50 | <50 | [NA] [2]	90.1	94.1
TRH >C16-C34 (F3)	mg/kg	100	<100	<100 | <100 | [NA]	<100 | <100 | [NA]	78.7	83.8
TRH >C34-C40 (F4)	mg/kg	100	<100	<100 | <100 | [NA]	<100 | <100 | [NA] [2]	89.6	94.0
Surrogate o-Terphenyl	*%*		*95.2*	*101 / 100*	*102 / 102*	*101*	*104*

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

METALS-020|Acid Extractable Metals (Soil) | Batch BEH0291

Analyte	Units	PQL	Blank	DUP1 PEG1691-01 Samp | QC | RPD %	DUP2 PEG1691-01 Samp | QC | RPD %	LCS %	Spike % PEG1691-02
Aluminium	mg/kg	10	<10	2040 | 1960 | 3.94	2040 | 1910 | 6.56	103	##[1]
Arsenic	mg/kg	4.0	<4.0	<4.0 | <4.0 | [NA]	<4.0 | <4.0 | [NA]	107	106
Barium	mg/kg	1.0	<1.0	14.3 | 14.3 | 0.00883	14.3 | 13.6 | 4.50	111	112
Boron	mg/kg	10	<10	<10 | <10 | [NA]	<10 | <10 | [NA]	98.3	94.0
Cadmium	mg/kg	0.40	<0.40	<0.40 | <0.40 | [NA]	<0.40 | <0.40 | [NA]	108	104
Chromium	mg/kg	1.0	<1.0	16.7 | 17.5 | 4.75	16.7 | 16.6 | 0.672	105	105
Copper	mg/kg	1.0	<1.0	1.36 | 1.33 | 2.39	1.36 | 1.24 | 9.70	104	103
Iron	mg/kg	10	<10	5880 | 5610 | 4.61	5880 | 5690 | 3.26	108	##[1]
Lead	mg/kg	1.0	<1.0	2.98 | 3.02 | 1.39	2.98 | 2.96 | 0.682	105	101
Manganese	mg/kg	1.0	<1.0	69.0 | 68.9 | 0.108	69.0 | 68.1 | 1.20	106	104
Mercury	mg/kg	0.10	<0.10	<0.10 | <0.10 | [NA]	<0.10 | <0.10 | [NA]	91.2	97.2
Nickel	mg/kg	1.0	<1.0	1.76 | 1.70 | 3.70	1.76 | 1.64 | 7.00	103	102
Phosphorus	mg/kg	10	<10	24.0 | 23.5 | 2.05	24.0 | 23.3 | 2.69	104	104
Selenium	mg/kg	2.0	<2.0	<2.0 | <2.0 | [NA]	<2.0 | <2.0 | [NA]	105	99.2
Strontium	mg/kg	1.0	<1.0	2.14 | 2.15 | 0.286	2.14 | 2.09 | 2.53	103	106
Sulfur	mg/kg	10	<10	<10 | <10 | [NA]	<10 | <10 | [NA]	103	102
Tin	mg/kg	2.0	<2.0	<2.0 | <2.0 | [NA]	<2.0 | <2.0 | [NA]	104	99.1
Zinc	mg/kg	1.0	<1.0	1.59 | 1.42 | 11.1	1.59 | 1.35 | 16.6	107	102

Quality Control PEG1691

METALS-020|Acid Extractable Metals (Water) | Batch BEH0094

Analyte	Units	PQL	Blank	DUP1 BEH0094-DUP1# Samp | QC | RPD %	LCS %	Spike % BEH0094-MS1#
Sulfur	mg/L	0.50	<0.50	35.2 | 33.9 | 3.88	104	##[1]

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

METALS-022|Acid Extractable Low Level Metals (Soil) | Batch BEH0291

Analyte	Units	PQL	Blank	DUP1 PEG1691-01 Samp | QC | RPD %	DUP2 PEG1691-01 Samp | QC | RPD %	LCS %	Spike % PEG1691-02
Thorium	mg/kg	0.50	<0.50	1.70 | 1.73 | 1.29	1.70 | 1.69 | 0.954	103	105
Uranium	mg/kg	0.10	<0.10	0.171 | 0.164 | 4.41	0.171 | 0.164 | 3.92	103	104

METALS-022|Acid Extractable Low Level Metals (Water) | Batch BEH0093

Analyte	Units	PQL	Blank	DUP1 BEH0093-DUP1# Samp | QC | RPD %	DUP2 BEH0093-DUP2# Samp | QC | RPD %	LCS %	Spike % BEH0093-MS1#
Aluminium	µg/L	10	<10	<10 | <10 | [NA]	327 | 338 | 3.22	90.3	##[1]
Chromium	µg/L	1.0	<1.0	<1.0 | <1.0 | [NA]	<10 | <10 | [NA]	97.8	112
Copper	µg/L	1.0	<1.0		85.3 | 83.1 | 2.61	100	98.8
Iron	µg/L	10	<10	<10 | <10 | [NA]	972 | 939 | 3.40	109	81.8
Lead	µg/L	1.0	<1.0	<1.0 | <1.0 | [NA]	<10 | <10 | [NA]	98.3	105
Manganese	µg/L	1.0	<1.0	<1.0 | <1.0 | [NA]	7690 | 7760 | 0.930	88.0	##[1]
Zinc	µg/L	1.0	<1.0	<1.0 | <1.0 | [NA]	77.3 | 87.5 | 12.4	96.3	##[1]

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

METALS-020_008A|Exchangeable Cations (Soil) | Batch BEH0258

Analyte	Units	PQL	Blank	DUP1 PEG1691-01 Samp | QC | RPD %	LCS %	Spike % PEG1691-02
Calcium	meq/100g	0.10	<0.10	0.820 | 0.760 | 7.59	105	105
Potassium	meq/100g	0.10	<0.10	<0.10 | <0.10 | [NA]	96.3	96.3
Magnesium	meq/100g	0.10	<0.10	0.190 | 0.170 | 11.1	97.6	97.7
Sodium	meq/100g	0.10	<0.10	<0.10 | <0.10 | [NA]	83.4	84.1
Cation Exchange Capacity (CEC)	meq/100g	0.10	<0.10		[NA]	[NA]

INORG-001|Inorganics - General Physical Parameters (Soil) | Batch BEH0320

Analyte	Units	PQL	Blank	DUP1 PEG1691-01 Samp | QC | RPD %	LCS %
pH	pH units		5.6	6.2 | 6.1 | 0.814	101
Electrical Conductivity	µS/cm	2.0	<2.0	3.30 | 4.40 | 28.6	101

INORG-118|Inorganics - General Chemical Parameters (Soil) | Batch BEH0289

Analyte	Units	PQL	Blank	DUP1 PEG1691-01 Samp | QC | RPD %	LCS %	Spike % PEG1691-02
Hexavalent Chromium	mg/kg	1.0	<1.0	<1.0 | <1.0 | [NA]	105	109

INORG-026|Inorganics - General Chemical Parameters (Soil) | Batch BEH0319

Analyte	Units	PQL	Blank	DUP1 PEG1691-01 Samp | QC | RPD %	LCS %	Spike % PEG1691-02
Fluoride	mg/kg	0.50	<0.50	<0.50 | <0.50 | [NA]	114	106

Quality Control PEG1691

INORG-060 | Inorganics - General Chemical Parameters (Soil) | Batch BEH0323

Analyte	Units	PQL	Blank	DUP1 PEG1691-01 Samp | QC | RPD %	LCS %	Spike % PEG1691-02
Phosphate as P	mg/kg	0.50	<0.50	<0.50 | <0.50 | [NA]	104	105

INORG-008 | Inorganics - Moisture (Soil) | Batch BEH0284

Analyte	Units	PQL	Blank	DUP1 PEG1691-01 Samp | QC | RPD %	DUP2 BEH0284-DUP2# Samp | QC | RPD %	LCS %
Moisture	%	0.1		1.56 | 1.50 | 3.92	24.4 | 24.0 | 1.69	[NA]

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

INORG-062 | Inorganics - Carbons, Nitrogen Species, Sulfur Species (Soil) | Batch BEG2895

Analyte	Units	PQL	Blank	DUP1 BEG2895-DUP1# Samp | QC | RPD %	LCS %	Spike % BEG2895-MS1#
TKN as N	mg/kg	10	<10	652 | 613 | 6.13	87.9	##[1]

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

INORG-036 | Inorganics - Carbons, Nitrogen Species, Sulfur Species (Soil) | Batch BEH0322

Analyte	Units	PQL	Blank	DUP1 PEG1691-01 Samp | QC | RPD %	LCS %
Organic Carbon (Walkley Black)	mg/kg	1000	<1000	2880 | 2960 | 2.54	102
Total Organic Carbon (Walkley Black)	mg/kg	1000	<1000	3840 | 3940 | 2.52	102
Total Organic Matter (Walkley Black)	mg/kg	1000	<1000	6620 | 6790 | 2.52	102

