

ENVIRONMENTAL AUDIT REPORT

**1-5 Ballarat Road
NORTH GEELONG, VIC**

**EPA CARMS Ref 74722-2
EPA Service Order Number 8005814**

**Prepared for
B.I.M. Investments Pty Ltd**

Date: 13 May 2019



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DOCUMENT CONTROL

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Approved by	13 May 2019  Steven Jon Kirsanovs Environmental Auditor (appointed pursuant to the Environment Protection Act 1970)	

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0	Final	13 May 2019	SJK / RH	SJK

Rev No	Copies	Recipient
0	2 x CD (audit report, Statement, appendices)	Mick Nikolovski, [authorised representative of B.I.M. Investments Pty Ltd]
0	1 x CD (audit report, Statement, appendices) 1 x hardcopy of audit report, key figures and tables, and Certificate	Manager – Environmental Audit EPA Victoria
0	1 x CD (audit report, Statement, appendices)	Principal Town Planner Greater Geelong City Council

EXECUTIVE SUMMARY

This is an environmental audit report for the site known as 1-5 Ballarat Road, North Geelong, Victoria, which has been completed by Mr. Steven Kirsanovs of Kirs Environmental, in his capacity as an environmental auditor (contaminated land) appointed by the Environment Protection Authority Victoria ('EPA') pursuant to the *Environment Protection Act 1970*. The audit details and outcomes are summarised in the table on the following pages.

Table 1: Summary of Audit Information

Auditor	Steven Kirsanovs
Auditor account number	75624
Auditor term of appointment	25/11/2018 to 25/11/2020
Auditor's appointment category	CL
Audit type	53X
Date EPA notified of audit	07/06/2018 An audit was originally commissioned July 2016 by Investco No.1 Pty Ltd but was terminated in February 2018 as plans to develop the site had ceased. Subsequently, the site was sold to B.I.M. Investments Pty Ltd (B.I.M.) and a new audit was commissioned in June 2018.
Audit service order number	8005814
Name of person requesting audit	Mick Nikolovski of B.I.M Investments Pty Ltd EPA customer account number not available.
Relationship of person requesting audit to site	Site owner / developer
Name of premises owner	B.I.M. Investments Pty Ltd
Date of auditor engagement	04/06/2018
Completion date of the audit	13/05/2019
Reason for audit	Planning System
Audit categorisation	Risk
Environmental segments	Air, Land, Groundwater, Surface water
If the audit was required by an EPA notice, licence or other, please provide EPA reference number	Not applicable
Current land use zoning	General Residential Zone – Schedule 1 (GRZ1) Special Use Zone – Schedule 3 (SUZ3) (along northern section of the site)
EPA Region	South West
Municipality	Greater Geelong City Council
Dominant lot on title plan	Lot S31 on PS647500
Additional lot(s) on title plan(s)	

Site/Premises name	1 – 5 Ballarat Road, North Geelong, Victoria													
Building/complex sub-unit/lot No.														
Street/Lot – Lower No.	1													
Street/Lot – Upper No.	5													
Street Name	Ballarat													
Street type (road, court, etc.)	Road													
Street suffix (North, South etc.)														
Suburb	North Geelong													
Postcode	3215													
GIS Coordinate of Site centroid														
Latitude (GDA94)	38.13060													
Longitude (GDA94)	144.34306													
Site area (in square metres)	6277 m ²													
Plan of site/premises showing the audit site boundary attached	Yes. Included in Appendix A.													
Plan of site/premises showing the audit site boundary attached in a spatial data format	Attached in electronic copy.													
Members and categories of support team utilised	None required.													
Further works or requirements	Statement issued with conditions requiring provision and maintenance of a barrier over site soils. Another environmental audit is required if any future development involving a basement is proposed. Groundwater is polluted and must not be extracted unless it is first tested and confirmed suitable for intended use.													
Nature and extent of continuing risk	None, on proviso that the Statement conditions are implemented.													
Outcome of the audit	Statement													
Has EPA determined CUTEP at this site?	No													
Has the auditor determined CUTEP at this site?	Yes													
Has a GQRUZ been identified at the site/beyond the site by EPA?	No, but the audit report and Statement has recommended for EPA to declare the site to be a GQRUZ.													
Does NAPL remain at the site?	No													
Please indicate which of the Protected Beneficial Uses of groundwater are precluded due to pollution	e.g. including site-sourced and regional pollution. <table border="1"> <thead> <tr> <th>Protected Use</th> <th>Precluded?</th> </tr> </thead> <tbody> <tr> <td>Water dependent ecosystems and species</td> <td>Yes (on-site only)</td> </tr> <tr> <td>Potable Water Supply (Desirable)</td> <td>N/A</td> </tr> <tr> <td>Potable Water Supply (Acceptable)</td> <td>N/A</td> </tr> <tr> <td>Potable Mineral Water Supply</td> <td>Yes</td> </tr> <tr> <td>Agriculture and Irrigation (Irrigation)</td> <td>N/A</td> </tr> </tbody> </table>		Protected Use	Precluded?	Water dependent ecosystems and species	Yes (on-site only)	Potable Water Supply (Desirable)	N/A	Potable Water Supply (Acceptable)	N/A	Potable Mineral Water Supply	Yes	Agriculture and Irrigation (Irrigation)	N/A
Protected Use	Precluded?													
Water dependent ecosystems and species	Yes (on-site only)													
Potable Water Supply (Desirable)	N/A													
Potable Water Supply (Acceptable)	N/A													
Potable Mineral Water Supply	Yes													
Agriculture and Irrigation (Irrigation)	N/A													

	Agriculture and Irrigation (Stock watering)	Yes
	Industrial and Commercial	Yes
	Water-based recreation (Primary contact recreation)	Yes
	Traditional Owner cultural values	Yes (onsite only)
	Cultural and spiritual values	Yes (onsite only)
	Buildings and structures	No
	Geothermal properties	N/A

Historical land use	Geelong Golf Course car park.
Current land use	Vacant
Proposed future land use	Childcare centre and sports rehabilitation centre and associated car parking.
Surrounding land use – north	Golf Course
Surrounding land use – south	Midland Highway (A300) with low density housing further north.
Surrounding land use – east	Geelong Table Tennis Centre, with a sports ground and low-density residential land further east.
Surrounding land use – west	Ballarat Road then low-density residential land further west.
Proposed land use zoning	General Residential Zone – Schedule 1 (GRZ1).
Nearest surface water receptor – name	Corio Bay
Nearest surface water receptor – distance (m)	Approx. 1.1 km
Nearest surface water receptor – direction	East
Likely point of groundwater discharge	Corio Bay
Site aquifer formation	Tertiary Pliocene Moorabool Viaduct Sands.
Groundwater flow direction	Inferred East-northeast
Groundwater TDS range (mg/L)	Approx. 3,501 – 7,000 mg/L
Groundwater Segment	C
Are there multiple aquifers impacted by pollution at the site	No
Perched groundwater depth – upper (metres below ground level (mbgl))	Localised perched water was observed at a depth of approximately 4.0 mBGS at two sampling locations (TP2 and TP4) and correlating with the location of an in-filled gully, orientated north-south in eastern portion of the site.
Perched groundwater depth – lower (mbgl)	-
Regional groundwater depth – upper (mbgl)	5 m
Regional groundwater depth – lower (mbgl)	10 m
Number of bores within 2 km	73 registered bores identified on Visualising Victoria's database (August 2016).

Closest extractive use (distance in m)	Approx. 1 km E. Bore listed as 'domestic'. Records indicate bore was drilled in 1983 to a depth of 15.85m
Zone of groundwater plume influence (m from site boundary)	N/A. No plume/s identified.
Year groundwater last monitored	N/A. No direct investigation at site.
Have you attached electronic copies of Current Groundwater Analytical Results presented as a summary table?	Yes (submitted electronically on EPA portal)

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Appendix C	Site History and Work Plan (Aug 2016)
Appendix D	ESA Report (Dec 2018)
Appendix E	ESA Report Addendum (Feb 2019)
Appendix F	Auditor Communications / Reviews

LIST OF ABBREVIATIONS / TERMS

ADWG	Australian Drinking Water Guidelines
All	Agriculture and irrigation (irrigation)
AIS	Agriculture and irrigation (stock watering)
ANZECC	Australian and New Zealand Environment and Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
ASC NEPM	National Environment Protection (Assessment of Site Contamination) Measure
ASS	Acid sulfate soils
BaP	Benzo(a)pyrene
BPEM	Best practice environmental management
BTEX	Benzene, toluene, ethylbenzene and xylene compounds
BGS	Below ground surface
CASS	Coastal acid sulfate soils
CoEA	Certificate of Environmental Audit
CIRIA	Construction industry research and information association
CRC CARE	Co-Operative Research Centre for Contamination and Remediation of the Environment
CSM	Conceptual site model
CSV	Cultural and spiritual values
DNAPL	Dense non-aqueous phase liquid
EC	Electrical conductivity
EP Act	Environment Protection Act 1970
EPA	Environment Protection Authority
EIL	Ecological investigation level
ESA	Environmental site assessment
GQRUZ	Groundwater quality restricted use zone
HIL	Health investigation level
HSL	Health screening level
LNAPL	Light non-aqueous phase liquid
NAPL	Non-aqueous phase liquid
NEPC	National Environment Protection Council
NEPM	National Environment Protection Measure
NHMRC	National Health and Medical Research Council
OCP	Organochlorine pesticide
OPP	Organophosphate pesticide
PAH	Polycyclic aromatic hydrocarbon
PASS	Potential acid sulfate soils
PID	Photoionisation detector
PSH	Phase separated hydrocarbon
SEPP	State environment protection policy
SoEA	Statement of Environmental Audit
SPOCAS	Suspension peroxide oxidation combined acidity and sulfur
SWL	Standing water level
TDS	Total dissolved solids
TKN	Total Kjeldahl nitrogen
TOC	Total organic carbon
TOCV	Traditional Owner cultural values
TPH	Total petroleum hydrocarbons
US EPA	United States Environment Protection Agency

UST	Underground storage tank
VOC	Volatile organic compound
WBR	Water-based recreation (primary contact recreation)
WDE	Water dependent ecosystems and species
WHO	World Health Organization

1. INTRODUCTION

1.1 Background

This is an environmental audit report for the site known as 1-5 Ballarat Road, North Geelong, Victoria ('the site'), which has been completed by Mr. Steven Kirsanovs of Kirs Environmental Pty Ltd ('the auditor'), in his capacity as an environmental auditor (contaminated land) by Environment Protection Authority Victoria ('EPA') pursuant to the *Environment Protection Act* (Vic) 1970. The location of the site is presented in Figure 1.

An audit was originally commissioned July 2016 by Investco No.1 Pty Ltd but was terminated in February 2018 as plans to develop the site had ceased. Subsequently, the site was sold to B.I.M. Investments Pty Ltd (B.I.M.) and a new audit was commissioned in June 2018. B.I.M Investments Pty Ltd intend to redevelop the site as a sports rehabilitation centre and child care centre. An environmental audit of the site is required as a condition of the re-zoning and redevelopment process.

The environmental audit was undertaken in accordance with Part IXD of the Act, and specifically Sections 53W and 53X which relate to an audit of the condition of a segment of the environment (the relevant segment being the site). The audit is an independent review of the information relating to the condition of the site, in particular whether there is historical contamination at the site, the significance of any such contamination, and the potential for adverse impacts on beneficial uses of the site. Relevant legislation, guidelines and standards current at the time of the audit are referenced in Section 5 of this audit report.

If the environmental audit finds there is no contamination at the site that is detrimental (or potentially detrimental) to any (relevant) beneficial use of the site, then a Certificate of Environmental Audit is issued. If the environmental audit finds there is contamination at the site that is detrimental (or potentially detrimental) to any (relevant) beneficial use of the site, then a Statement of Environmental Audit is issued, which identifies what uses the auditor considers the site is suitable for, and any associated conditions that might be necessary for protection of human health or the environment.