INORG-055 | Inorganics - Carbons, Nitrogen Species, Sulfur Species (Soil) | Batch BEH0323

Analyte	Units	PQL	Blank	DUP1 PEG1691-01 Samp | QC | RPD %	LCS %	Spike % PEG1691-02
Nitrate as N	mg/kg	0.50	<0.50	<0.50 | <0.50 | [NA]	97.7	98.9
Nitrate as NO3 by calculation	mg/kg	3.0	<3.0		[NA]	[NA]
Nitrite as N	mg/kg	0.50	<0.50	<0.50 | <0.50 | [NA]	[NA]	[NA]
Nitrite as NO2 by calculation	mg/kg	2.0	<2.0		[NA]	[NA]
NOx as N	mg/kg	0.50	<0.50	<0.50 | <0.50 | [NA]	97.7	98.9

INORG-057 | Inorganics - Carbons, Nitrogen Species, Sulfur Species (Soil) | Batch BEH0324

Analyte	Units	PQL	Blank	DUP1 PEG1691-01 Samp | QC | RPD %	LCS %	Spike % PEG1691-02
Ammonia as N	mg/kg	0.50	<0.50	1.37 | 1.39 | 1.99	97.1	85.5

INORG-014 | Inorganics - Cyanide Species and Similar (Soil) | Batch BEH0290

Analyte	Units	PQL	Blank	DUP1 PEG1691-01 Samp | QC | RPD %	LCS %	Spike % PEG1691-02
Total Cyanide	mg/kg	0.50	<0.50	<0.50 | <0.50 | [NA]	111	113

INORG-001_CACL2 | Inorganics (CaCl2 extraction) (Soil) | Batch BEH0321

Analyte	Units	PQL	Blank	DUP1 PEG1691-01 Samp | QC | RPD %	LCS %
pH (1:5 soil:CaCl2)	pH units			4.9 | 4.9 | 0.00	101

QC Comments

Identifier	Description
[1]	Spike recovery is not applicable due to the relatively high analyte background in the sample (>3* spike level). However, the LCS recovery is within acceptance criteria.
[2]	Duplicate %RPD may be flagged as an outlier to routine laboratory acceptance, however, where one or both results are <10*PQL, the RPD acceptance criteria increases exponentially.

CHAIN OF CUSTODY - Client

Client: Gemec
Project Mgr: Nicolo Jelovsek
Sampler: Nicolo Jelovsek
Address: 1/25 Foss St Palmyra 6157
Email: nicolo@gemec.com.au
Phone: 08 9339 8449 / 0439 093 980

Client Project Name and Number: BME - Valhalla
Location: Valhalla Proposed Well 3
MPL Quote No: 22PE483
Date results required:
Or choose: standard ~~/ 1 day / 2 day / 3 day~~
Note: Inform lab in advance if urgent turnaround is required - surcharge applies

MPL Laboratories
Address: 16-18 Hayden Crt
Myaree 6154
Phone: 08 9317 2505
Fax: 08 9317 4163
E-mail: lab@mpl.com.au

Sample information

MPL Sample ID	Client Sample ID	Depth (m)	Date sampled	Time	Type of sample
(1)	Split	-	25.07.23	-	Soil

Analyses Required

CS001_M: BTEXN, TRH, 8 metals (As, Cd, Cr, Cu, Hg, Ni, Pb, Zn)	Extra metals: Al, Ba, B, Fe, Mn, S, Se, Sn, Sr, Th,	Hexavalent chromium	Cyanide (total)	Fluoride	E010302: Nutrient suite	pH & EC	vTRH (C6-C9) + BTEXN	8 metals: Al Cu Cr Fe Pb Mn S Zn (total) - excl.	SS350: NEPM2013 Soil Characteristics EIL			
X	X			X								

Comments

Email CoC with report also please
Sample containers labelled VDE
Please send Split sample to Envirolab Sydney

12 Ashley St
Chatswood NSW 2067
Ph: (02) 9910 6200

Job No: 329380
Date Received: 1/8/23
Time Received: 1325
Received by:
Temp: Cool / ambient 11°C
Cooling: Ice/Ice pack
Security: Intact / Broken/None

Relinquished by (company): Gemec
Print Name: Nicolo Jelovsek
Date & Time: 28.07.23, 10:00
Signature:

Received by (company): MPL
Print Name: CTadura
Date & Time: 28 JUL 2023 @ 1135
Signature:

EBS_Syd.
1/8/23
1325

Laboratory Use Only:
Samples Received: Cool / ambient
Temperature Received at: 8 (if applicable)
Transported by: Hand delivered / courier

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
customerservice@envirolab.com.au
www.envirolab.com.au

SAMPLE RECEIPT ADVICE

Client Details

Client	Gemec
Attention	Nicolo Jelovsek

Sample Login Details

Your reference	BME- Valhalla
Envirolab Reference	329380
Date Sample Received	01/08/2023
Date Instructions Received	01/08/2023
Date Results Expected to be Reported	08/08/2023

Sample Condition

Samples received in appropriate condition for analysis	Yes
No. of Samples Provided	1 Soil
Turnaround Time Requested	Standard
Temperature on Receipt (°C)	11
Cooling Method	Ice Pack
Sampling Date Provided	YES

Comments

Nil

Please direct any queries to:

Aileen Hie	Jacinta Hurst
Phone: 02 9910 6200	**Phone: 02 9910 6200**
Fax: 02 9910 6201	**Fax: 02 9910 6201**
Email: ahie@envirolab.com.au	**Email: jhurst@envirolab.com.au**

Analysis Underway, details on the following page:

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
customerservice@envirolab.com.au
www.envirolab.com.au

Sample ID	vTRH(C6-C10)/BTEXN in Soil	svTRH (C10-C40) in Soil	Acid Extractable metalsin soil	Misc Inorg - Soil
Split	✓	✓	✓	✓

The '✓' indicates the testing you have requested. **THIS IS NOT A REPORT OF THE RESULTS.**

Additional Info
Sample storage - Waters are routinely disposed of approximately 1 month and soils approximately 2 months from receipt.
Requests for longer term sample storage must be received in writing.
Please contact the laboratory immediately if observed settled sediment present in water samples is to be included in the extraction and/or analysis (exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, Total Recoverable metals and PFAS analysis where solids are included by default.
TAT for Micro is dependent on incubation. This varies from 3 to 6 days.

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
customerservice@envirolab.com.au
www.envirolab.com.au

CERTIFICATE OF ANALYSIS 329380

Client Details

Client	Gemec
Attention	Nicolo Jelovsek
Address	1/25 Foss St, Palmyra, WA, 6157

Sample Details

Your Reference	**BME- Valhalla**
Number of Samples	1 Soil
Date samples received	01/08/2023
Date completed instructions received	01/08/2023

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date results requested by	08/08/2023
Date of Issue	08/08/2023

NATA Accreditation Number 2901. This document shall not be reproduced except in full.

Accredited for compliance with ISO/IEC 17025 - Testing. **Tests not covered by NATA are denoted with ***

Results Approved By
Diego Bigolin, Inorganics Supervisor
Dragana Tomas, Senior Chemist
Loren Bardwell, Development Chemist
Steven Luong, Senior Chemist

Authorised By
Nancy Zhang, Laboratory Manager

vTRH(C6-C10)/BTEXN in Soil		
Our Reference		329380-1
Your Reference	UNITS	Split
Date Sampled		25/07/2023
Type of sample		Soil
Date extracted	-	02/08/2023
Date analysed	-	04/08/2023
TRH C_6 - C_9	mg/kg	<25
TRH C_6 - C_{10}	mg/kg	<25
vTPH C_6 - C_{10} less BTEX (F1)	mg/kg	<25
Benzene	mg/kg	<0.2
Toluene	mg/kg	<0.5
Ethylbenzene	mg/kg	<1
m+p-xylene	mg/kg	<2
o-Xylene	mg/kg	<1
Naphthalene	mg/kg	<1
Total +ve Xylenes	mg/kg	<1
Surrogate aaa-Trifluorotoluene	%	89

svTRH (C10-C40) in Soil		
Our Reference	UNITS	329380-1
Your Reference		Split
Date Sampled		25/07/2023
Type of sample		Soil
Date extracted	-	02/08/2023
Date analysed	-	05/08/2023
TRH C_{10} - C_{14}	mg/kg	<50
TRH C_{15} - C_{28}	mg/kg	<100
TRH C_{29} - C_{36}	mg/kg	<100
Total +ve TRH (C10-C36)	mg/kg	<50
TRH >C_{10} -C_{16}	mg/kg	<50
TRH >C_{10} - C_{16} less Naphthalene (F2)	mg/kg	<50
TRH >C_{16} -C_{34}	mg/kg	<100
TRH >C_{34} -C_{40}	mg/kg	<100
Total +ve TRH (>C10-C40)	mg/kg	<50
Surrogate o-Terphenyl	%	89

Acid Extractable metals in soil		
Our Reference		329380-1
Your Reference	UNITS	Split
Date Sampled		25/07/2023
Type of sample		Soil
Date prepared	-	08/08/2023
Date analysed	-	08/08/2023
Arsenic	mg/kg	<4
Cadmium	mg/kg	<0.4
Chromium	mg/kg	15
Copper	mg/kg	2
Lead	mg/kg	2
Mercury	mg/kg	<0.1
Nickel	mg/kg	2
Zinc	mg/kg	1
Aluminium	mg/kg	1,400
Barium	mg/kg	13
Boron	mg/kg	<10
Iron	mg/kg	5,400
Manganese	mg/kg	69
Sulphur	mg/kg	10
Selenium	mg/kg	<2
Tin	mg/kg	<2
Strontium	mg/kg	2
Thorium*	mg/kg	1

Misc Inorg - Soil		
Our Reference		329380-1
Your Reference	UNITS	Split
Date Sampled		25/07/2023
Type of sample		Soil
Date prepared	-	03/08/2023
Date analysed	-	03/08/2023
Fluoride (1:5 soil:water)	mg/kg	1.0

Moisture		
Our Reference		329380-1
Your Reference	UNITS	Split
Date Sampled		25/07/2023
Type of sample		Soil
Date prepared	-	02/08/2023
Date analysed	-	03/08/2023
Moisture	%	0.9

Method ID	Methodology Summary
Inorg-008	Moisture content determined by heating at 105+/-5 °C for a minimum of 12 hours.
Inorg-026	Fluoride determined by ion selective electrode (ISE) in accordance with APHA latest edition, 4500-F-C.
Metals-020	Determination of various metals by ICP-AES.
Metals-021	Determination of Mercury by Cold Vapour AAS.
Metals-022	Determination of various metals by ICP-MS. Please note for Bromine and Iodine, any forms of these elements that are present are included together in the one result reported for each of these two elements.
Org-020	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-FID. F2 = (>C10-C16)-Naphthalene as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater (HSLs Tables 1A (3, 4)). Note Naphthalene is determined from the VOC analysis.
Org-020	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-FID. F2 = (>C10-C16)-Naphthalene as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater (HSLs Tables 1A (3, 4)). Note Naphthalene is determined from the VOC analysis. Note, the Total +ve TRH PQL is reflective of the lowest individual PQL and is therefore "Total +ve TRH" is simply a sum of the positive individual TRH fractions (>C10-C40).
Org-023	Soil samples are extracted with methanol and spiked into water prior to analysing by purge and trap GC-MS.
Org-023	Soil samples are extracted with methanol and spiked into water prior to analysing by purge and trap GC-MS. Water samples are analysed directly by purge and trap GC-MS. F1 = (C6-C10)-BTEX as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater.
Org-023	Soil samples are extracted with methanol and spiked into water prior to analysing by purge and trap GC-MS. Water samples are analysed directly by purge and trap GC-MS. F1 = (C6-C10)-BTEX as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater. Note, the Total +ve Xylene PQL is reflective of the lowest individual PQL and is therefore "Total +ve Xylenes" is simply a sum of the positive individual Xylenes.

QUALITY CONTROL: vTRH(C6-C10)/BTEXN in Soil						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-7	[NT]
Date extracted	-			02/08/2023	[NT]	[NT]	[NT]	[NT]	02/08/2023	[NT]
Date analysed	-			04/08/2023	[NT]	[NT]	[NT]	[NT]	04/08/2023	[NT]
TRH C_6 - C_9	mg/kg	25	Org-023	<25	[NT]	[NT]	[NT]	[NT]	119	[NT]
TRH C_6 - C_{10}	mg/kg	25	Org-023	<25	[NT]	[NT]	[NT]	[NT]	119	[NT]
Benzene	mg/kg	0.2	Org-023	<0.2	[NT]	[NT]	[NT]	[NT]	110	[NT]
Toluene	mg/kg	0.5	Org-023	<0.5	[NT]	[NT]	[NT]	[NT]	114	[NT]
Ethylbenzene	mg/kg	1	Org-023	<1	[NT]	[NT]	[NT]	[NT]	110	[NT]
m+p-xylene	mg/kg	2	Org-023	<2	[NT]	[NT]	[NT]	[NT]	132	[NT]
o-Xylene	mg/kg	1	Org-023	<1	[NT]	[NT]	[NT]	[NT]	123	[NT]
Naphthalene	mg/kg	1	Org-023	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Surrogate aaa-Trifluorotoluene	%		Org-023	84	[NT]	[NT]	[NT]	[NT]	91	[NT]

QUALITY CONTROL: svTRH (C10-C40) in Soil						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-6	[NT]
Date extracted	-			02/08/2023	[NT]	[NT]	[NT]	[NT]	02/08/2023	[NT]
Date analysed	-			05/08/2023	[NT]	[NT]	[NT]	[NT]	05/08/2023	[NT]
TRH C_{10} - C_{14}	mg/kg	50	Org-020	<50	[NT]	[NT]	[NT]	[NT]	123	[NT]
TRH C_{15} - C_{28}	mg/kg	100	Org-020	<100	[NT]	[NT]	[NT]	[NT]	126	[NT]
TRH C_{29} - C_{36}	mg/kg	100	Org-020	<100	[NT]	[NT]	[NT]	[NT]	114	[NT]
TRH >C_{10} -C_{16}	mg/kg	50	Org-020	<50	[NT]	[NT]	[NT]	[NT]	123	[NT]
TRH >C_{16} -C_{34}	mg/kg	100	Org-020	<100	[NT]	[NT]	[NT]	[NT]	126	[NT]
TRH >C_{34} -C_{40}	mg/kg	100	Org-020	<100	[NT]	[NT]	[NT]	[NT]	114	[NT]
Surrogate o-Terphenyl	%		Org-020	94	[NT]	[NT]	[NT]	[NT]	106	[NT]

QUALITY CONTROL: Acid Extractable metals in soil						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			08/08/2023	[NT]	[NT]	[NT]	[NT]	08/08/2023	[NT]
Date analysed	-			08/08/2023	[NT]	[NT]	[NT]	[NT]	08/08/2023	[NT]
Arsenic	mg/kg	4	Metals-020	<4	[NT]	[NT]	[NT]	[NT]	103	[NT]
Cadmium	mg/kg	0.4	Metals-020	<0.4	[NT]	[NT]	[NT]	[NT]	95	[NT]
Chromium	mg/kg	1	Metals-020	<1	[NT]	[NT]	[NT]	[NT]	100	[NT]
Copper	mg/kg	1	Metals-020	<1	[NT]	[NT]	[NT]	[NT]	105	[NT]
Lead	mg/kg	1	Metals-020	<1	[NT]	[NT]	[NT]	[NT]	96	[NT]
Mercury	mg/kg	0.1	Metals-021	<0.1	[NT]	[NT]	[NT]	[NT]	114	[NT]
Nickel	mg/kg	1	Metals-020	<1	[NT]	[NT]	[NT]	[NT]	98	[NT]
Zinc	mg/kg	1	Metals-020	<1	[NT]	[NT]	[NT]	[NT]	95	[NT]
Aluminium	mg/kg	10	Metals-020	<10	[NT]	[NT]	[NT]	[NT]	104	[NT]
Barium	mg/kg	1	Metals-020	<1	[NT]	[NT]	[NT]	[NT]	100	[NT]
Boron	mg/kg	10	Metals-020	<10	[NT]	[NT]	[NT]	[NT]	102	[NT]
Iron	mg/kg	10	Metals-020	<10	[NT]	[NT]	[NT]	[NT]	102	[NT]
Manganese	mg/kg	1	Metals-020	<1	[NT]	[NT]	[NT]	[NT]	103	[NT]
Sulphur	mg/kg	10	Metals-020	<10	[NT]	[NT]	[NT]	[NT]	94	[NT]
Selenium	mg/kg	2	Metals-020	<2	[NT]	[NT]	[NT]	[NT]	100	[NT]
Tin	mg/kg	2	Metals-020	<2	[NT]	[NT]	[NT]	[NT]	96	[NT]
Strontium	mg/kg	1	Metals-020	<1	[NT]	[NT]	[NT]	[NT]	100	[NT]
Thorium*	mg/kg	0.5	Metals-022	<0.5	[NT]	[NT]	[NT]	[NT]	102	[NT]

QUALITY CONTROL: Misc Inorg - Soil						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-7	[NT]
Date prepared	-			03/08/2023	[NT]	[NT]	[NT]	[NT]	03/08/2023	[NT]
Date analysed	-			03/08/2023	[NT]	[NT]	[NT]	[NT]	03/08/2023	[NT]
Fluoride (1:5 soil:water)	mg/kg	0.5	Inorg-026	<0.5	[NT]	[NT]	[NT]	[NT]	102	[NT]

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

The recommended maximums for analytes in urine are taken from “2018 TLVs and BEIs”, as published by ACGIH (where available). Limit provided for Nickel is a precautionary guideline as per Position Paper prepared by AIOH Exposure Standards Committee, 2016.