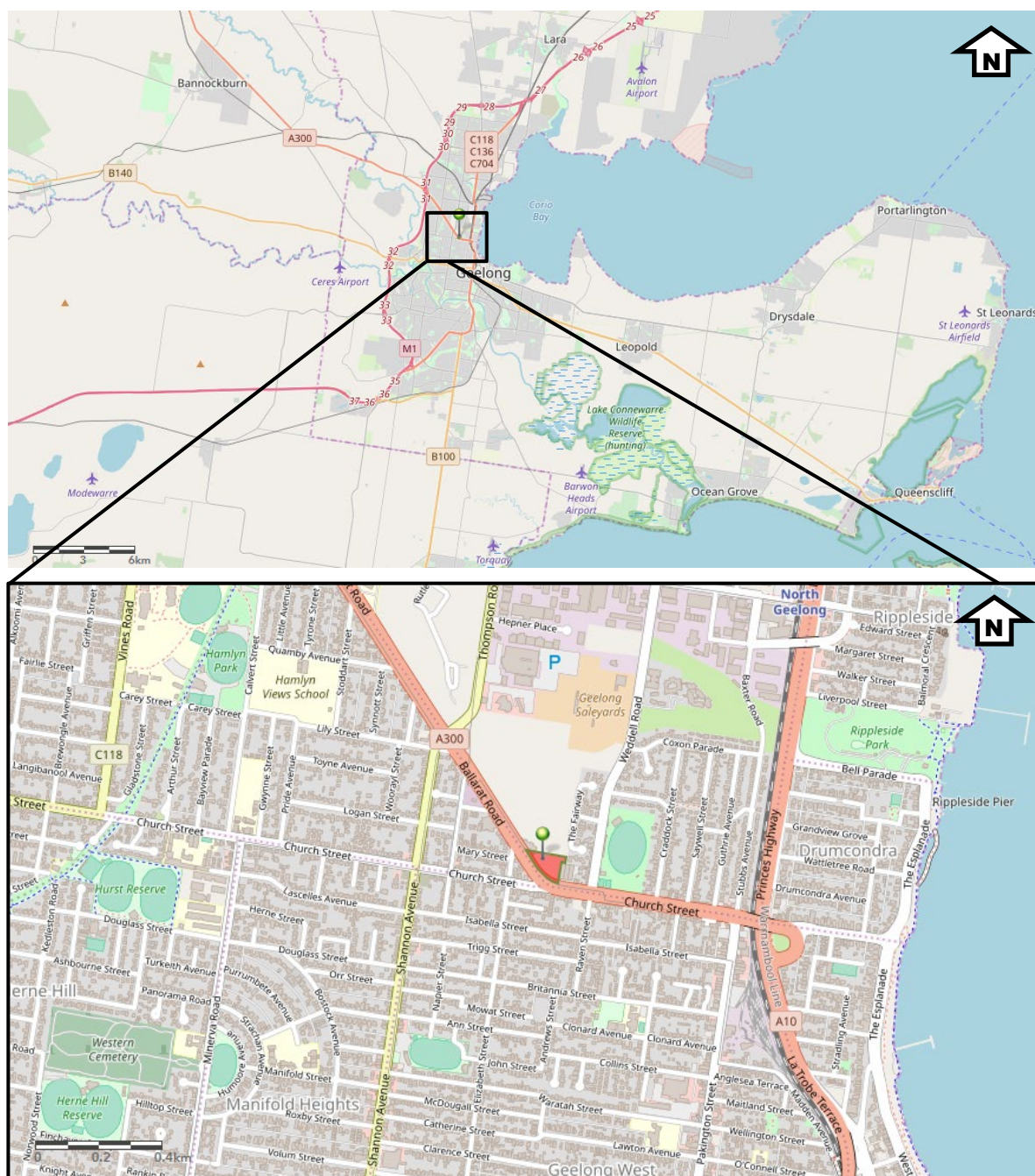


Figure 1. Site Location

1.2 Reports / Documentation

The audit of the condition of the site has been based on the reports as listed below.

Table 2: List of Reports

Report / document title	Prepared by	Date	Copy provided in audit report
<i>Site History Review and Work Plan: 1 – 5 Ballarat Road, North Geelong Vic</i>	Compass Environmental Pty Ltd	26 August 2016	Appendix C
<i>Environmental Site Assessment, 1 – 5 Ballarat Road, North Geelong VIC</i>	Compass Environmental Pty Ltd	21 December 2018	Appendix D
<i>Environmental Site Assessment: 1 -5 Ballarat Road, North Geelong VIC (Addendum)</i>	Compass Environmental Pty Ltd	11 February 2019	Appendix E

1.3 Audit Activities

The sequence of the main activities conducted by the auditor is summarised below: -

- The audit was originally commissioned on behalf of Investco No.1 Pty Ltd. EPA Victoria was formally notified of the auditor's engagement on 29 November 2017. On 6 February 2018, notification of termination of the audit was provided to EPA Victoria, due to the planned site redevelopment being within the scope of the General Residential Zone (GRZ1) requirements and therefore an audit was not required under the local planning scheme for the development, as proposed.
- The site was divested by Investco No. 1 Pty Ltd on 20 September 2017 and the auditor was subsequently engaged by B.I.M. to undertake an audit of which EPA Victoria was notified on 7 June 2018, for redevelopment of the site for a proposed childcare centre and sports rehabilitation facility.
- Between September 2016 and September 2018, assessment works were undertaken by Compass Environmental Pty Ltd. Reporting of these works and associated environmental assessments were provided. Interim reviews were completed and the reporting was updated to address comments and queries from the auditor.
- Notification for Auditor Determined CUTEF was submitted to EPA Victoria on 12 December 2018.
- Review by the auditor of additional requested information provided by Compass during January and February 2019 (Compass Addendum information dated 11 February 2019).
- The audit report was finalised in May 2019, with copies provided to the EPA, the planning authority (City of Greater Geelong) and B.I.M. (the instructing party).

Further details of the assessment and remediation works are provided in this audit report.

2. SITE INFORMATION

2.1 Site Identification and Ownership

The legal property identification for 1-5 Ballarat Road, North Geelong is Lot S31 on PS647500 (CT Volume 11588 Folio 505). The majority of the site is located in a 'General Residential Zone (GRZ1)' except for the northern portion which is within a 'Special Use Zone (SUZ3)'. The site is currently owned by B.I.M. Investments Pty Ltd.

2.2 Site Description and Conditions

The Site is irregular in shape and covers approximately 6,277m². At the time the audit was commissioned (August 2016), the site was vacant land with asphalt hardstand remaining in the western portion of the site and grassed/unsealed surface in the eastern portion. No buildings or structures (with the exception of metal fencing) were present on the site. The conditions have not changed appreciably since then.



Figure 2. Site Photographs (2018)

2.3 Proposed Future Use

The site is intended to be re-developed for a childcare facility, sports rehabilitation centre and associated car parking. It is understood that stormwater drainage infrastructure will also be upgraded as part of the overall stormwater management strategy for this part of Geelong.

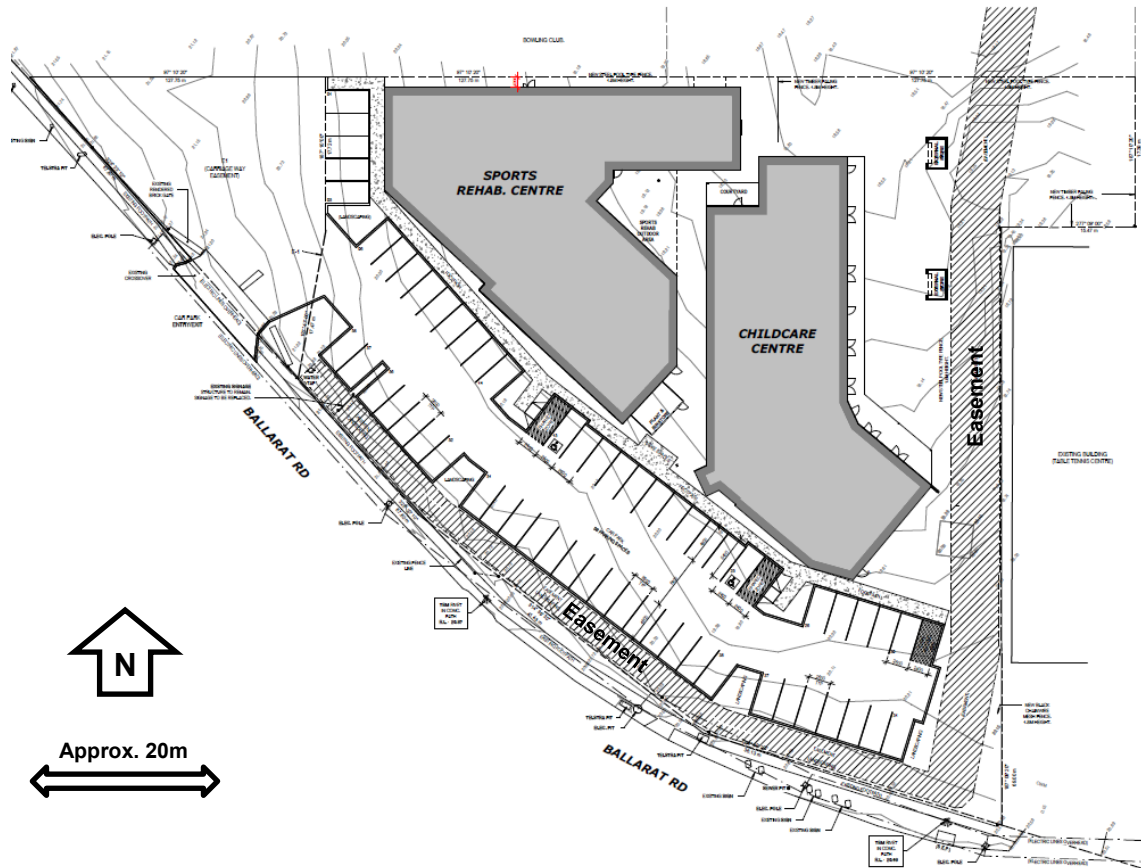


Figure 3. Proposed site development – concept layout

3. ENVIRONMENTAL SETTING

3.1 Location and Surrounding Use

The site is located in North Geelong, approximately 2.5km north west of the Geelong city centre. The land in the area has a gentle downward slope towards the north-east with an elevation of approximately 23 – 25mAHD.

The site was originally part of the Geelong Golf Course, and the remainder (majority) of the golf course remains on the adjacent land to the north west. At the time of completion of the audit, construction of the Geelong Bowls Club had also commenced on adjacent land to the north east. The properties to the west of the site along Ballarat Road include low density residential housing and a former service station (108 Church St) (now Totalcare IT, a computer servicing and repair business). The Geelong Table Tennis Centre is to the east of the site with residential beyond and Church Street/Midland Highway to the south and further low-density residential housing beyond.

The local stormwater from areas south of Ballarat Road is collected in underground drains that run through a drainage easement in the eastern portion of the site via an underground pipe and surface flow. The stormwater is then diverted to an ephemeral watercourse located on the north side of the golf course, which then drains into Corio Bay. As noted previously, it is understood that the stormwater drainage will be upgraded in parallel with the site redevelopment as part of the City of Geelong's over-arching stormwater management plan for this area.



Figure 4. Surrounding Land Use

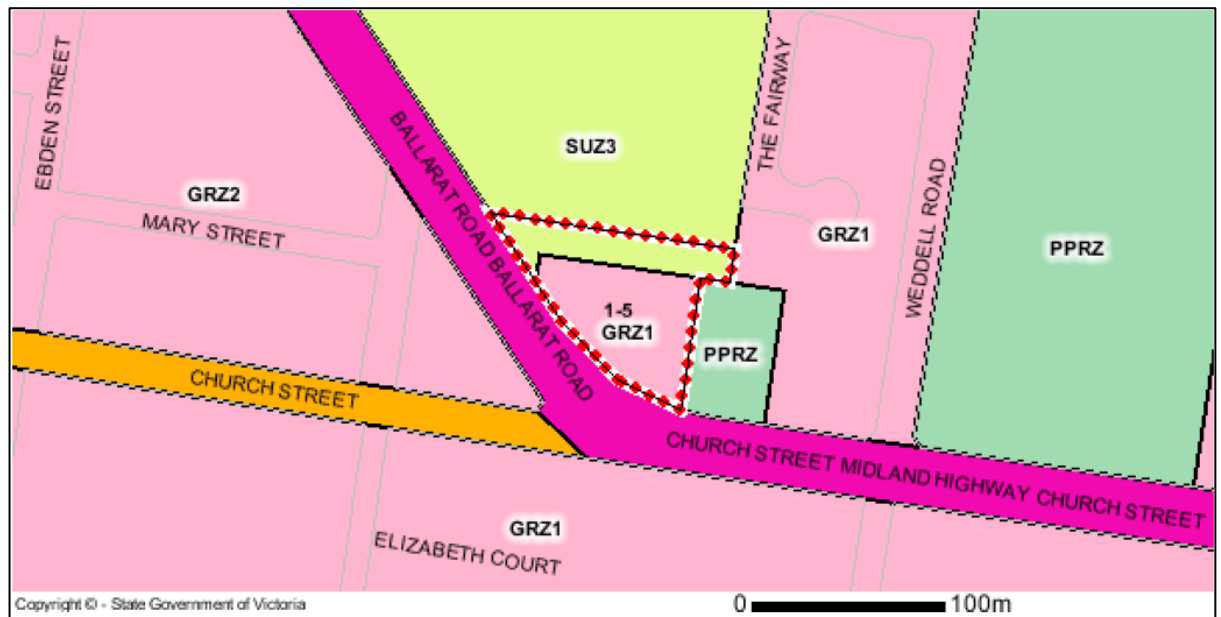


Figure 5. Surrounding Land Use / Zoning (Source:- DEWLP)

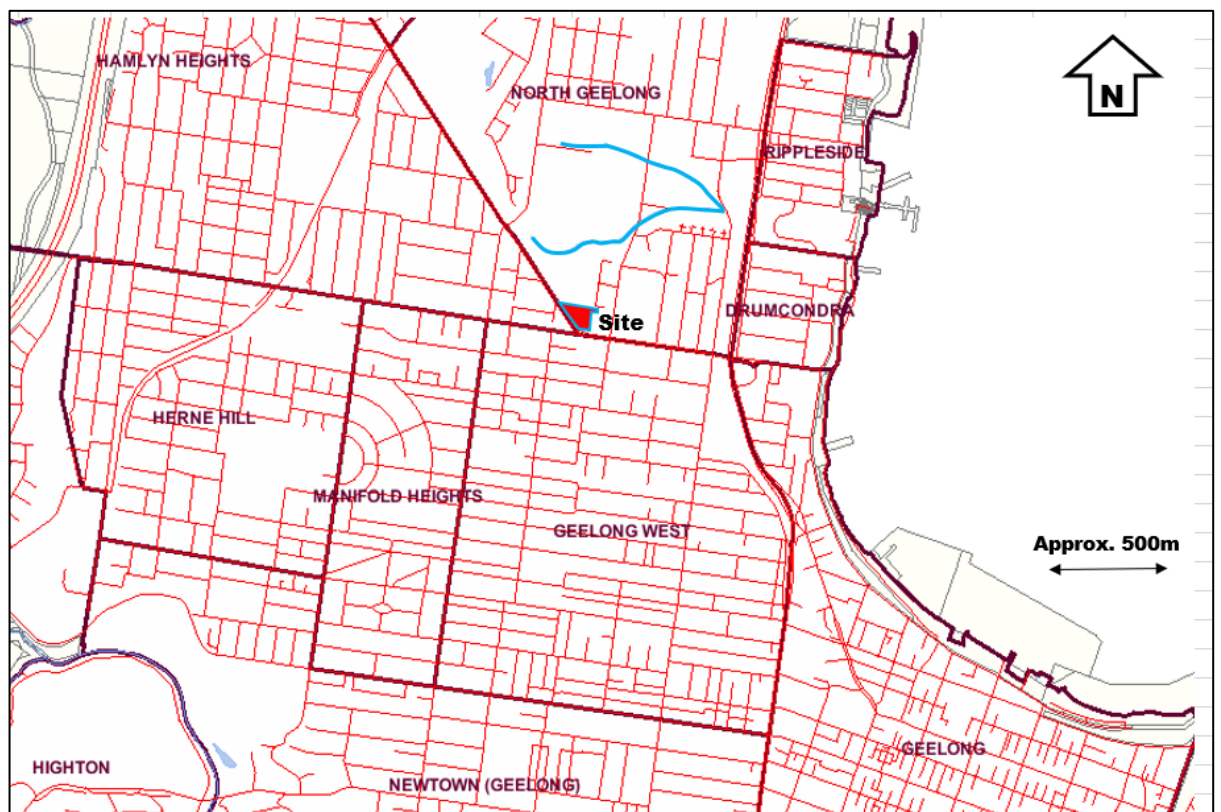


Figure 6. Watercourses and Drainage (Source:- Land Channel Interactive Map Tool)

3.2 Regional Geology and Hydrogeology

Compass Environmental reviewed the Geological Survey of Victoria 1:63,360 series Geelong Map sheet which indicated the surface geology is Tertiary Pliocene Moorabool Viaduct Sands (Mv). These reportedly comprise calcareous sand, clayey sand, quartzite, ferruginous sand and gravel. Approximately 1km west of the site is mapped as the basalts of the Newer Volcanics formation.

Regionally, groundwater has been intersected between 5 – 10mBGS and has a salinity between 3,500 and 7,000mg/L. This would place groundwater under Segment C (3,501 to 13,000mg/L), according to SEPP (Waters). Groundwater movement is expected to follow the local topography, with an east / north east gradient towards Corio Bay.

3.3 Site Specific Geology & Hydrogeology

A layer of fill was encountered across the site, and was reported by Compass to vary up to approximately 1m depth across the western and central portions of the site. A thicker layer of fill was noted in the eastern portion of the site, correlating with a backfilled gully indicated on historical aerial photographs, and also possibly associated with past installation of underground stormwater infrastructure in the drainage easement in that part of the site.

The fill was characterised as fine to coarse grained silty sand, sandy clays, silty clay and clayey sand with rounded to angular gravels and minor organic matter. The fill also included secondary constituents of brick, concrete, metal and glass fragments, crushed rock, wood and ash. Some larger fragments of concrete and basalt were encountered in the deeper fill present in the eastern portion of the site. Materials suspected or known to contain asbestos have not been noted during any of the phases of investigation.

The underlying natural soils at the site have been described as sandy silty clay, clayey sand with fine-grained rounded gravels and fine to coarse grained sands. This is consistent with the expected regional geological information.

Water was encountered in loose fill and brick at the base of two test pits excavated in the eastern portion of the site - TP2 (approx. 4.0m depth) and TP4 (approx. 4.5m). This water was interpreted by Compass as localised perched water within the backfilled gully or associated with the existing underground stormwater infrastructure in that part of the site. Groundwater was otherwise not intersected during the site assessment works and no direct groundwater assessment was undertaken.

3.4 Groundwater Use

The DSI Report (Compass, December 2018) included results of a search of the Visualising Victoria's Groundwater (VVG) online database from August 2016, which identified 74 bores within a 2km radius of the site. The listed uses were as follows:-

- Domestic (1).
- Investigation (37).
- Observation (26).
- Non-groundwater (1)
- Unknown (8).

The majority of registered bores in the search radius are either investigation or monitoring bores. There is very limited indication of groundwater extraction / use, with only a single domestic bore identified, approximately 1km south east. The database indicates the bore was drilled for domestic purposes in 1983 to a depth of 15.9m. The auditor completed a confirmatory search in January 2019 over a 2km search radius, which identified the same bore as the only registered potential extraction bore listed in the study area.

4. HISTORICAL INFORMATION

4.1 Site History

The *Site History Review and Work Plan* (Compass Environmental, August 2016) includes a summary of the site's history, noting that it was part of the Geelong Golf Club since at least the 1940's. During the period the site was part of the golf course, it was primarily a car park. The historical review was based on the following information:-

- **Historical land titles.** Site was owned by Geelong Golf Club prior to being acquired by Links Investco No.1 Pty Ltd in 2004, and then B.I.M. Investments Pty Ltd in September 2017.
- **Historical aerial photographs** (1947, 1963, 1970, 1984, 1990, 2002, 2013 and 2015). The majority of the site appeared to be the entrance and car park to the Golf Course and remained largely unchanged around 2002 when the surface was covered with asphalt. 2 rectangular buildings appeared in the early 1940's and 1984 partially encroaching onto the northern portion of the site, both of which are no longer visible in the 2013 photographs.
- **Review of Royal Historical Map and Sands and McDougal records.** Sands and MacDougall directory listing show the site as part of the Geelong Golf Links from the early 1990's. A 1905 plan also shows the site as part of the Geelong Golf Links. Other archive plans show the adjacent land to the north east was originally part of the Geelong cattle yards but was eventually redeveloped for housing, with land to the east being part of the Housing Commission and church owned housing.
- **Enquiry to Local Water Authority.** The sewage and drainage plans indicate that underground utilities currently within the site are limited to a stormwater drainage pipe in the eastern portion.
- **Enquiry to Local Council.** On historical information in relation to the site was available.

Although the site was primarily a car park, there were two buildings that partially encroached onto the audit site which has been subdivided off from the remainder of the former golf club property. This included part of the former clubroom in the north west, and a storage shed in the north.

The auditor also noted the property across Ballarat Road (108 Church Street) had the appearance that it may have formerly been a service station and requested further information. Compass Environmental confirmed via title and archive sewer plans that the property was a former service station until the 1970's. The auditor has also located Sands and McDougall directory listings which show there was a service station present on that property from the 1940s to 1970s.

4.2 EPA Information / Records

The following information was reviewed using the online databases and records on the EPA website:-

Priority Sites and Groundwater Quality Restricted Use Zones. Compass Environmental reported that no sites within close vicinity of the site were listed on the EPA Victoria priority sites register (PSR). A search by the auditor identified the following sites (on PSR, updated 31 December 2018) listed: -

- Site 009000922: 35-37 Shannon Avenue, Manifold Heights, approximately 440m W-SW of the site being a former service station requiring ongoing management.
- Site 0090001664: 1-39 Roseneath St, Geelong North, approximately 1.1km north west of the site being a former chemical storage facility requiring ongoing management.

EPA Victoria list of sites for which certificates or statements of environmental audit have been issued. Compass Environmental identified 4 environmental audits within a 750m radius of the site, while the auditor identified previously completed audits at 12 sites within 1km of the site.

- **57 Church St, Geelong West (EPA CARMS 46232-1, SoEA). Approximately 275m E of the site (2004).** Former service station and mechanic. Features noted included 11 USTs, hydraulic hoist, vehicle pit and triple interceptor trap. Groundwater was reportedly encountered between 5.1m and 6.1m depth. Multiple rounds of groundwater monitoring were undertaken on bores located on and offsite monitoring wells located on and offsite. Groundwater was assessed as Segment C (superseded SEPP (Groundwaters of Victoria)) and TPH, ethylbenzene and xylene impacts were identified in a plume identified offsite and down-gradient to the east towards Corio Bay. EPA confirmed that groundwater pollution had been cleaned up “to the extent practicable”, and a Statement of Environmental Audit was ultimately issued with a requirement for ongoing groundwater management.
- **151-153 Church Street, North Geelong (EPA CARMS Ref 68842-1, SoEA). Approximately 370m W of the site (2012).** Former service station and workshop. Features noted included lubricant bay, 6 USTs and triple interceptor trap. Groundwater was assessed as segment C (superseded SEPP (Groundwaters of Victoria)), with groundwater present between 7m and 11m depth. Inferred groundwater flow was E-NE towards Corio Bay, with the site assessment including a monitoring well network of 51 onsite and offsite wells. Groundwater was identified to be impacted by TPH, BTEX, lead, PAH and phenols and LNAPL was historically present onsite. Extensive remediation was completed and eventually EPA confirmed that groundwater pollution had been cleaned up “to the extent practicable”. A Statement of Environmental Audit was issued with a requirement for ongoing groundwater management. A GQRUZ was imposed to the east of the site, however it does not encumber the site itself.
- **10 – 12 Britannia Street, Geelong West (EPA CARMS Ref 55167-1, SoEA). Approximately 530m SE of the site (2004).** Formerly a council depot, with infrastructure including 2 USTs, an above ground kerosene tanks and wash bay, all decommissioned and removed by 1995. One groundwater monitoring well was installed at the site, with groundwater encountered at approximately 8.5m depth. Groundwater was assessed as

segment D (superseded SEPP (Groundwaters of Victoria)), and trace levels of TPH (C₁₀-C₁₄) (45µg/L) were identified in groundwater, with all other groundwater analysis undertaken below LOR. Imported fill was present across the site and a Statement of Environmental Audit was issued with a condition requiring provision of barriers preventing direct access to soils.