Guideline limits for Rinse Water Quality reported as per analytical requirements and specifications of AS 4187, Amdt 2 2019, Table 7.2

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% – see ELN-P05 QA/QC tables for details; <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals (not SPOCAS); 60-140% for organics/SPOCAS (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Where matrix spike recoveries fall below the lower limit of the acceptance criteria (e.g. for non-labile or standard Organics <60%), positive result(s) in the parent sample will subsequently have a higher than typical estimated uncertainty (MU estimates supplied on request) and in these circumstances the sample result is likely biased significantly low.

Measurement Uncertainty estimates are available for most tests upon request.

Analysis of aqueous samples typically involves the extraction/digestion and/or analysis of the liquid phase only (i.e. NOT any settled sediment phase but inclusive of suspended particles if present), unless stipulated on the Envirolab COC and/or by correspondence. Notable exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, total recoverable metals and PFAS where solids are included by default.

Samples for Microbiological analysis (not Amoeba forms) received outside of the 2-8°C temperature range do not meet the ideal cooling conditions as stated in AS2031-2012.

Appendix B – Supporting Data

Soil Bore Log

GEMEC BORE LOG

CLIENT: Black Mountain Energy
CONSULTANT: Gemec
PROJECT: Valhalla
LOCATION: Proposed Well 3
DRILL DATE: 25.07.23

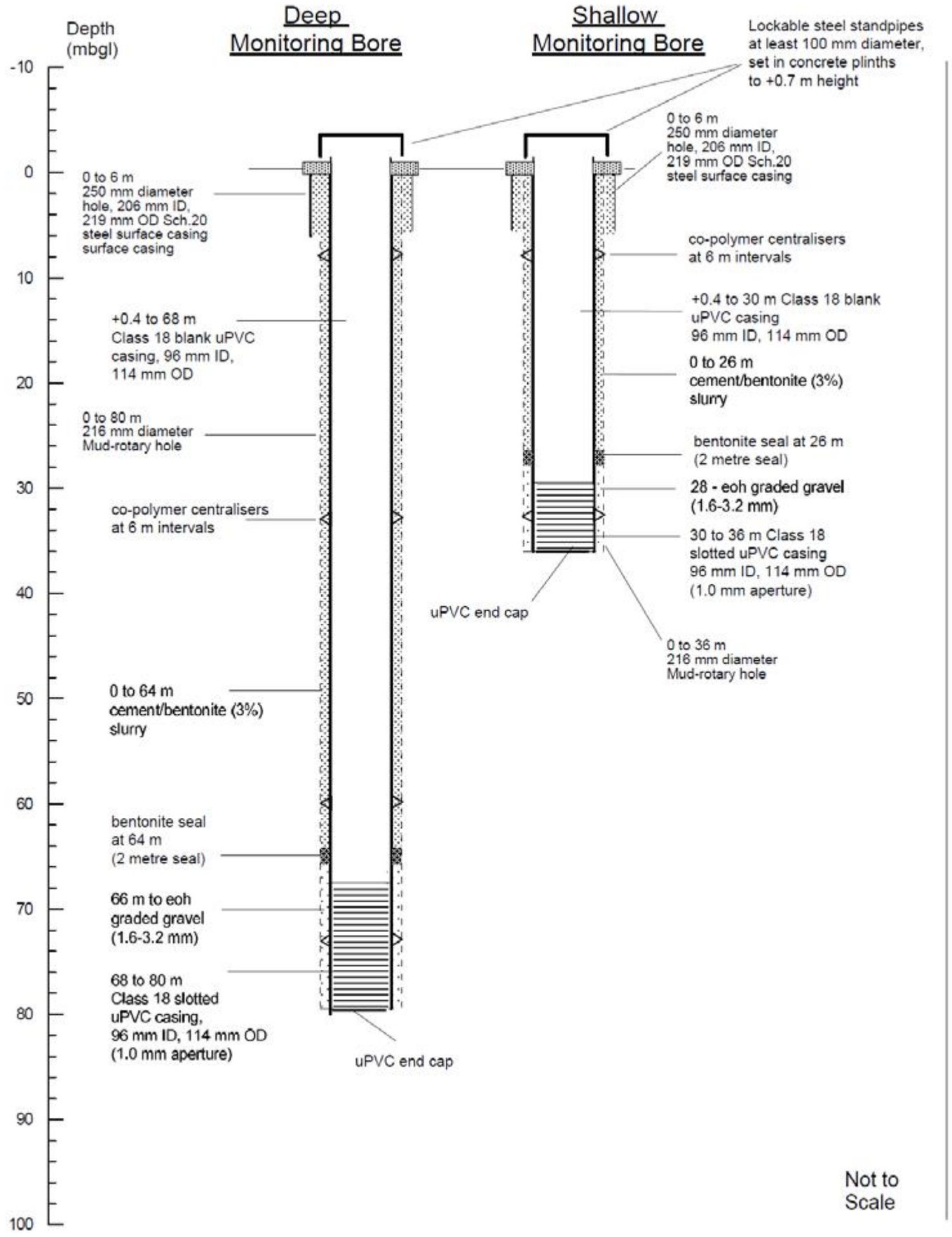
SOIL BOREHOLE NO: SB1
BOREHOLE Ø: 75 mm
EASTING: 708780 m E
NORTHING: 7978129 m N (MGA2020, Zone 51)
DRILL RIG: NA
DRILL METHOD: Hand Auger
DRILLING CO: NA

DEPTH (m bgs)	WELL MATERIALS	LITHOLOGY	DESCRIPTION	ODOUR	PID (ppmv)	SAMPLE (X)	OBSERVATIONS
			Ground Surface				
0.0			**SILTY CLAYEY SAND** Brown, fine grain, dry to slightly damp.				
			SILTY CLAYEY SAND Brown/red, damp.	NO	0.0	X	
							No odours or staining noted
1.0				NO			
2.0				NO	0.0	X	EOH @ 2.0 m bgs

NOTES: **NO / WO / DO / SO / VSO = No / weak / distinct / strong / very strong (odour);**
m BGS = metres below ground surface; AGS = above ground surface; EoH = end of hole;
NR = no response.

Buru Energy Monitoring Bore Conceptual Design

Drawing No.2



MB Concep Design Valhalla-Asgard.grf

Client : Buru Energy Ltd	MONITORING BORES CONCEPTUAL DESIGN
Project : Groundwater Monitoring	VALHALLA - ASGARD AREA
Date : May 2013	
Dwg No. : 416-0/13/2-2	Rockwater Pty Ltd

Field Equipment Calibration Certificates

AES
sensing safety

Calibration and Service Report – PID

Company:	GEMEC	**Manufacturer:**	Ion Science	**Serial #:**	T-105368
Contact:	Dan Baldwin	**Instrument:**	PHOCHECK TIGER SN: T-105	**Asset #:**	
Address:	PO Box 89 Melville WA 6956	**Model:**	TIGER	**Part #:**	
		Configuration:	VOC	**Sold:**	19.04.2023
		Wireless:		**Last Cal:**	
Phone:	0893398449	**Network ID:**		**Job #:**	149372
Fax:		**Unit ID:**		**Cal Spec:**	
Email:	dan@gemec.com.au	**Details:**		**Order #:**	CREDIT CARD

Calibration Certificate

Sensor	Type	Serial No.	Span Gas	Concentration	Traceability Lot #	CF	Reading	
							Zero	Span
Oxygen								
LEL								
PID	PID Sensor		Isobutylene	100 PPM	6481-2-1	1.0	0.0	100.0ppm
Battery								
Toxic 1								
Toxic 2								
Toxic 3								
Toxic 4								
Toxic 5								
Toxic 6								

Calibrated/Repaired by: SURESH KUMAR Date: 19.04.2023 Next Due: 19.10.2023

Calibration and Service Report – PID

Company:	GEMEC	**Manufacturer:**	Ion Science	**Serial #:**	T-105368
Contact:	Dan Baldwin	**Instrument:**	PHOCHECK TIGER SN: T-105	**Asset #:**	
Address:	PO Box 89 Melville WA 6956	**Model:**	TIGER	**Part #:**	
		Configuration:	VOC	**Sold:**	19.04.2023
		Wireless:		**Last Cal:**	
Phone:	0893398449	**Network ID:**		**Job #:**	149372
Fax:		**Unit ID:**		**Cal Spec:**	
Email:	dan@gemec.com.au	**Details:**		**Order #:**	CREDIT CARD

Item	Test	Pass/Fail	Comments	Serial Number
Battery	NiCd, NiMH, Dry cell, LiIon	P		
Charger	Power Supply	P		
	Cradle, Travel Charger	P		
Pump	Flow	P	>100 mL/min	
Filter	Filter, fitting, etc	X	Replaced	
Alarms	Audible, visual, vibration	P		
Display	Operation	P		
Switches	Operation	P		
PCB	Operation	P		
Connectors	Condition	P		
Firmware	Version	P	V 0.8.14	
Datalogger	Operation	P		
Monitor Housing	Condition	P		
Case	Condition / Type	P	Cleaned	
Sensors				
PID	Lamp	P		
PID	Sensor	P		
THP	Sensor	P		

Engineer's Report

Boot is cleaned. Date and time is updated.
Pump flow is at 157ml/min.
Inspected and calibrated, pass.