- **59-65 Britannia Street, Geelong West (EPA CARMS Ref 28143-1). Approximately 400m S of the site (1997).** Formerly a Telstra depot, with a UST and hoist area. No intrusive groundwater investigation was undertaken, depth to groundwater was inferred to be approximately 10mBGS. A Certificate of Environmental Audit was issued for the site.
- **17 Isabella Street, Geelong West (EPA CARMS Ref 51158-1, SoEA), approximately 600m SE of the site (2003).** Former council depot carpark. Standing water level was reported at 8.3m depth and groundwater was assessed as segment C (superseded SEPP (Groundwaters of Victoria)). Elevated heavy metals (manganese and nickel) were identified in fill across the site. Copper, selenium and cyanide concentrations in groundwater exceeded the adopted trigger values (exact concentrations unknown as assessors report not provided as a part of the database). Statement of Environmental Audit issued with conditions requiring provision and maintenance of barriers to prevent direct access to soils.
- **9-13 Collins Street, Geelong West (EPA CARMS Ref 68323-1). Approximately 750m SE of the site (2011).** Formerly a rope works, brick factory, delicacy company, residence and supermarket with carparking. Shallow layer of fill found to be impacted by metals (arsenic) and also PAH's. Three groundwater monitoring wells were installed with depth to groundwater reported between 7m and 8m depth, with groundwater directional flow toward Corio Bay to the SE. Elevated concentrations of boron, copper, selenium, sodium, chloride and nitrate were present in groundwater and attributed by the auditor to be naturally occurring concentrations or potentially a sewer located to the north of the site boundary.
- **8 Donaghy Street, West Geelong (EPA CARMS Ref 69382-1). Approximately 780m SE of the site (2011).** The site formed part of the Donaghy rope factory. No direct groundwater assessment was undertaken as a part of the site audit. A Certificate of Environmental Audit was issued for the site.
- **5-9 Donaghy Street, West Geelong (EPA CARMS Ref 68289-1). Approximately 790m SE of the site (2011).** The site formed a part of the Donaghy rope factory, with 10 USTs removed from the site. Groundwater was encountered at 7-8m depth. Historical fill was present on the site with identified elevated concentrations of arsenic, copper, nickel and TPH. Groundwater was found to contain elevated nitrate, nitrite and selenium (deemed to be associated with a leaking sewer near the site, and boron, chromium, chloride, copper, sodium and zinc determined likely to be naturally elevated. A Statement of Environmental Audit was issued with a condition requiring maintenance of a cap to limit site soil exposure and a prohibition on extractive water use.
- **7 Sargeant Street, West Geelong (EPA CARMS Ref 71550-1). Approximately 840m S of the site (2013).** The site was grazing land which formed part of the former rope factory. No groundwater investigation was undertaken. Certificate of Environmental Audit issued for the site.
- **9 Scarlett Street, West Geelong (EPA CARMS Ref 75261-1). Approximately 850m S of the site (2018).** The site was the rope walk building for the former Donaghy Rope

factory. No intrusive groundwater investigation was undertaken. Fill onsite was identified to contain elevated concentrations of barium, chromium (total), copper, manganese, vanadium, zinc and an elevated pH.

- **Former Geelong Abattoir, North Geelong (EPA CARMS Ref 25879-1). Approximately 600m NE of the site (1995).** Features noted at this site included holding yards, the processing building, a boiler house, diesel tanks, and liquid treatment tanks. Groundwater was encountered at 6m depth and was sampled and analysed for a range of indicators for petroleum products and volatile halogenated compounds. All groundwater monitoring analysis results were below laboratory limits of reporting for TPH, MAH, PAH and halogenated volatile organics. A Certificate of Environmental Audit was issued for the site.
- **Rippleside Quay, North Geelong (EPA CARMS Ref 60418-2). Approximately 1.4km NE of the site (2008).** The site was historically used for shipbuilding and maintenance. Infrastructure included a sewerage pump house, workshops and maintenance areas, fuel and oil storage and USTs. Groundwater was identified to contain elevated concentrations of selenium, arsenic, boron, and cyanide. Depth to groundwater ranged from 1.7 – 2.7m depth reflecting the site's location adjacent to the coast. A Statement of Environmental Audit was issued requiring maintenance of a barrier over site soils and for a soil management plan to be prepared for any excavation works.



Figure 7. Environmental Audit Reports completed in area and other sites of interest

4.3 Potential Historical Contamination

The following table provides an overview of potential historical contamination sources and contaminants of concern onsite, as identified by DSI Report (Compass, December 2018). Overall, the auditor considers the listing of potential contamination sources and contaminants of concern to be reasonable for onsite sources based on the available information. The original historical review and work plan did not identify the former service station across Ballarat Road (108 Church Street) as a potential source of contamination. The potential for impacts from the former service station was subsequently considered in later stages of the site investigations. The potential contaminants of concern associated with a service station were not listed in the assessment reports and have been listed by the auditor below.

Table 3. Potential Historical Contamination

Sources	Contaminants of potential concern	Potentially affected media	Likelihood
Sources. Onsite.			
Historical filling.	Various contaminants depending on origin of the fill. Commonly identified contaminants include:- metals, petroleum hydrocarbons, polycyclic aromatic hydrocarbons (PAH), and asbestos containing material (ACM).	Generally only soils, unless certain highly soluble and / or volatile organic chemicals are involved, and if the fill materials are in close proximity to groundwater.	Low to moderate potential
Demolition waste from former buildings	Mainly asbestos containing materials	Potentially present in fill materials	Low to moderate potential
Historical use of the site for car parking (oil and fuel leaks from parked cars).	Commonly identified contaminants include:- petroleum hydrocarbons, lead and BTEX.	Soil, soil vapour.	Low potential
Sources. Offsite.			
Former service station site located SW of the site boundary.	Various contaminants depending on specific site operations. Commonly identified contaminants include:- petroleum hydrocarbons, BTEX, PAH, and other solvents (including chlorinated compounds).	Groundwater, soil vapour.	Low to moderate potential

5. BENEFICIAL USES AND AUDIT CRITERIA

5.1 Relevant Elements and Beneficial Uses

The beneficial uses of the site considered for this audit included (but were not limited to) the beneficial uses for land [as outlined in State Environment Protection Policy ('SEPP') *Prevention and Management of Contamination of Land (PMCL)*], groundwater and surface water (as outlined SEPP *Waters*), and air (as outlined in SEPP *Ambient Air Quality*). Further details of the beneficial uses of the main elements (land, surface water and groundwater) are provided in the following paragraphs and tables.

Land has a very high intrinsic value and, on this basis, all the beneficial uses are relevant when considering whether a Certificate of Environmental Audit can be issued. The relevant beneficial uses for the site are highlighted for the proposed redevelopment, although it is noted that the requirement for an environmental audit is to initially consider all beneficial uses and the possibility of being able to issue a Certificate of Environmental Audit.

Table 4: Beneficial Uses of Land Relevant to Proposed Redevelopment

Beneficial Use	Land Use						
	Parks & Reserves	Agriculture	Sensitive Use (High Density Residential)	Sensitive Use (Other)	Recreation / Open space	Commercial	Industrial
Maintenance of ecosystems – natural	X						
- modified	X	X		X	X		
- highly modified		X	X	X	X	X	X
Human health	X	X	X	X	X	X	X
Buildings & structures	X	X	X	X	X	X	X
Aesthetics	X		X	X	X	X	
Production of food, flora & fibre	X	X		X			

Sensitive use (other) includes residential uses (other than high density residential), child care centre, pre-school, or primary school.

Beneficial uses of groundwater as identified in the SEPP *Waters* (2018) are outlined in the following table. Only those groundwater uses which are relevant (i.e. existing or likely, as set out in Section 13 of EPA Publication 759.3) affect the ability to issue a Certificate of Environmental Audit. The mapping on the Visualising Groundwaters of Victoria website indicates the expected groundwater salinity is in the range of 3,500 to 7,000mg/L TDS. This is consistent with other sites in the locality where environmental audits have been completed – see discussion in Section 4 of this audit report. This audit has assumed groundwater to be within Segment C, as outlined in Table 2, SEPP *Waters* (2018) and reproduced below.

Table 5: Beneficial Uses of Groundwater

Beneficial uses	Groundwater Segments (mg/L TDS)						
	A1 (0-600)	A2 (601-1,200)	B (1,201-3,100)	C (3,101-5,400)	D (5,401 - 7,100)	E (7,100-10,000)	F (>10,000)
Water Dependent Ecosystems and Species	X	X	X	X	X	X	X
Potable water supply							
- Desirable	X						
- Acceptable		X					
Potable mineral water supply	X	X	X	X			
Agriculture and irrigation (Irrigation)	X	X	X				
Agriculture and irrigation (stock watering)	X	X	X	X	X	X	
Industrial and commercial	X	X	X	X	X		
Water-based recreation (primary contact recreation)	X	X	X	X	X	X	X
Traditional Owner cultural values	X	X	X	X	X	X	X
Cultural and Spiritual Values	X	X	X	X	X	X	X
Buildings and structures	X	X	X	X	X	X	X
Geothermal properties	X	X	X	X	X	X	X

Table 6. Relevance of Groundwater Beneficial Uses (water table aquifer)

	On-Site			Off-Site		
	Existing	Likely	Relevant	Existing	Likely	Relevant
Water Dependent Ecosystems and Species	N	N	N	N	N	N
	This beneficial use would be considered relevant in the context of protection of surface water bodies where groundwater may ultimately discharge. The nearest potential discharge point is the Corio Bay, which is approximately 1.1 km to the east. The distance to this waterbody is considered sufficient to limit any potential threat from any groundwater impacts that might be identified at the audit site.					
Potable water supply	N	N	N	N	N	N
	This beneficial use is not protected in Segment C, and therefore this beneficial use will not be considered further.					
Potable mineral water	N	N	N	N	N	N
	The site is not in a recognized mineral water supply area and therefore this beneficial use is not considered to be relevant.					
Agriculture and irrigation (Irrigation)	N	N	N	N	N	N
	This beneficial use is not protected in Segment C, and therefore this beneficial use will not be considered further.					
Agriculture and irrigation (Stock watering)	N	N	N	N	N	N
	Not considered relevant due to the use being incompatible with this urban setting and land use in the area, and the availability of a reliable reticulated water supply.					
Industrial and commercial	N	N	N	N	N	N
	This beneficial use is not considered relevant as it is not compatible with the proposed future development of the site and there is no indication groundwater in the surrounding area is being used for industrial purposes.					

	On-Site			Off-Site		
	Existing	Likely	Relevant	Existing	Likely	Relevant
	Other relevant factors include the fact the area is provided with a reliable reticulated potable water supply.					
Water-based recreation (Primary contact recreation)	N	N	N	N	N	N
	Although the search of registered bores showed one bore within 2 km of the site could potentially be in use or were listed for domestic use (and also potentially for recreational use), this beneficial use is not considered compatible with the proposed development of the site or land use in the surrounding area. Other relevant factors include the relatively high costs of installing a bore, and the fact the area is provided with a reliable reticulated potable water supply.					
Traditional Owner cultural values	N	N	N	N	N	N
	The SEPP Waters indicates that Traditional Owner cultural values include traditional aquaculture, fishing, harvesting, cultivation of freshwater and marine foods, fish, grasses, medicines and filtration of water holes. Therefore, groundwater beneath the site in this particular urban setting is unlikely to be directly extracted for this protected use of groundwater. On this basis, it is considered that this beneficial use would apply at the point of discharge (i.e. Corio Bay). As noted previously, the distance to this waterbody is considered sufficient to limit any potential threat from any groundwater impacts that might be identified at the audit site.					
Cultural and spiritual values	N	N	N	N	N	N
	The SEPP Waters indicates that cultural and spiritual values include baptisms, water-based festivals and cultural celebrations held by communities. Therefore, groundwater beneath the site in this particular urban setting is unlikely to be directly extracted for this protected use of groundwater. On this basis, it is considered that this beneficial use would apply at the point of discharge (i.e. Corio Bay). As noted previously, the distance to this waterbody is considered sufficient to limit any potential threat from any groundwater impacts that might be identified at the audit site.					
Buildings and Structures	N	N	N	N	N	N
	This beneficial use is relevant in the context of protecting structures that may come into contact with groundwater. Data from sites in the surrounding area indicates the depth to groundwater is approximately 5m -10m. The proposed buildings and car parking are limited to shallow footings and there is unlikely to be any interaction with groundwater. The pattern of land use and buildings in the surrounding area also suggests it would be unlikely for buildings in the surrounding area to have deeper footings and/or basements that are interacting with groundwater.					
Geothermal Properties	N	N	N	N	N	N
	The SEPP Waters indicates that for the purposes of geothermal uses that no activity must affect the geothermal properties of groundwater and the specific indicators include temperatures between 30 and 70 degrees Celsius. Based on general groundwater properties reported from other sites in the area, the natural temperature of groundwater beneath the site is not likely to be in this range so the groundwater would not support geothermal uses.					

5.2 Environmental Quality Criteria

Soil

The soil results were compared with the indicators specified in the *SEPP Prevention and Management of Contamination of Land* (as varied by Variation in No. G39 Gazette, 26 Sept 2013). This is referred to hereafter as the SEPP PMCL.

The SEPP PMCL requires assessment of impacts to the beneficial uses of 'maintenance of ecosystems and 'human health' to be based on the ecological and health investigation levels in the National Environment Protection (Assessment of Site Contamination) Measure (the ASC NEPM), or levels derived using the risk assessment methodology in the ASC NEPM. At the time of this audit the following investigation levels had been proposed in the ASC NEPM (as updated in May 2013): -

- Ecological investigation levels (EILs). Generic EILs are listed in the current version of the ASC NEPM for arsenic, DDT, and naphthalene. A method is provided for deriving EILs for copper, chromium III, lead, nickel and zinc. This requires an assessment of the ambient background concentration (ABC) for the relevant soil, by applicable measurements of background concentrations of uncontaminated soils either on site or in the broader locality and soil properties including pH, cation exchange capacity, and clay content.
- Ecological screening levels (ESLs). There are ESLs listed in the current version of the ASC NEPM for petroleum hydrocarbon compounds including BTEX, benzo(a)pyrene, C6-C10 TPH (total TPH in this fraction minus total BTEX), and C10-C16 TPH (total TPH in this fraction minus naphthalene).
- Health investigation levels (HILs). The health investigation levels (HILs) listed in the current version of the ASC NEPM include asbestos, metals/metalloids (including arsenic, beryllium, boron, cadmium, chromium VI, cobalt, copper, lead, manganese, inorganic mercury, methyl mercury, nickel, selenium, zinc), cyanide, polycyclic aromatic hydrocarbons, polychlorinated biphenyls, phenols, cresols, organochlorine pesticides, phenoxy acid herbicides, other priority pesticides (atrazine, chlorpyrifos, bifenthrin), PBDE flame retardants.
- Soil and soil vapour health screening levels (HSLs) for vapour intrusion for petroleum hydrocarbons (BTEX, naphthalene and various TPH fractions).
- Interim soil vapour health investigation levels for volatile organic chlorinated compounds.