Field Data Sheets

Soil Sample Register

GEMEC

Project:	VALHALLA	Sampler:	NJ	Date:	25.7.23

Sample ID	Depth (m BGS)	Time	PID (ppm_v)	Dup / Split	Wall / Base	Sample Description	Contamination Observations
SB1	0-0.3	:	0.0	✓		Silty, clayey sand,	—
		:				~~f-gr~~, dry/sl. damp	
	1.7-	:				Brn.	
	2.0	:	0.0			" , brn. red, damp,	—
		:				sl. damp from 0.7m	
		:					
		:					
		:					
		:					
		:					
		:					
		:					
		:					
		:					
		:					
		:					
		:					
		:					
		:					
		:					
		:					
		:					
		:					
		:					
		:					
		:					
		:					
		:					
		:					
		:					
		:					
		:					
		:					
		:					
		:					
		:					
		:					
		:					
		:					
		:					
		:					
		:					
		:					
		:					

Notes:

HSL Application Checklist

HSL APPLICATION CHECKLIST

INTRODUCTION

This checklist is designed to allow assessors to conceptualise potential issues with contaminated land, and how to apply the HSLs. The checklist is designed to trigger responses from the assessor in determining whether the HSLs are applicable or whether consideration should be given to a more site-specific determination of risk. It highlights the key limitations and considerations that are common to contamination assessments and risk assessment.

The checklist summarises the key items from this Application Document.
It is recommended that the Application Document be read in conjunction with the use of this Checklist.

Summary of Steps

Step 1	**Identification of key limitations to the application of health screening levels**
Step 2	**Identification of key receptors and scenarios**
Step 3	**Identification of relevant soil type**
Step 4	**Identification of impacted media and depths**
Step 5	**Identification of source concentrations to be compared with health screening levels**
Step 6	**Selecting appropriate HSL and consideration of combining vapour intrusion and direct contact exposure**
Step 7	**Applying adjustments to the HSLs based on vapour biodegradation, soil organic carbon content, air exchange rate, and soil moisture content Consideration given to soil saturation and water solubility limits**
Step 8	**Adjustments for cancer risk assessment - modification of acceptable cancer risk level, assessment of cumulative cancer risk**

Step 1 – Limitations to HSLs			Comments
Assessing contamination in soil and groundwater should only be carried out by a qualified professional.			
Are guidelines relevant for site? Check the following limitations:			
Have chemicals other than petroleum hydrocarbons been identified at the site? →	NA	May consider site-specific risk asessment (refer to Section 5.2 of the Application Document)	No impact - baseline assessment
Is the groundwater to be used for irrigation purposes? →	N	May consider site-specific risk asessment (refer to Section 2.4.5 of the Application Document)	
Is the site conservation land? →	N	May be required to also assess ecological values (refer to Section 2.4.6 of the Application Document)	
Is the depth to groundwater impact less than 2m bgs ? →	NA	May consider site-specific risk asessment for direct contact May consider soil vapour sampling for vapour intrusion (refer to Section 2.4.2 of the Application Document)	No impact - baseline assessment
Has significant odour been observed at the site? →	N	May be required to also assess odour for sensitive land uses (refer to Section 5.4 of the Application Document)	
Is the identified chemical a result of a solvent spill rather than petroleum spill/leak? →	NA	HSLs may be used where saturation point is not considered (refer to Section 5.3 of the Application Document)	No impact - baseline assessment
Is the identified contamination an atypical petroleum mixture? →	NA	May consider site-specific risk asessment to consider cumulative effects between chemicals (refer to Section 3.6 of the Application Document)	No impact - baseline assessment
Is the soil source thickness significantly different than 2 m? →	NA	For small source thicknesses, HSLs may be overly conservative if source fully depletes. For larger thicknesses HSLs may not adequately characterise risk, however lateral extent of contamination should also be considered. A site-specific HRA may be considered. (refer to Section 2.4.7 of the Application Document)	No impact - baseline assessment
Does the building have a crawl space rather than slab-on-ground construction? →	NA	HSLs may be used as likely to be conservative. However, for situations where habitants may be exposed in crawl space area such as spaces under dwellings which incorporate garages/workshop then consideration may be given to ambient air sampling. (refer to Section 2.3.4 of the Application Document)	No slab-on-ground structures
Does the building have or is likely to have a habitable basement? →	NA	May consider site-specific risk asessment (refer to Section 2.3.3 of the Application Document)	

Note that the HSLs may be used for assessing health risk. In addition to this assessment, legislation requirements still need to be fulfilled which may include other considerations and assessments. Such considerations may include:

- Assessment of environmental values and ecological impacts
- Consideration of sustainability issues
- Risks for extraction and use of groundwater
- Soil source ongoing source to groundwater contamination
- Local planning requirements, such as sensitive uses under commercial zones, or future land use zones
- Social impacts and consultation with stakeholders

Step 2 – Identify receptors and scenarios to be considered

Check the receptors and scenarios to be assessed. Note that receptors and scenarios may require consideration of future land use planning and local regulations pertaining to site redevelopment.

	☐	Residential use (refer to Sections 2.1.1 and 2.3.1 of the Application Document)
HSL-A	☐	Low-Density Residential – assumes access to soils with no management controls on site. Assessment may consider surface soils with direct contact, intrusive maintenance worker protection, and consider using surface soil HSL for all soils down to 3 m depth to protect uncontrolled excavation of contamination.
HSL-B	☐	High-Density Residential – assumes limited access to surface soils with management controls on site. Assessment may consider surface soils/dust with limited direct contact. Intrusive maintenance workers may be protected under suitable site management plan.
HSL-A	☐	Medium-Density Residential with grassed open space – assumes access to soils with management controls on site. Assessment may consider surface soils with direct contact and subsurface soils through vapour intrusion. Intrusive maintenance workers may be protected under suitable site management plan.
HSL-B	☐	Medium-Density Residential with permanent paving open space – assumes limited access to soils with management controls on site. Assessment may consider surface soils/dust with limited direct contact. Intrusive maintenance workers may be protected under suitable site management plan.
HSL-A (for VI) *HSL-A or HSL-B (for DC)*	☐	Low- or Medium-Density Residential with single basement garage – for vapour intrusion, low-density residential (HSL-A) may apply due to low air exchange rate for basement garage. HSL depth is displaced by depth of basement. For soil direct contact HSLs, select from above medium density scenarios based on access to soils. Intrusive maintenance workers may be protected under suitable site management plan (refer to Section 2.3.3 of the Application Document).
HSL-D (for VI) *HSL-B (for DC outside footprint)*	☐	Medium- or High-Density Residential with communal basement car park – assumes no access to soils with management controls on site. HSL depth is displaced by depth of basement. Intrusive maintenance workers may be protected under suitable site management plan. Note that areas outside of the basement footprint may be required to be assessed as a building without basement and with limited direct contact with soil. Also, limited exposure time for basement users and therefore HSL for Commercial Worker may be used for vapour intrusion (refer to Section 2.3.3 of the Application Document).
HSL-C	X	Recreational / Public Open Space (refer to Section 2.1.2 of the Application Document)
	☐	Parks, ovals, pedestrian areas
	☐	National parks, conservation areas – may be required to also assess ecological values (refer to Section 2.4.6 of the Application Document)
HSL-D	☐	Commercial / Industrial Workers (refer to Section 2.1.3 of the Application Document) – considers only healthy adults under normal working conditions. Does not consider sensitive commercial uses such as schools, day care centres and medical practices.
	☐	Commercial sensitive users – may consider using residential HSLs or a site-specific HRA (refer to Section 2.4.1 of the Application Document)
	☐	Agricultural land – may consider a site specific HRA (refer to Section 2.4.5 of the Application Document)
	☐	Shallow intrusive workers down to 1 m deep. May require assessment of direct contact for soils surface to <2 m (refer to Sections 2.1.4 and 2.4.3 of the Application document)
	☐	Deep intrusive workers down to >1 m deep, such as sewer. Should be managed with appropriate procedures and work practices for confined spaces (refer to Section 2.4.4 of the Application Document)