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

The auditor notes the above ecological investigation and screening levels are based on protection of plants, soil processes and organisms, wildlife and pets. The ASC NEPM notes they are not applicable for agricultural soils, which need evaluation in relation to crop toxicity, plant contaminant uptake, and detailed consideration of soil type. This would be an important consideration where the potential impacts of contamination on the beneficial use 'production of food, flora and fibre' are being assessed.

The SEPP PMCL requires that contamination of land must not adversely affect produce quality or yield, or affect the level of any indicator in food, flora and fibre produced at the site such that the level of that indicator is greater than that specified by the *Australia New Zealand Food Authority, Food Standards Code*. In this case the auditor used professional judgement and did not require any site-specific assessment to assess the impact on this beneficial use.

For the beneficial use 'buildings and structures', the auditor had regard for the SEPP PMCL requirement that contamination must not cause the land to be corrosive or to adversely affect the integrity of buildings and structures. Section 6 of the *Australian Piling Code (AS2159-2009)* was referred to, as well as a general assessment of the presence of any other impacts that might potentially affect the integrity of buildings and structures.

In terms of the beneficial use 'aesthetics', the auditor had regard for the SEPP PMCL requirement that contamination must not cause the land to be offensive to the senses of human beings. The auditor referred to general guidance in Section 14 of *Guidelines for Issue of Certificates and Statements of Environmental Audit* (EPA Publication 759.3) and in Section 3.6 in Schedule B1 in the ASC NEPM.

The SEPP PMCL also provides direction in relation to objectives for cleanup of land. Cleanup can be based on the relevant objectives specified in Table 2 of the SEPP (PMCL), for the protected beneficial uses defined in the SEPP (PMCL), or alternatively via clean up objectives derived via a site-specific risk assessment undertaken in accordance with the ASC NEPM.

The following table provides a selection of the ecological and health-based investigation levels adopted for the main contaminants of interest at the site. The auditor broadly agreed with the screening values adopted by the consultant, with some occasional exceptions as noted. It is noted that the DSI Report calculated separate EIL values for fill soils and natural soils, and also based on 'urban residential / public open space' and 'commercial / industrial' land use. The auditor considered it would be simpler to consider a single set of values based on the more sensitive land use 'urban residential / public open space', and for all soils across the site.

Table 7: Review of Adopted Ecological Screening Values

Analytes	EILs adopted by assessment consultant (Compass, 2018)	Comments	EILs adopted by auditor
Arsenic	100	The value adopted by Compass is the generic EIL for aged arsenic, irrespective of soil properties, are listed in are listed in Table 1B(5) in Schedule B1 of the ASC NEPM. The auditor agrees the adopted value is reasonable and justifiable.	100
Copper	200 (fill) 210 (natural)	Compass adopted a site specific EIL for fill and natural soil domains based on Schedule B1 of the ASC NEPM and an assumed background concentration of 10mg/kg, a pH of 7.9 (fill) and 7.8 (natural soil), CEC of 9.5cmol/kg (fill) and 17 cmol/kg (natural soil) for aged copper in a low traffic flow area. The auditor agrees that the values are reasonable and justifiable.	200
Chromium III	410	Compass adopted an EIL for chromium based on an assumed clay content of 25% (fill) and 49% natural soils), and assumed background concentration of 10mg/kg. When this data was entered into the ASC NEPM EIL calculation spreadsheet by the auditor and conservatively assuming ,1% iron content in soil, this resulted in an EIL of 550mg/kg for the fill and 680 mg/kg for natural soils.	550
Lead	1,200	The adopted value by the consultant was the generic added contaminant limit for aged lead, as listed in are listed in Schedule B1 of the ASC NEPM, and adding an assumed background concentration of 68mg/kg (rounded up to 1,200 mg/kg). This is considered reasonable and defensible.	1,200
Nickel	180 (fill) 230 (natural)	Compass adopted a site specific EIL for fill and natural soil domains based on Schedule B1 of the ASC NEPM and an assumed background concentration of 10mg/kg and CEC of 9.5cmol/kg (fill) and 17cmol/kg (natural soil) for aged nickel in a low traffic flow area. When the CEC data was entered into the ASC NEPM EIL calculation spreadsheet by the auditor and conservatively assuming 1% iron content in soil, it resulted in an EIL of 150 mg/kg for fill and 240mg/kg for natural soils (value for urban residential and public open spaces).	150
Zinc	460 (fill) 660 (natural)	Compass reported an EILs for zinc based on a CEC value of 9.5cmol/kg for fill and 17cmol/kg for natural soils and a pH of 7.9 and 7.8 respectively and a background concentration of 50mg/kg. When the values were input into the ASC NEPM EIL calculation spreadsheet and conservatively assuming 1% iron content for soils, the resulting EILs were 440 mg/kg (fill) and 660 mg/kg (natural soils).	440

Table 8: Screening Criteria for Main Contaminants of Interest in Soil

Screening Values	Ecological Investigation and Screening Levels	Health Investigation and screening Levels		
Land Use Category	Urban residential and public open space	Residential A. Residential with garden / accessible soil (<10% intake of fruit and vegetables from home grown produce, no poultry)	Residential B. Residential with minimal opportunity for soil access (including apartments)	Commercial/ industrial, includes premises such as shops, offices, factories and industrial sites
Default Source (unless alternative values are adopted)	NEPM EIL and ESL Values ¹	NEPM HIL A ²	NEPM HIL B ²	NEPM HIL D ²
Metals/Metalloids				
Arsenic (As)	100	100	500	3,000
Cadmium (Cd)		20	150	900
Chromium (III)	550 ³			
Chromium (VI)		100	500	3,600
Cobalt (Co)		100	600	4,000
Copper (Cu)	200 ³	6,000	30,000	240,000
Lead (Pb)	1,200 ³	300	1,200	1,500
Manganese		3,800	14,000	60,000
Mercury (inorganic)		40	120	730
Nickel (Ni)	150 ³	400	1,200	6,000
Zinc (Zn)	440 ³	7,400	60,000	400,000
TPH Fractions				
F1 (>C6-C10 TPH – total BTEX)	180			
F2 (>C10-C16 TPH – naphthalene)	120			
F3 (>C16-C34 TPH)	1,300			
Polycyclic Aromatic Hydrocarbons				
Carcinogenic PAHs (as BaP TEQ)		3	4	40
Total PAHs		300	400	4,000
OC Pesticides				
DDT	180			
DDD/DDE/DDT (total)		240	600	3,600
Aldrin / Dieldrin (total)		6	10	45
Chlordane		50	90	530
Endosulfan		270	400	2,000
Heptachlor		6	10	50
Methoxychlor		300	500	2,500

NOTES:

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

1. Refer Tables 1 B(1) to 1 B(7) in Schedule B(1) of the ASC NEPM. All values assume aged (not fresh) contamination in soil.
2. Refer Tables 1 A(1) to 1 A(3) in Schedule B(1) of the ASC NEPM
3. Values adopted by auditor after review of the consultant's assessment reporting. Values are based on urban residential and open space areas and aged contamination. Refer to Table 7 for discussion and justification.

Table 9. Auditor Screening Criteria - Soil Health Screening Levels for Direct Contact

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

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

Groundwater

Where required, groundwater results obtained from a desktop review of surrounding EPA audits were compared with the criteria specified in the *SEPP Waters (2018)*. These are primarily derived from ANZECC and NHMRC documents, and are referenced as follows:

- Water dependent ecosystems and species: The SEPP Waters (2018) specifies the water quality objectives for 'water dependent ecosystems and species'. The segment defined in the SEPP Waters which is relevant to the audit site is '*Central foothills and coastal plains*'. The SEPP Waters indicates the water quality objectives for these segments should be sourced from the ANZECC 2000 *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* freshwater ecosystems protection criteria, for slightly to moderately modified marine ecosystems (95% of species to be protected).
- Potable mineral water supply: *Australian Food Standards Code (1987) – Standard 08 Mineral Water*, criteria for potable mineral water supply.
- Agriculture and irrigation (Irrigation): ANZECC (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*. Generally, long term trigger values in irrigation waters were adopted (if available).
- Agriculture and irrigation (Stock watering): ANZECC (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*, criteria for livestock water.
- Industrial and commercial: ANZECC (1992) *Australian Water Quality Guidelines for Fresh and Marine Waters*, criteria for industrial water use. It is noted that there are various criteria specified in the ANZECC (1992) guidelines and they are specific to the particular industry and/or purpose. The auditor has made an assessment, based on professional judgement, of the uses that might be supported by the background water quality and the suitability of the groundwater for other uses (noting it would likely be suitable for a wide variety of industrial uses on the proviso other beneficial uses are not precluded by the water quality).
- Primary contact recreation: The SEPP Waters indicates that the risk-based approach recommended in *Guidelines for Managing Risks in Recreational Water (NHMRC, 2008)* should be applied for the environmental quality indicators and objectives for this beneficial use of groundwater. This guideline notes that waters contaminated with chemicals that are either toxic or irritating to the skin or mucous membranes are unsuitable for recreational

purposes and advocates a simple screening approach where “a substance occurring in recreational water at a concentration of 10 times that stipulated in the drinking water guidelines may merit further consideration”. The auditor adopted screening values of 10 x potable criteria for the majority of analytes but retained the potable screening values for some organics to account for uncertainty in dermal absorption, or where there is a lower aesthetic / odour based threshold. In addition, some values were adopted based on advice from EPA, where discrepancies exist between the ANZECC 1992 values and more recent criteria. The auditor also had regard for guidance in the NHMRC 2008 document in relation to aesthetic aspects of recreational water (*“the water should be free from visible materials that may settle to form objectionable deposits including floating debris, oil, scum and other matter, substances producing objectionable colour, odour, taste, or turbidity, and substances and conditions that produce undesirable aquatic life”*). The undesirable aquatic life referred to include toxic algal blooms and cyanobacteria, primarily caused by eutrophication (nutrient enrichment).

- Traditional Owner Cultural Values and Cultural and Spiritual Values: The SEPP Waters indicates that there are no specific environmental quality objectives for these protected beneficial uses of groundwater. However environmental quality objectives for other beneficial uses such as water dependent ecosystems and species are also likely to protect these potential beneficial uses.
- Buildings and structures: No specific criteria are listed in the SEPP, but results were considered with regard to Section 6 of the Australian Piling Code (AS2159) for groundwater conditions and potential adverse effects on buildings and structures.
- Geothermal properties: The SEPP Waters indicates that for the purposes of geothermal uses that no activity must affect the geothermal properties of groundwater and the specific indicators include temperatures between 30 and 70 degrees Celsius.

Table 10: Auditor Screening Criteria for Main Contaminants of Interest in Groundwater

Beneficial Uses	Water Dependent Ecosystems and Species	Potable	Irrigation	Stock Watering	Primary Contact Recreation (6)
Nitrate (as N) (mg/L)	3.4 (1)	10	-	100	100
Arsenic	42	10	100	500	100
Boron	680	300	500	5,000	1,000 (4)
Cadmium	0.4	2	10	10	20
Chromium	6 (as Cr (VI) - (as Cr III)	50 (as Cr VI)	100 (as Cr VI)	1,000	500 (as Cr VI)
Copper	1.8	1,000	200	500	10,000
Nickel	13	20	200	1,000	200
Selenium	18	10	20	20	100
Zinc	15	3,000	2,000	20,000	30,000
Benzene	700	1	-	-	10
Toluene	180 (7)	25 (aesthetics)	-	-	25 (5)
Ethylbenzene	5 (7)	3 (aesthetics)	-	-	3 (5)
Xylenes	200 (7)	20 (aesthetics)	-	-	20 (5)
TPH C6-C9 (8)	600	600	-	600	600
TPH C10-C36 (8)	600	600	-	600	600
Trichloroethene (TCE) (2)	-	20	-	20	200
Tetrachloroethene (PCE) (3)	-	50	-	50	300

NOTES:-

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

- (1) Value adopted is the nitrate value of 3.4 mg/L specified in the ANZECC (2000) guidelines for 90% level of protection. It is acknowledged there has been an erratum issued for the ANZECC (2000) guidelines stating the nitrate criteria for aquatic ecosystems protection should be replaced with 'under review'.
- (2) Trichloroethene / TCE. The adopted screening value for potable water is the value of 0.02 mg/L listed in the current World Health Organisation (WHO) drinking water guidelines. The odour threshold in water quoted in the latest WHO drinking water guidelines is 0.31 mg/L, so the auditor adopted a screening value for recreational water based on 10 x the WHO drinking water guideline.
- (3) Tetrachloroethene / PCE. The adopted screening value for potable water is 0.05 mg/L from the current version of the ADWG. The adopted screening value for water based recreation is the odour threshold in water quoted in the current WHO drinking water guidelines.
- (4) Values adopted based on advice from EPA, where a discrepancy existed between ANZECC (1992) values and other updated values.
- (5) Primary contact recreation screening criteria for TEX were sourced from the aesthetics based guideline values from the Australian Drinking Water Guidelines (NHMRC, 2011)
- (6) Primary contact recreation screening values for the majority of analytes are based on 10 x guideline values for drinking water to account for limited consumption in a recreational water use scenario (as per NHMRC Managing Risks in Recreational Water guidance (2008)). Drinking water guidelines sourced from NHMRC Australian Drinking Water Guideline (2011 Vsn, as updated August 2018). Exceptions are values for benzene and cyanide specified in the ANZECC (2000) Water Quality Guidelines for Fresh & Marine Waters (value for recreational waters).
- (7) Screening values for TEX were based on low reliability criteria for marine waters quoted in the ANZECC (2000) guidelines.
- (8) In the absence of Victorian or Australian criteria, the TPH criteria adopted for this audit are based on Dutch Intervention Values as specified in the Netherlands (2009) Circular on Target Values and Intervention Values, Spatial Planning and the Environment. These values have been adopted by EPA in recent clean up to extent practicable (CUTEP) determinations and reiterated in advice to the auditor that these are the values considered applicable by EPA for assessment of groundwater pollution by TPH.

Soil Vapour

The following sources were used for screening values for volatile chemicals of interest:-

- Interim soil vapour health investigation levels from the Assessment of Site Contamination NEPM (as amended 2013) (for PCE, TCE, cis 1,2 DCE and vinyl chloride);
- Health screening levels from the Assessment of Site Contamination NEPM (as amended 2013) (for BTEX) (values used were for sandy soil, and source <1m depth), which are in turn based on CRC CARE Technical Report 10 (Health Screening Levels for Petroleum Hydrocarbons in Soil and Groundwater);
- World Health Organisation ambient air guidelines or tolerable concentrations in air (from 2000 and updates to 2011); and
- US EPA risk based screening levels (RSLs) for residential and industrial air (most recent available version, 19 November 2018).

Measured values in soil gas are not a measure of the exposure concentration. Where volatiles in soil gas migrate from a subsurface soil or groundwater source into a building overlying the impacts, the volatiles will be subject to one or more processes such as diffusion, degradation, mixing, and dispersion. These processes have the overall effect of a reduction in indoor air concentrations compared to those in the underlying soil vapour. The adopted screening values for soil gas are based on relevant ambient air quality criteria, adjusted via a factor to reflect the dilution from the subsoil values to resulting indoor air concentrations. Different attenuation factors were adopted by the auditor for different volatile chemicals as follows:-

- A 200 x reduction for benzene toluene, ethyl benzene and xylenes (BTEX). This was based on the methodology used in deriving the soil vapour health screening levels (HSLs) for BTEX in the CRC CARE Technical Publication 10 and the Assessment of Site Contamination NEPM (as amended in April 2013). Note the methodology used to derive the HSLs does not use the attenuation factor directly, rather it is used in calculating one of the input parameters (advective flow) in the model used to predict the indoor air concentration from a sub floor soil gas concentration. For further detail refer to Section 7.3.2 in CRC CARE Technical Publication 10 (Part 1: Technical Development Document).
- A 10 x reduction for vinyl chloride, trichloroethylene, and tetrachloroethylene. This was based on the methodology used in deriving the interim soil vapour health investigation levels (soil vapour HILs) for these compounds in the Assessment of Site Contamination NEPM (as amended in April 2013).
- A 33 x reduction for the other volatile organic compounds. This was based on the OSWER Technical Guide for Assessing and Mitigating the Vapour Intrusion Pathway from Subsurface Vapour Sources to Indoor Air (OSWER Publication 9200.2-154, June 2015). The OSWER guideline provides recommendations for attenuation factors for use in evaluating subsurface sample concentrations collected as part of vapour intrusion investigations. The information is based on the US EPA vapour intrusion database which

consists of pairings of concentrations of indoor air results with subslab soil gas, external soil gas, and groundwater from hundreds of sites. For external soil gas data such as that collected beneath the audit site, the OSWER guidance recommends a generic soil gas / indoor air attenuation factor of 0.03 for initial screening purposes.

A number of the vapour screening values adopted by Compass in their DSI Report were not considered justifiable and / or there were errors in the derivation of adopted values. This is discussed further in the following table.

Table 11. Summary of Vapour Screening Criteria

Chemicals	Soil Vapour Screening Values Adopted by Consultant ($\mu\text{g}/\text{m}^3$)		Comments
	Sensitive Use	Commercial Use	
Benzene	1,000	4,000	Soil vapour HSL from the ASC NEPM (as amended 2013), derived using an attenuation factor of 0.005 (3). Considered reasonable and justifiable.
Toluene	1,300,000	4,800,000	Soil vapour HSL from the ASC NEPM (as amended 2013), derived assuming an attenuation factor of 0.005 (3). Considered reasonable and justifiable.
Ethylbenzene	330,000	1,300,000	Soil vapour HSL from the ASC NEPM (as amended 2013), derived using an assumed attenuation factor of 0.005 (3). Considered reasonable and justifiable.
Xylenes	220,000	840,000	Soil vapour HSL from ASC NEPM (as amended 2013), derived assuming an attenuation factor of 0.005 (3). Considered reasonable and justifiable.
Chloroform	240	1,060	US EPA RSL values for ambient air, adjustment of lifetime cancer risk from 10 ⁻⁶ to 10 ⁻⁵ , and soil gas / indoor air attenuation factor of 0.005 (citing Oregon DEQ 2010 recommended attenuation factors after evaluation of the US EPA vapour intrusion database). The auditor has been advised by Jackie Wright of his expert support team that the appropriate reference value should be the WHO tolerable concentration of 140 $\mu\text{g}/\text{m}^3$. The Oregon DEQ recommendations are not considered justifiable as they are unproven for Australian conditions, and therefore screening values based on an attenuation factor of 0.03 (OSWER, 2015) were adopted by the auditor and using the WHO value as follows:- Residential and commercial:- $140 \times 1 / 0.03 = 4,620 \mu\text{g}/\text{m}^3$.
Cis 1,2 dichloroethene	80	300	Interim vapour HIL from ASC NEPM (as amended 2013), derived using an assumed attenuation factor of 0.1 (2)
Trichloroethene	20 (NEPM) 4,000 (alt value)	80 (NEPM) 16,000 (alt value)	Default values were based on interim HILs from the ASC NEPM (as amended 2013), derived assuming an attenuation factor of 0.1 (2). This is based on the USA EPA (2011) inhalation threshold value of 2 $\mu\text{g}/\text{m}^3$ and assuming background intakes from other sources account for 10% of the overall intake. Compass Environmental also proposed alternative screening values based on an adjustment of the soil gas / indoor air attenuation factor of 0.005 (citing Oregon DEQ 2010 recommended attenuation factors after evaluation of the US EPA vapour intrusion database). The auditor notes using this attenuation factor instead of the default of 0.1 used in derivation of the interim HILs in the

Chemicals	Soil Vapour Screening Values Adopted by Consultant ($\mu\text{g}/\text{m}^3$)		Comments
	Sensitive Use	Commercial Use	
			NEPM provides for a further 20 fold increase in the screening value (ie. 0.1 / 0.005). Compass appear to have made an error in their adjustment of the interim HILs by a factor of 10. Using their logic the resulting adjusted HILs should have been 400 $\mu\text{g}/\text{m}^3$ (residential) and 1,600 $\mu\text{g}/\text{m}^3$ (commercial). The Oregon DEQ recommendations are not considered justifiable as they are unproven for Australian conditions, and therefore screening values based on an attenuation factor of 0.03 (OSWER, 2015) were adopted by the auditor to provide for a further 3 fold increase in the interim HIL values (ie. 0.1 / 0.03) as follows:- Residential:- 60 $\mu\text{g}/\text{m}^3$ Commercial:- 240 $\mu\text{g}/\text{m}^3$.
Tetrachloroethene	2,000 (NEPM) 400,000 (alt value)	8,000 (NEPM) 1,600,000 (alt value)	Default values were based on interim HILs from the ASC NEPM (as amended 2013), derived assuming an attenuation factor of 0.1 (2). Alternative screening values were derived by Compass using a similar approach and rationale as for the TCE value discussed above. As for the TCE values, compass appear to have made a 10 fold error in deriving these value, but as was also noted for TCE, the auditor does not believe the use of the Oregon DEQ recommended attenuation factors for Australian conditions without further site specific justification. The auditor considers screening values based on an attenuation factor of 0.03 (OSWER, 2015) can be justified to provide for a further 3 fold increase in the interim HIL values (ie. 0.1 / 0.03) as follows:- Residential:- $3 \times 2,000 = 6,000 \mu\text{g}/\text{m}^3$ Commercial:- $3 \times 8,000 = 24,000 \mu\text{g}/\text{m}^3$.
Vinyl chloride	30	100	Interim vapour HIL from ASC NEPM (as amended 2013), derived using an assumed attenuation factor of 0.1 (2)

All results expressed in micrograms per cubic metre ($\mu\text{g}/\text{m}^3$).

6. REVIEW OF ASSESSMENT AND CLEAN UP WORKS

Direct sampling of soil and soil vapour was carried out as part of the assessment of the audit site. Soil sampling is a fundamental information requirement in assessing the condition of land. Direct groundwater investigation was not undertaken at the site. Groundwater and vapour sampling may also be considered for site assessments depending on the circumstances. In this case no direct groundwater investigation was completed, but some vapour assessment was also completed. All assessment work and results are documented in the following report – *Environmental Site Assessment, 1-5 Ballarat Road, North Geelong* (Compass Environmental, Dec 2018).

6.1 Sequence of Assessment and Clean Up Works

Compass Environmental (2016) – targeted and grid-based soil assessment

The original phase of environmental assessment work was carried in September 2016, which included drilling 17 soil bores (via geoprobe) across the site. This included 10 targeted bores, investigating the footprint of the earlier demolished buildings, concrete hardstand and the asphalted area predominantly used for carparking, and a further seven bores were installed for the purposes of grid-based coverage of the remaining site areas on an approximate 15 X 15m grid.

The initial works identified that fill was significantly deeper within the eastern portion of the site, along the former gully alignment that was evident in the historical aerial photographs. Fill was otherwise reported as relatively shallow (0.2 to 0.65m thick).

Compass Environmental May 2018 – test pitting and soil boring

Five test pits (TP1 – TP5) were excavated, in the eastern portion of site, to further investigate the depth and composition of fill in the former gully. Boreholes for the installation of two soil vapour bores (SV1 and SV2) were drilled in the south western portion of the site, targeting the boundary area closest to the former service station across Ballarat Road to the south west (108 Church St). The soil vapour probes were installed to a depth of 3mBGS, and soil samples were collected during those drilling works.

SGS Leeder, June 2018 – vapour sampling

SGS Leeder personnel sampled the 2 newly installed vapour bores into summa canisters and submitted the samples to their laboratory for analyses.

Compass Environmental July 2018 – soil borings and additional vapour survey

Compass installed five soil vapour probes in 3m deep soil bores (PSV1 to PSV5). These bores were located in the areas surrounding SV1 to delineate elevated TCE concentrations identified during laboratory analysis of vapour samples collected at SV1. Soil samples were collected and analysed from selected bores. Passive diffusion samplers (Waterloo WMS-LU type) were deployed for a 7 day

period by Compass field staff, and then retrieved and submitted for analyses.

Compass Environmental September 2018 – soil borings

Compass Environmental attended the site during the drilling of a geotechnical investigation bore located in the eastern portion of the site (designated by Compass as BH1). Two soil samples were collected from BH1 and the bore was terminated in fill on suspected concrete rubble at a depth of 2.8m.