Is a site management plan (that includes specific occupational hazard management for works on the site) to be implemented on the site (controlled site)? → N May not need to consider health risks to intrusive workers

Step 3 – Identify soil type relevant to site (soils above impacts in soil and/or groundwater)

Comments

Note the following before selecting soil type for use in assessment:

1. The prime parameter that influences the value of the HSL is the air filled porosity and volatility of the specific chemical. The higher the air filled porosity the greater the potential for volatile chemicals to migrate vertically through the soil profile.
2. The selection of a generic soil type requires knowledge of the soil profile across the site.
3. The selection of generic soil types should take into account the predominant characteristics of the soil profile and depth of contamination. The generic soil types assume a uniform profile, which at many, if not all, sites will not be the case. Where the overlying profile is predominantly fine materials (clays) (i.e. > 50% for soil column), these may be considered as the generic soil type. If the profile has a significant proportion of loose/coarse materials (including backfill) (i.e. > 50%), these materials may be considered as the generic soil type.
4. Air filled porosity is affected by moisture content. The wetter the soil, the lower the air filled porosity. Generic soil types have assumed a typical moisture content for the profile typical of average soil conditions occurring at depth. Moisture content will vary greatly by location and season. Moisture content will also vary between sub-categories of soil, e.g. between sand and clayey sand. HSLs may be adjusted based on moisture content. This is done in Step 7.
5. The selection of appropriate soil type is discussed in Section 3.2 of the Application Document.

Is there one dominant soil type on the site (> 50% of soil column)?
Or can a geological setting be conservatively identified (i.e. allowing greater vapour transport)? →

- [X] Y - Proceed
- [ ] N - Consideration may be given to assuming the more conservative soil type, or may be given to a site-specific HRA (refer to Section 4.6 of the Application Document)

Has excavated area(s) been backfilled with more porous materials ? →

- [ ] Y - Consideration should be given to adopting a more porous soil type (refer to Section 3.2 of the Application Document)
- [ ] N - Proceed

Does the site lithology contain rock formations
or soil with large cracks that can form preferential pathways? →

- [X] Y - The derived HSLs do not include lithogies with rock formations. Consideration may be given to using soil-vapour sampling or carrying out a site-specific HRA (refer to Section 4.6 of the Application Document)
- [ ] N - Proceed

Identify HSL soil type relevant to site and assessment (above impacts)

The soil profile properties have been based on a predominant soil texture grouping developed by the US Department of Agriculture. The 12 texture classes have been grouped into 3 groups: sand, silt and clay. The groupings of the classes are based on mean particle size and saturation porosities. Refer to Section 3.2 for further discussion on the soil properties.

HSL soil type selected:

- [ ] **Sand** – Properties selected to be representative of a coarse textured undisturbed soil profile. Consists of texture classes sand, sandy clay.
- [ ] **Silt** – Properties selected to be representative of a coarse textured undisturbed soil profile. Consists of texture classes silt, silty clay.
- [ ] **Clay** – Properties selected to be representative of a fine textured undisturbed soil profile. Consists of texture classes clay.
- [X] **Other** – Including soil with large cracks (preferential pathways) and fractured rock (basalt, sandstone, siltstone, limestone) - refer to Section 4.6 of the Application Document. Soil vapour measurement is preferred to soil or groundwater. Due to fractures and preferential vapour pathways in rock, consideration should be given to overlying weathered soil, or to using HSLs for surface soil in sand.

For soil assessment (texture classification) undertaken in accord with AS 1726 the classifications of sand, silt and clay may be applied as coarse, fine with liquid limit less than 50%, and fine with liquid limit greater than 50% respectively.

Where there is uncertainty, laboratory analysis should be carried out. This may include parameters for detailed particle analysis and exact soil texture sub-class, and saturation porosity.

Step 4 – Impact media		Comments
Are there impacts to media other than soil and groundwater? (e.g surface water, biota, odours etc) Note: aesthetic issues (odours/staining/ecological impacts etc.) to be addressed separately →	NA As well as human health assessment, consideration of other issues such as ecological, aesthetics, etc. may be required.	No impact - baseline assessment
Soils Are there soil impacts remaining on the site? →	NA Y - Proceed NA N - Go to groundwater section	No impact - baseline assessment
Depth to soil impacts. Note if considering basements, depths need to be displaced e.g. a 3 m deep basement means surface to <1 m represents 3 m to <4 m. (refer to Section 2.3.3 of the Application Document) ☐ surface to <1 m ☐ 1 m to <2 m ☐ 2 m to <4 m ☐ 4 m and deeper ☐ Displacement due to basement Distance of displacement (m) _____		
Is the site of interest an uncontrolled site where excavation activities such as construction may result in subsurface soil contaminantion brought to surface in the future? →	☐ Consideration may be given to use of HSLs for direct contact and surface HSLs for vapour intrusion, for deeper soils. A site management plan may be used to address uncontrolled excavation at a site. (refer to Sections 2.3.1, 3.4.1, and 4.7 of the Application Document)	
Groundwater Are there groundwater impacts beneath the site? →	NA Y - Proceed ☐ N - Go to soil vapour section	No impact - baseline assessment
Is the depth to groundwater less than 2 m? →	☐ Y - The HSL values may not adequately address this scenario. A site-specific HRA may be considered. Soil vapour sampling may be used to assess vapour intrusion. (refer to Section 2.3.3 of the Application Document)	
Depth to groundwater impacts. Note if considering basements, depths should be displaced e.g. a 3 m deep basement means surface to 2 m represents 5 m (refer to Sections 2.3.3 of the Application Document). With basements, groundwater HSLs may not adequately characterise risks where the groundwater level is within 2 m of basement foundation. ☐ 2 m to <4 m ☐ 4 m to <8 m ☐ 8 m and deeper ☐ Displacement due to basement Distance of displacement (m) _____		

Step 4 – Impact media (cont.)		Comments
Soil vapour Has soil vapour sampling been used to characterise vapour intrusion at the site? → [ ] Y - Proceed; [X] N - Proceed to Step 5 Depth to soil impacts. Note if considering basements, depths need to be displaced e.g. a 3 m deep basement means surface to <1 m represents 3 m to <4 m. (Refer to Section 2.3.3 of the Application Document.) [ ] surface to <1 m [ ] 1 m to <2 m [ ] 2 m to <4 m [ ] 4 m to <8 m [ ] 8 m and deeper [ ] Displacement due to basement Distance of displacement (m) _____ In using soil vapour sampling, please note the following: 1) It is recommended that soil vapour samples be taken as laterally close to a vapour source as possible (within or above). 2) Any sample taken within 1 m of the open air is subject to high levels of uncertainty due to atmospherical and meteorological effects. This includes the base and wall of excavation pits. 3) For sites subject to redevelopment with residential or commercial buildings, the soil vapour profiles are subject to change due to presence of concrete slabs. Caution is required on the use of soil vapour samples that are not within a soil source and in locations where buildings currently do not exist (refer to Section 1.6 of the Application Document).		

Step 5 – Selection of relevant source concentrations		Comments
Soil concentrations		
1. Is the investigation site likely to be subdivided into smaller lots? → [ ] Y - Statistical analysis using entire data set may not be applicable. Consideration may be given to using the maximums or using a sub-set for statistical analysis (refer to Section 3.4.1 of the Application Document) [X] N - Statistical analysis using entire data set may be applicable		
2. Is the site public open space / recreational land where users are unlikely to be in the same location for extended period? → [X] Y - Statistical analysis using entire data set may not be applicable. Consideration may be given to using the maximums or using a sub-set for statistical analysis (refer to Section 3.4.1 of the Application Document) [ ] N - Statistical analysis using entire data set may be applicable		
<u>If statistical analysis is appropriate consideration should be given to the following methodology (refer to Section 3.4.1 of the Application Document):</u> 1. Samples should be sub-divided into appropriate depth ranges as defined by HSLs (i.e. surface to <1 m, 1 m to <2 m, 2 m to <4 m, 4 m+). Note if considering basement, the appropriate displacement distance should be accounted for. 2. For each depth range, the statistical mean (e.g. 95% UCL arithmetic mean) soil concentration should be calculated for each chemical. One approach is described in the NSW EPA *Contaminated sites: Sampling design guidelines* (1995). The coefficient of variance test described in the document may be used to determine if the distribution is normal or lognormal. Consideration of other statistical methods may be adopted if justified (e.g. distribution does not fit a normal or lognormal distribution). 3. For samples with no detection, it is recommended to use half the detection limit during statistical analysis. 4. If the standard deviation is very large (due to outliers or low number of samples) the statistical mean may be higher than the maximum concentrations. In this case it is recommended to use the maximum. 5. It is recommended to keep note of maximum concentrations as well as statistical mean concentrations. Maximum concentrations may be required to address potential acute exposure issues.		
Groundwater concentrations		
Has floating product been identified in any well? → [NA] Y - Refer to point (a)		
(a) If PSH is identified, dissolved phase is likely to contain chemicals at solubility limits. Proceed with HSL comparison, noting that if there is at least one chemical for which HSLs in groundwater is limiting (i.e. not all chemical HSLs are NL) then presence of PSH may be a potential vapour risk to site users (refer to Section 3.4.2 of the Application Document). Also note that the presence of PSH may trigger other legislative requirements for remediation/monitoring.		
Is the area of interest represented by a single groundwater location or multiple ? → [X] Single - small area of interest such as residential dwelling may be represented by the maximum groundwater concentration if the dwelling location is unknown, otherwise if the building footprint is known, the groundwater well nearest to the point of interest may be used. [ ] Multiple - where exposure may occur over larger areas such as recreational parkland, consideration may be given to averaging the concentrations across the area of interest.		Mostly single wells
In deciding which set of monitoring data is most useful for analysis consideration may also be given to: - Historical results to determine trends in groundwater concentrations (i.e. the likelihood that concentrations may increase) - Upgradient wells and background concentrations - Groundwater flow direction (Refer to Section 3.4.2 of the Application Document.)		