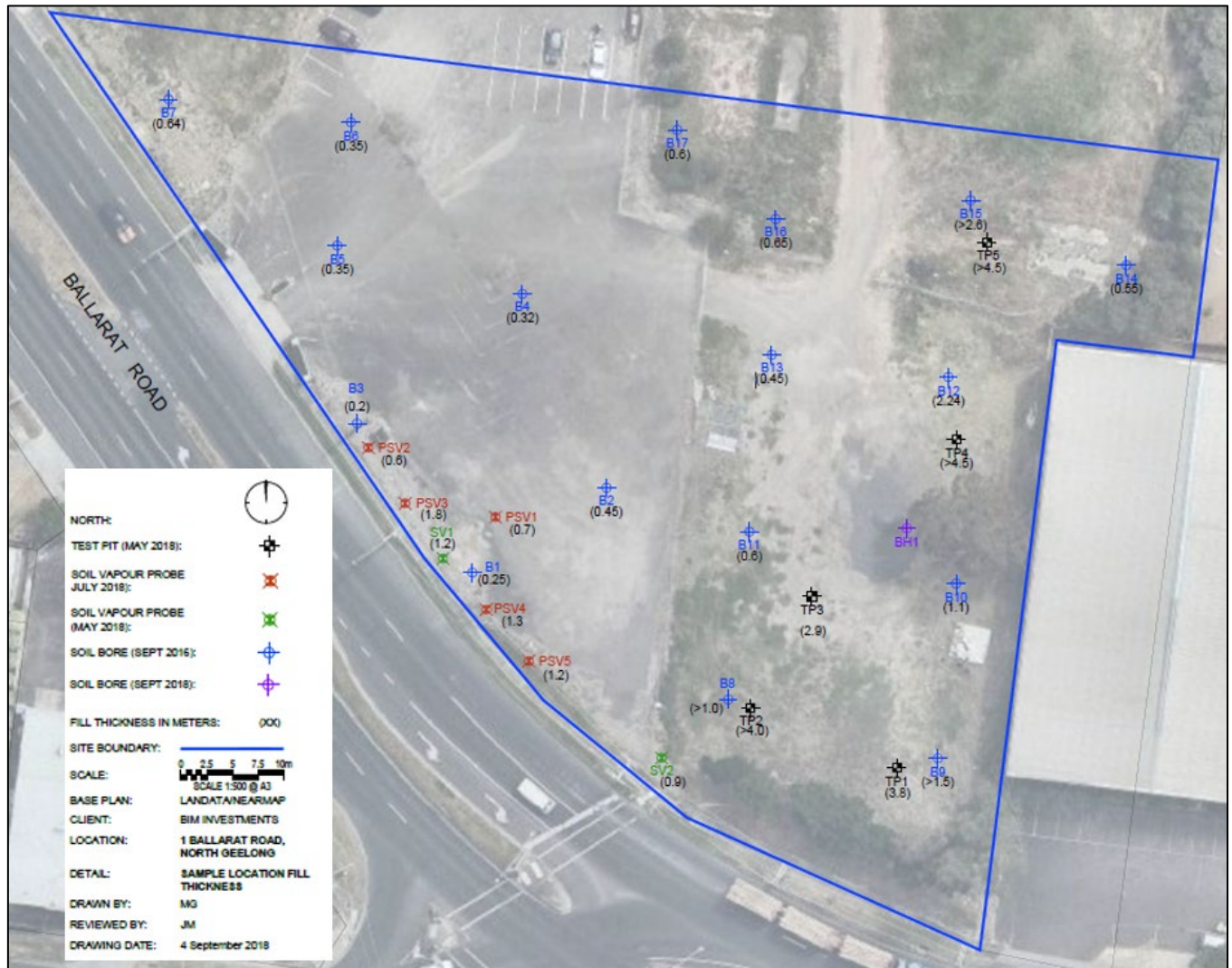


Figure 8. Sampling locations 2016 and 2018 (Compass Environmental)

Table 11: Sampling and Analysis Program (Soil)

Dates	Objective	Sample locations	Analyses
12 September 2016	Characterisation	Grid based and targeted location soil bores B1 to B17.	Metals ¹ , PAH, CHCs, OCPs (20 samples, including QA samples) IWRG 621 Screen (2 samples of fill) Asbestos analysis (4 samples) TRH, MAH, HVOL (4 samples, chosen based on highest PID readings obtained) pH and sulphate (2 samples) ASLP analyses for Barium (B13/0.9) and total PAH, B(a)P and naphthalene (B10/0.8)
17 May 2018	Characterisation	Test pitting TP1 to TP5 Soil vapour bores SV1 and SV2	<u>Test pits</u> PAH (5 samples of fill and natural soils, plus the QA samples) TRH (4 selected samples, 3 of fill and 1 of natural) MAH (1 sample, TP3/3.0 in natural soil) ASLP analysis for lead on TP2/3.0 (fill) <u>Soil vapour bores</u> TRH, MAH, HVOL (2 samples, natural soil) Metals ¹ , PAH, TRH (1 fill sample plus QA samples) IWRG 621 Screen (1 fill sample)
20 to 25 July 2018	Characterisation	Installation of soil vapour probes PSV1 to PSV5	HVOL (PSV4/2.75).
18 September 2018	Characterisation	Soil bore BH1	Two samples analysed for metals ¹ , TRH, TRH (silica gel clean-up), PAH and pH. No QA samples collected.

(1) Metals (Sb, As, Ba, B, Be, Cd, Cr (total), Co, Cu, Pb, Mn, Hg, Mo, Ni, Se, Ag, Sn, V, Zn).

Table 12: Sampling and Analysis Program (Soil Vapour)

Date	Objective	Scope of work	Analyses
1 June 2018	Assessment of potential impacts in soil vapour arising from a former service station located across Ballarat Road to the SW (108 Church Street)	Sampling of vapour bores, (SV1 and SV2) by SGs Leeder personnel, with samples submitted to SGs Leeder for analyses.	Three summa cannister samples analysed for VOCs, TPH, TRH, MAH, PAH, HVOLs, CHCs, Solvents and isoproponal (including one QA sample).
25 July 2018	Further assessment / delineation of soil vapour impacts.	Passive diffusion samplers (WMS-LU type) were deployed for a 7 day period in 5 x vapour bores (PVB1 to PVB5), then collected and submitted to SGs Leeder for analyses.	Low uptake passive Waterloo membrane samplers analysed for VOCs, (five samples in total)

6.2 Soil Assessment Results

As noted previously, a layer of fill has been encountered covering the entire site. The layer was generally less than 0.5 m thick, however was thicker in the eastern portion of the site, where there is suspected to be a backfilled former gully as noted on historical aerial photographs, and also possibly associated with past installation of underground stormwater infrastructure in the drainage easement in that part of the site. Fill was reported as comprising brown and tan-brown, fine to coarse grained silty sand, dark brown sandy silt, pale brown silty clay, and tan brown clayey sand, with varying quantities of rounded or angular to rounded gravel, and minor organic matter. All fill was reported to contain varying amounts of asphalt, crushed rock, brick and reworked natural soils. Ash was identified at locations B4, B16 and B17, at depths between ground level and 0.6 mBGS and at deeper locations (between 0.5 m and 2.6 mBGS) at B9, B10 and B15. Minor grey discolouration was noted at B8 above 1.0 mBGS. No suspected asbestos containing materials were noted.

The underlying natural lithology was described in the bore logs as light brown, tan brown to mottled brown sandy silty clay, clayey sand, silty sand with minor clay, or silty clay, with varying amounts of fine-grained rounded gravel or fine to coarse-grained sand, consistent with Moorabool Viaduct Sands.

Test pitting in the eastern portion of the site undertaken by Compass in 2018, confirmed there was an area of deeper suspected to be associated with a former gully area with the depth of fill extending from 2.9 m to over 4.5 mBGS (with refusal within the fill due to the extent of the excavator reach into the test pit). Some larger concrete and bluestone fragments were also uncovered in the deeper filled area during test pitting in the eastern portion of the site. The auditor inspected the site in the days following the test pitting in May 2018 and was able to verify the composition of the excavation spoil was consistent with that described in the Compass Environmental reporting.

An area of deeper fill was also encountered near the southwestern boundary, during installation of the soil bores and passive vapour probes in that area, with fill ranging from 0.7 m to 1.8 mBGS. The composition of the south western fill consisted of fine to coarse grained silty sand, pale brown silty clay and tan brown clayey sand with angular to rounded gravels. An elevated PID reading of 105 ppm, the highest reported during the assessment was recorded at SV2, on the south western boundary. The elevated PID reading was reported in shallow fill (0.25 mBGS), however no odour or staining was reported at this sampling location, and no elevated results were reported in soil samples collected from that bore. In addition, no significant impacts were reported in the vapour sample collected at this location (refer to discussion in Section 6.5).

Perched water was identified by Compass at test pit locations TP2 and TP4 at depths of 4.0 and 4.5 mBGS respectively (within the deeper fill in the eastern portion of the site. The perched water was not identified at other sampling locations in close proximity, and was interpreted by Compass Environmental as likely to be localized perched water associated with the stormwater drainage infrastructure in this part of the site, rather than groundwater.

It is noted by the auditor that no excavation / removal of soils has occurred, and all assessed fill and natural soils remain onsite.

Within the fill that remains onsite, the following results exceeded one or more of the adopted screening values:-

-
- The TRH C₁₆-C₃₄ Fraction (580 mg/kg) reported for B10/0.8 exceeded the ESL / EIL for residential and urban open space areas.
 - The lead concentration reported at TP2/3.0 within fill (340 mg/kg) exceeded the adopted HIL-A (residential) value, considered applicable as a screening value for soils in a sensitive land use scenario (noting part of the site is being proposed for use as a child care centre). All results were below the HIL B (residential) value of 1,200 mg/kg, and the HIL D (commercial / industrial) value of 1,500 mg/kg.
 - Benzo(a)pyrene concentrations at BH1/1.0 (1.5 mg/kg), B10/0.8 (19 mg/kg), B15/0.3 (16 mg/kg) and B15/2.5 (2.1mg/kg) exceeded the EIL value for residential and urban open space (0.7 mg/kg).
 - Carcinogenic PAHs (as BaP TEQ) concentration reported at two locations (30 mg/kg at BH10/0.8m, 25mg/kg at B15/0.3m and 3.2 mg/kg at B15/2.5m) exceeded the HIL A (residential) value of 3 mg/kg and the HIL B (residential) value of 4 mg/kg. All results were below the HIL D (commercial / industrial) value of 40 mg/kg.
 - Total PAH at B10/0.8 (330 mg/kg) exceeded adopted HIL-A value (300 mg/kg). All results were below the HIL B (residential) value of 400 mg/kg, and the HIL D (commercial / industrial) value of 4,000 mg/kg.

Two elevated barium results in natural soils exceeded the EIL / ESL adopted by Compass of 330 mg/kg (maximum 780 mg/kg). The auditor notes Compass adopted this screening value based on the US EPA soil screening level (Eco-SSL) for barium for soil invertebrates. Barium concentrations were considered by Compass to be representative of naturally occurring background concentrations within the Moorabool Viaduct formation and not an indication of leachable contamination from the overlying fill, as supported by lower results reported in the fill materials (generally less than 100 mg/kg) and ASLP analysis conducted on one of the elevated barium samples (B13/0.9), with a reported leachable concentration of 2.4 mg/L (DI buffer).

The range of reported barium results is comparable to results in natural soils at two other sites in the area:-

- 151-153 Church Street, Geelong West. Barium results reported for Moorabool Viaduct formation soils ranged from approximately 160 to 410 mg/kg.
- 7 Sargeant Street, Geelong West. Barium results reported for Moorabool Viaduct formation soils ranged from approximately 42 to 480 mg/kg. The audit report for this site also referenced results at the adjacent 8 Sargeant Street site which ranged up to 600 mg/kg.

The majority of results in the overlying fill soils at the 1-5 Ballarat road site were significantly lower (generally less than 100 mg/kg), with only a few results of the natural soils showing results above 100 mg/kg. Considering the above, the interpretation of the barium results as reflecting natural variation in the Moorabool Viaduct formation soils is reasonable. The auditor notes the screening level adopted by the assessment consultants may not be relevant to Australian conditions, but in any case it is agreed the results are not indicative of a potential issue regarding barium levels in site soils.