Step 5 – Selection of relevant source concentrations (cont)		Comments
Soil vapour concentrations		
Is the area of interest represented by a single or multiple vapour location? →	NA Single - small area of interest such as residential dwelling may be represented by the maximum soil vapour concentration if the dwelling location is unknown, otherwise if the building footprint is known, the groundwater well nearest to the point of interest may be used. NA Multiple - where exposure may occur over larger areas such as recreational parkland, consideration may be given to averaging the concentrations across the area of interest.	Not applicable - baseline assessment
Are soil vapour samples measured in shallow soil less than 1 m from the surface where there is no existing slab or concrete paving? →	Y - Measurements are subject to influence from weather and atmospheric conditions and may not be considered reliable.	
Are soil vapour samples measured in areas where there is no existing slab or concrete paving, and the site is planned to be redeveloped where a building will exist (residential/commercial/ industrial use)? →	Y - Soil vapour samples not measured within a soil or groundwater source, may not be representative of the soil vapour in the future when a building is located on site. The placement of an impermeable barrier such as a concrete slab can cause build-up of soil vapour within the soil and sub-slab, above levels measured where there is no slab present. Note soil vapour measurements from within soil and groundwater sources are not subject to vapour build-up as the soil vapour is likely to be at its maximum concentration when located within the source.	
Soil vapour measurements may be taken at multiple depths, including within the source zone, above the source zone, and directly under a building foundation. Each of the measurement depths should be considered individually.		
Refer to Sections 3.4.3 and 1.6 of the Application Document.		

Step 6 – HSL determination and combined vapour intrusion and direct contact

		Comments
HSL determination		
HSLs and satuaration/solubility limits are presented in the Appendix B HSL tables. Select the appropriate HSLs for vapour intrusion from tables for: 1) Each selected receptor listed in Step 2 2) Dominant soil texture classification listed in Step 3 3) Source depth listed in Step 4 HSLs may be compared to soil/groundwater/soil vapour source concentrations determined in Step 5. Note for TPH C6 to C10, BTEX should be subtracted from analytical result prior to comparing with HSL		
1. Is the HSL value Not Limiting 'NL'? →	[X] Y - Indicates that vapour reaches saturation point and cannot increase to a point which would result in an unacceptable health risk [ ] N - Continue with Question 2 for groundwater, or proceed to Question 3	
2. Is groundwater HSL not 'NL' and PSH identified in water? →	[NA] Y - May indicate potential vapour risk (refer to Section 3.4.2 of Application Document) [NA] N - Proceed to Question 3	
3. Are comparisons being made against soil HSLs? →	[NA] Y - Proceed to Question 4 [NA] N - Proceed to Question 5	Not applicable - baseline assessment
4. Does direct contact need to be considered as well as vapour intrusion? →	[ ] HSL-A Low-Density Residential - surface soils, and possibly subsurface soils if determined to be relevant (refer to Section 4.7 of Application Document). Proceed to 'Combined pathways exposure' [ ] HSL-B High-Density Residential – surface soils. Proceed to 'Combined pathways exposure' [ ] HSL-C Open Space Recreational – surface soils.Proceed to 'Combined pathways exposure' [ ] HSL-D Commercial / Industrial – surface soils. Proceed to 'Combined pathways exposure' [ ] Intrusive Maintenance Worker – down to 2 m. Proceed to 'Combined pathways exposure' [X] N - Proceed to Question 5	
5. Do cross-scenario exposure need to be considered? (eg. adjacent residential and open space) →	[ ] Y - Proceed to 'Combined pathways exposure' [X] N - Proceed to Step 7	

Combined pathways exposure

Refer to Section 3.3 of the Application Document.
Combined exposures may occur on the same property where indoor vapour intrusion occurs concurrently with outdoor direct contact.
Combined exposure may also occur on adjacent properties, e.g. vapour intrusion on residential property and direct contact on adjacent open space (park).
For the given scenarios/chemicals, list the HSLs.

Where a vapour intrusion HSL is Not Limiting (NL) the chemical / scenario does not need to be considered in the combined pathway exposure.

The combined exposure is assessed as follows:

Multiple exposure pathways: $$\textbf{Cumulative Fraction} = \frac{C_{\text{Under Building}}}{HSL_{\text{Vapour Intrusion}}} + \frac{C_{\text{Outside Building}}}{HSL_{\text{Direct Contact}}}$$ where vapour intrusion can refer to soil, groundwater or soil vapour source

Multiple exposure scenarios: $$\textbf{Cumulative Fraction} = \frac{C_{\text{Land use 1}}}{HSL_{\text{Land use 1}}} + \frac{C_{\text{Land use 2}}}{HSL_{\text{Land use 2}}}$$ where the HSLs may refer to HSLs for vapour intrusion or direct contact

If a given C/HSL fraction is less than 0.1, the contribution of risk may be considered insignificant and the cumulative exposure need not be assessed for this scenario.
Where a cumulative fraction is less than 1 risk is normally acceptable. Where the value exceeds 1 a site-specific assessment should be undertaken, or proceed to Step 7.

Step 7 – HSLs and adjustments (vapour intrusion)		Comments
HSL adjustments (vapour intrusion only) For each adjustment, careful consideration and justification is required. **1. Vapour biodegradation** (refer to Section 4.2 of Application Document) Prior to applying attenuation factor for vapour degradation it is recommended to read the source documentation (Davis et al. 2009). The minimum requirements for allowing attenuation factors for vapour degradation are as follows: 1. Is there evidence of oxygen penetration? → NA Y - Requires measurement of oxygen in soil gas with at least 5% at 1 m depth (refer to Section 4.2.1 of Application Document) NA N - Attenuation factor may not be applicable 2. Is the source depth 2 m or deeper? → NA Y - Continue to Question 3 (refer to Section 4.2.2 of Application Document) NA N - Attenuation factor may not be applicable 3. Does the slab have one side less than 15m length? → NA Y - Degradation factor may apply. Less than 4 m depth, a factor of 10 may apply. 4 m and deeper, a factor of 100 may apply. (refer to Section 4.2.3 of Application Document) NA N - Attenuation factor may not be applicable **2. Soil organic carbon content** (refer to Section 4.3 of Application Document) May be used to adjust soil HSLs only. Soil HSLs were based on fraction organic carbon content of 0.003. HSL may be adjusted if background levels of organic carbon content at the same depth as source is different from baseline. Background sample must not be contaminated with hydrocarbons. If surface soil, background sample in open space may not be appropriate to use if comparing for soil under slab. Adjustment is linear, i.e. doubling the organic carbon will double the HSL. Applies only to soil HSL for vapour intrusion. **3. Air exchange rate** (refer to Section 4.4 of Application Document) HSLs are based on air exchange rate (AER) of 0.6 h^{-1} for residential and 0.83 h^{-1} for commercial. Careful justification may be required prior to changing AER. Consideration should be given to weather conditions, practice of leaving doors/windows open, or closed in climate controlled building. New buildings tend to be more air tight to comply with energy saving regulations. For soil and groundwater, adjustment is linear with respect to AER. For soil vapour, adjustment is variable depending on soil type and depth. Refer to the charts in Appendix D to determine the adjustment factor. **4. Moisture content** (refer to Section 4.5 of Application Document) HSLs may be adjusted if moisture content in soil is significantly different from baseline HSLs. The baseline moisture contents used were (dry wt) for sand 8%, silt 22% and clay 20%. Moisture content should be representative of long-term moisture content and not short-term result from recent rain event. Also note that for a development with future building where no building currently exists, moisture contents on site may not be representative for the future state of the site. HSL scaling factors for different land use/chemicals/soils are presented in Appendix C of the Application Document and may be applied as described in Section 4.5.		Not applicable - baseline assessment

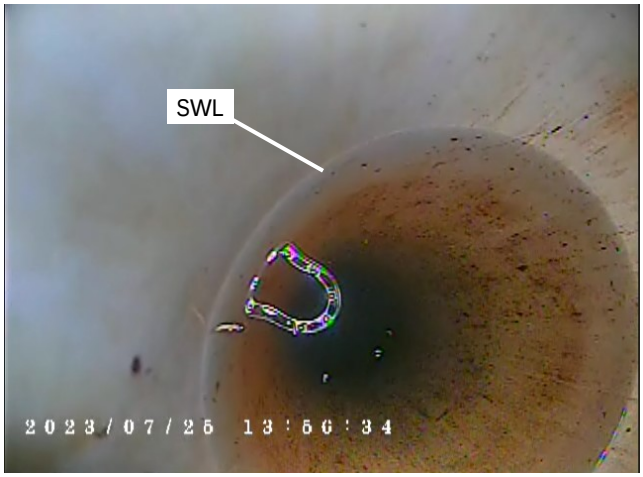
Step 7 – HSLs and adjustments (vapour intrusion) (cont.)		Comments
Saturation/solubility limits (soil and groundwater HSLs only)		
Apply the adjustments to the HSLs for vapour intrusion by multiplying by the determined factors.		
After applying the adjustments to the HSLs, is the revised HSL greater than the solubility / saturation limit? →	X Y - Indicates that the predicted source concentration to produce an unacceptable vapour risk is higher than the saturation point. The revised HSL is not limiting to vapour (NL). Note this does not apply to soils with direct contact. N - Revised HSL may be compared with measured source concentrations.	
Multi-Pathway Exposure		
1. Is inclusion of direct contact with soils required? →	NA Y - Repeat Step 6 with Adjusted Vapour Intrusion HSLs and Direct Contact HSLs NA N - Proceed to Question 2	
2. Is cross-scenario exposure required to be assessed?	NA Y - Repeat Step 6 with Adjusted Vapour Intrusion HSLs and Direct Contact HSLs NA N - Proceed to 'Screening assessment'	
Screening assessment		
Is the adjusted HSL less than source concentration? →	Y - Indicates potential health risk X N - Considered within acceptable health risks. If cancer endpoint (benzene) may also need to assess cancer risk level and cumulative cancer risk in Step 8	
Is the maximum soil, groundwater or soil-vapour concentration greater than the HSL by more than one or two orders of magnitude? →	Y - Indicates potential acute risk around hotspot X N - Considered within acceptable health risks	
If the screening assessment indicates the potential for unacceptable health risk, consideration may be given to further investigations such as further contaminantion deliniation, site-specific health risk assessment or site management. Before deciding the appropriate form of action considerations should include: - The magnitude of HSL exceedence - The nature of the source - The time frame required for managing health risks - Other statutory requirements		

Step 8 – Cancer risk assessment		Comments
Acceptable cancer risk (Refer to Section 5.1 of Application Document) HSLs for benzene have been based on 1 x 10^{-5} cancer risk. In some jurisdictions it may be required to assess carcinogenic risks based on 1 x 10^{-6} cancer risk. 1) The HSLs are linearly related to acceptable risk. HSLs based on a cancer risk of 1 x 10^{-6} may be calculated by dividing the HSLs in Appendix B by a factor of 10. 2) If the HSL is NL (vapour only HSL), it is possible that it may become limiting if the HSL is within a factor of 10 of the soil saturation concentration (or solubility limit for groundwater). 3) If soil or groundwater source concentration is less than an order of magnitude of the saturation concentration / solubility limit (in Appendix B), then even dividing the non-limiting HSL by 10 would result in an acceptable risk. Hence there is no need to proceed further. 4) If soil or groundwater source concentration is within an order of magnitude of the saturation concentration / solubility limit it is recommended to calculate the revised HSL from the non-limiting HSL. This process is outlined as follows: **Calculating revised HSL for 10^{-6} cancer risk from non-limiting HSL.** 1) The non-limiting HSLs are presented in Friebel & Nadebaum 2011 (Part 1). 2) The derived HSLs are presented in Appendix F. 3) Find the pages that correspond to the source type (soil, groundwater, soil vapour) for the given scenario (residential / commercial / recreational / intrusive maintenance). Note indicator chemicals and TPH have been separated. 4) For the corresponding soil category, depth and chemical, the Vapour Intrusion HSL and saturation/solubility concentration is presented in the columns on the right. 5) If this HSL is divided by 10 and the result is greater than Csat (for soil) or saturation limit (for groundwater), then the revised HSL is still NL. Otherwise the result is the revised Vapour HSL.		
Cumulative cancer risk (Refer to Section 3.6.1 of Application Document) HSLs for benzene have been based on 1 x 10^{-5} cancer risk. In most jurisdictions it is required to assess total carcinogenic risks based on 1 x 10^{-5} cancer risk. If HSLs are not NL for benzene and another carcinogenic chemical is identified, such as PAHs, follow the proedure outlined in Section 3.6.1. The-cumulative fraction may also be applied to more than two chemicals. Note that multiple sources should be considered. For example, a resident may be exposed through direct contact with PAHs in surface soil, but also benzene vapours from soil and groundwater. For vapour risk (benzene), the risk contribution should consider the greatest risk for the receptor from all vapour sources. Because multiple sources do not have an additive effect, the source with the greatest risk needs to be identified (refer to Section 3.5 for discussion on multiple vapour sources). This means that for all sources/depths the source concentration should be divided by their respective HSLs to calculate the benzene contribution to cumulative risk. The highest fraction determines which source poses the greatest risk to receptors. The same may be carried out for carcinogenic PAHs. The sum of the highest benzene fraction and the highest PAH fraction results in the highest possible cumulative fraction.		

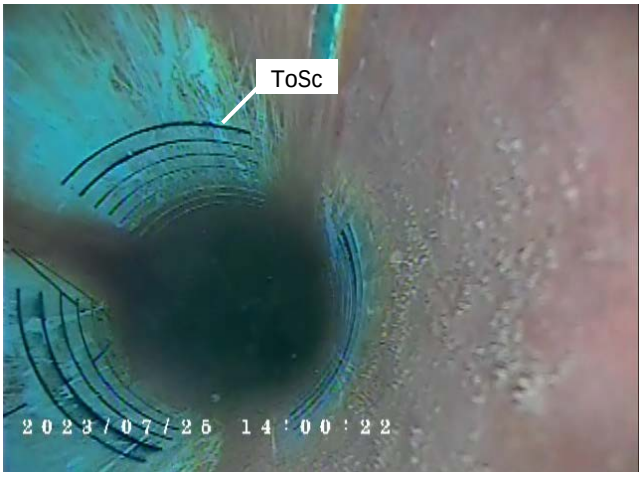
Appendix C – Site Photographs

SB1 soil profile.


SB1 location and soil characteristics.

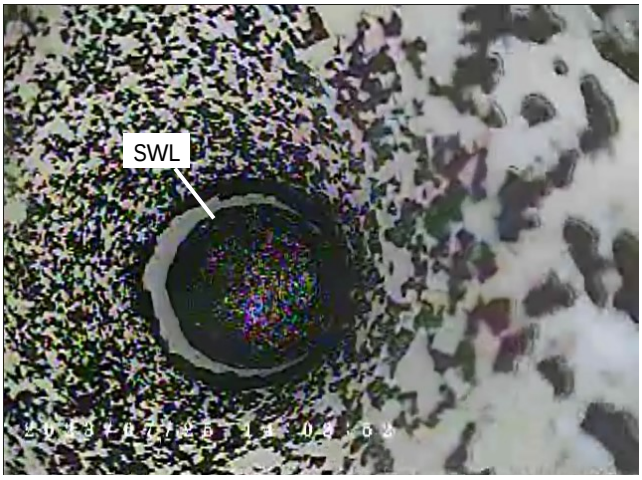


AB1S standing water level (SWL) 23.070 metres below top of casing (m btoc).



AB1S top of screened interval (ToSc) 30.8 m btoc.

AB1S debris build up on casing wall and bottom of well.



AB1D insect debris build up on casing wall above SWL at 21.780 m btoc.

AB1D insect debris build up on casing wall below SWL.

AB1D ToSc at 67.0 m btoc.

AB1D debris build up on casing wall and bottom of well.

VNB4S casing join showing PVC cement.

VNB4S casing below SWL of 30.686 m btoc.

VNB4S ToSc at 36.6 m btoc.

VNB4S bottom of well of 42.3 m btoc.

VNB4D insect debris at dry casing join 6.7 m btoc.

VNB4D blank casing condition.

VNB4D debris below SWL at 30.956 m btoc.

VNB4D ToSc at 66.9 m btoc.

VNB4D bottom of well at 78.4 m btoc.