Table 13. Soil Results, Combined Assessment

Analytes	Investigation Levels			HIL/HSL Comm / Ind D	Range of Reported Results	
	EIL/ESL	HIL/HSL Res A	HIL/HSL Res B		Fill and impacted soils (2016 / 2018)	Natural soils (no impacts) (2016 / 2018)
Arsenic	100	100	500	3,000	<5 - 40	<5-37
Barium	330 [^]				7 - 270	16 - 780
Cadmium		20	150	900	<0.2	<0.2
Chromium (III)	550				<5-43	<12-43
Cobalt		100	600	4,000	<5- 22	7-37
Copper	200	6,000	30,000	240,000	<5 – 21	<5
Lead	1,200	300	1,200	1,500	<5 - 340	<5 – 8
Manganese		3,800	14,000	60,000	18 - 310	35 - 110
Mercury		40	120	730	<0.05-0.11	<0.05
Vanadium					8 - 78	49 - 60
Nickel	150	400	1,200	6,000	<5 - 78	9 - 36
Zinc	440	7,400	60,000	400,000	<5-89	<12 - 35
TRH C6-C10	180				<20	<20
TRH C10-C16	120				<20	<20
TRH C16-C34	300				<50-580	<50
TRH C34-C40	2,800				<50	<50
Benzo(a)pyrene	0.7	NS	NS		<0.1 - 19	<0.1
Carcinogenic PAHs (as BaP TEQ)		3	4	40	0.1 - 30	0.1
Total PAHs		300	400	4,000	<0.1 - 330	<0.1
BTEX					<LORs	<LORs
Chlorinated hydrocarbons & HVOLs					<LORs	<LORs
OC Pesticides	Varies	Varies	Varies	Varies	<LORs	-
Cyanide (free)		250	300	1,500	<5	<5
Phenols					<LORs	<LORs
		Denotes max results above EIL / ESL				
		Denotes max results above HIL / HSL A				

[^] Value adopted by Compass Environmental -US EPA 2005, Ecological Soil Screening Level (Eco-SSL) based on soil invertebrates.

Table 14. Soil Results - Initial Assessments (TPH / BTEX Results and HSLs for Direct Contact)

	HSL-A (low density residential)	HSL-B (high density residential)	HSL-D (commercial / industrial)	Intrusive maintenance worker – shallow trench	Maximum reported results (2016 – 2018)
Benzene	100	140	430	1,100	<0.5
Toluene	14,000	21,000	99,000	120,000	<0.5
Ethyl Benzene	4,500	5,900	27,000	85,000	<0.5
Xylenes	12,000	17,000	81,000	130,000	<1
Naphthalene	1,400	2,200	11,000	29,000	2.3
TPH C6-C10	4,400	5,600	26,000	82,000	<20
TPH >C10- C16	3,300	4,200	20,000	62,000	<20
TPH >C16- C34	4,500	5,800	27,000	85,000	580
TPH>C34-C40	6,300	8,100	38,000	120,000	<50
	Max results above HSL-A				
	Max results above HSL-A, HSL-B and HSL-D				

6.3 Soil Vapour Assessment - Results

The sampling and analysis results are discussed in Section 10 of the Compass DSI Report. The initial sampling event was via the 2 permanent soil vapour points SV1 and SV2, located along the south western boundary of the site, adjacent to Ballarat Road. As noted previously, the intention was to check for impacts in soils vapour associated with the former service station located across Ballarat road to the south west (108 Church Street, Hamlyn Heights). All results were below adopted screening values assuming sensitive land use, with the exception of one TCE result at SV1 of 0.024 mg/m³, which was marginally above the HSL A/B screening value of 0.02 mg/m³. All other VOCs and TPH results were below adopted screening values. In a second phase of soil vapour assessment, additional delineation bores were installed and further soil vapour data was collected. Results in these delineation bores were lower and all were below adopted screening criteria.

Based on the relatively benign history of the audit site and absence of any features identified that might be indicative of a historical source within the audit site, the former service station at 108 Church Street is considered the most obvious potential source of these volatiles.

The results are not indicative of a significant vapour intrusion risk for the proposed redevelopment at the site. In terms of screening values for residential / sensitive land use (relevant for a future child care centre), all results within the site were below adopted screening criteria with the exception of one marginal exceedance for TCE close to the south west boundary. All results were well below adopted screening values in terms of commercial / industrial buildings (relevant for a future medical centre / rehabilitation facility). It is noted there are no proposed buildings anywhere in proximity to the south western boundary where the vapour impacts were identified, and no further assessment of vapour intrusion risks was considered to be warranted. The results have however been considered further in terms of indications of potential groundwater impacts / pollution, and this is discussed in the next section.

Table 15. Soil Vapour Testing Results (selected VOCs)

Analytes	Screening Value (HSL A residential)	Screening Value (HSL D Commercial)	SV1	SV2	PSV1	PSV2	PSV3	PSV4	PSV5
			1/6/2018	1/6/2018	1/8/2018	1/8/2018	1/8/2018	1/8/2018	1/8/2018
Benzene	1	4	<0.0024	0.045	<0.0074	<0.0074	0.0016	<0.0074	<0.0074
Toluene	1,300	4,800	<0.0029	0.130	<0.005	<0.005	0.0077	<0.005	<0.005
Ethylbenzene	330	1,300	0.0046	0.012	<0.004	<0.004	<0.004	<0.004	<0.004
Xylenes	220	840	0.0191	0.091	<0.0041	<0.0041	0.0073	0.028	<0.0041
PCE	2	8	0.045	<0.0053	<0.0044	<0.0044	<0.0044	<0.0044	<0.0044
TCE	0.02	0.08	0.024	<0.0044	<0.0056	<0.0056	<0.0056	<0.0056	<0.0056
cis-1,2-DCE	0.080	0.3	0.016	<0.0039	<0.0093	<0.0093	<0.0093	<0.0093	<0.0093
TPH C6-C10 F1	180	680	1.6	1.6	-	-	-	-	-
TPH >C10-C16 F2	130	500	3.0	3.4	-	-	-	-	-

All results presented in milligrams per litre (mg/m³)

Adopted HSLs for TPH / BTEX assume sandy soil, source at <1m depth.

Adopted screening values for PCE, TCE and DCE apply to all soil types and all depths of sources.

6.4 Groundwater Assessment Results

Direct groundwater investigation was not completed as part of the environmental assessment at the audit site. The audit has been completed on the assumption that groundwater is polluted, which is allowed under Section 13 of '*Guidelines for issue of certificates and statements of environmental audit*' (EPA Publication 759.3, Dec 2015), with the following provisos:-

- a) Groundwater is likely to be polluted, but the site is not a source of groundwater pollution. Refer to the discussion below in relation to this.
- b) The beneficial uses of groundwater are not likely to occur at the site. The likelihood of the beneficial uses of groundwater being realised at the site has been assessed and documented in Section 5.1 / Table 6. There is no likelihood of groundwater being extracted and used at the audit site.
- c) Any pollution of groundwater would not affect any other beneficial uses of the site. The assumed pollution in groundwater would not affect any other beneficial use of the site. The key consideration for this is indirect exposures via vapour intrusion from the assumed groundwater pollution. Refer to section 6.3 - vapour intrusion risks are considered acceptable for the proposed future development.

Likelihood That Groundwater Is Polluted

The DSI report concluded that the site is unlikely to be a source of groundwater pollution, however groundwater at the site is likely to be polluted as a result of one or more offsite source/s. The auditor agrees with this assessment based on the following lines of evidence:-

Lines of evidence the site is unlikely to be a source of groundwater pollution:-

- Relatively benign site history. Site has been part of the Geelong Golf Links / Golf Course since at least the early 1900's. The site itself has been a car park. Two buildings partially encroached onto the northern portion of the site historically, but investigations targeting those areas found no evidence of any historical impacts.
- Absence of any features such as drainage sumps or underground tanks identified.
- Absence of any impacts found in soils that might be indicative of potential groundwater impacts. Impacts were limited to localised metals, PAHs, and >C10 TPH. These are not generally associated with groundwater impacts, and in addition, no impacts were reported in deeper soil samples analysed from locations where impacts were reported.

Lines of evidence groundwater is likely to be polluted from one or more offsite sources:-

- Trace concentrations of volatile organic compounds have been detected in soil vapour near the south western site boundary. Chemicals identified included benzene, toluene, ethylbenzene, xylenes, 1,2,4 trimethyl benzene, tetrachloroethylene, and trichloroethylene.
- The property directly to the south west across Ballarat Road at 108 Church Street Hamlyn Heights has been identified as a former service station that operated from the 1940s to 1970s. This property is located up gradient topographically and in terms of the expected direction of groundwater movement in this area, and is located close enough to the site (within 25m) for it to be considered a plausible offsite source of groundwater impacts and the impacts identified in soil vapour near that south western boundary.

Assumed groundwater pollution present under audit site

Figure 5 provided earlier in this audit report shows the locations of sites in the surrounding area where environmental audits have been completed previously. The auditor requested the assessment consultants to review available local groundwater information from the EPA's online database of environmental audit reports. The groundwater results from these sites are summarised below:-

- The closest site with groundwater data directly upgradient / west is at 151-153 Church Street, Geelong West – approximately 370m west. This is a former service station that was subjected to extensive remediation and follow up monitoring. Localised petroleum hydrocarbon impacts were identified at the site and a few adjacent properties to the west. Monitoring indicated the impacts were not continuing to migrate. The hydrocarbon impacts and remedial efforts including injections of amendments also resulted in changes to the geochemical conditions which were attributed to localised elevated results in groundwater including some metals (arsenic, copper, nickel, lead, and zinc), and also ammonia. Elevated nitrate results were also reported and were attributed as likely partly due to the remediation and also regional / background conditions. Given the localised nature of the impacts in groundwater identified at this site and the significant distance from the audit site, the auditor considers it is unlikely these impacts are relevant in the assessment of groundwater pollution at the audit site.
- The closest site down gradient / east is at 57 Church Street – approximately 275m east. This is another former service station. This site also had localised petroleum hydrocarbon impacts identified in groundwater and was subjected to remediation and follow up monitoring. The monitoring was focussed on the hydrocarbons and there is limited information available on other chemicals / substances. The results are considered of limited value in terms of inferring potential pollution under the audit site.
- Other sites with available groundwater data are located more than 500m north and south. There is limited groundwater data available from these sites and little if any is considered relevant to inferring possible pollution under the audit site.

Given the audit site is located a relatively large distance from the above sites the auditor does not consider the above data provides a suitable basis for assuming the presence of groundwater pollution under the audit site. The auditor has therefore assumed that groundwater under the audit site is polluted based simply on the detection of some volatile chemicals in soil vapour near the south western boundary. As noted previously, the volatiles detected in soil vapour were as follows:-

- BTEX (benzene, toluene, ethylbenzene, xylenes);
- Tetrachloroethene (PCE) and degradation products trichloroethene (TCE) and cis 1,2 dichloroethene (DCE);
- Trimethylbenzene; and
- Volatile petroleum hydrocarbons (TPH C6-C10 and >C10-C16).

The above chemicals would only be considered pollution if the concentrations present precluded beneficial uses of groundwater protected under the SEPP (Waters). In order to refine the above list and provide further technical justification for assumed groundwater pollution, the auditor ran some modelling to estimate the groundwater concentrations that in theory could be present under

the south western portion of the site that might correlate with the reported soil vapour results.

The model runs were completed using the RISC software package (Vsn5.1) and the vapour intrusion model from a groundwater source. The model provides estimates of vapour concentrations resulting from the groundwater source in vapour directly above the water table, and also in a building overlying the impacted groundwater. More sophisticated models can be used to predict concentrations in the soil profile for different scenarios and relate these back to a concentration at a source, but some conservative simplifications can be used so that the RISC modelling provides enough insights into potential groundwater concentrations that might correlate with the reported vapour results.

For this particular case, the auditor considered various model scenarios depicted in OSWER (2012)¹ which illustrate how the distribution of volatile organic compounds (VOCs) in the vicinity of subsurface soil or groundwater vapour sources are influenced by different chemical properties, as well as the site conditions and building conditions. Key observations from the OSWER (2012) document relevant to estimating source concentrations based on subsurface vapour measurements are noted below:-

- VOCs generated from a subsurface source will attenuate as they migrate upwards through the soil profile.
- If there is sufficient oxygen present then this will increase the attenuation of petroleum hydrocarbon vapours via biodegradation processes. Chlorinated hydrocarbons such as PCE and TCE are not subject to increased attenuation via biodegradation in the subsurface (although degradation products such as vinyl chloride are known to biodegrade if there is sufficient oxygen present in the subsurface).
- For petroleum hydrocarbon VOCs such as BTEX where there is oxygen present in the subsurface and biodegradation of vapours is occurring, scenarios depicted for groundwater sources within 3m-8m of the surface (applicable for this particular site) show the vapour concentration at a mid point between the groundwater and surface might be 2 to 3 orders of magnitude less than the source concentration. There have not been any measurements collected of oxygen levels in the subsurface at the site so it is not possible to confirm whether biodegradation of BTEX vapours might be occurring. However, based on the above discussion, assuming biodegradation is occurring at least to some degree would be a conservative approach and result in a higher estimate of the groundwater concentrations for these VOCs. For the purpose of this exercise, the auditor has conservatively assumed the vapour concentrations at the source for BTEX are 3 orders of magnitude higher than the reported results in soil vapour.
- For VOCs where there is no biodegradation of vapours occurring (eg. if the VOCs are PCE or TCE irrespective of oxygen levels, or BTEX where there is insufficient oxygen present in the subsurface), scenarios depicted for groundwater sources within 3m-8m of the surface (applicable for this particular site) show the vapour concentration at a mid point between the groundwater and surface might be between 0.3 to 0.7 times the source concentration. For the purpose of this exercise, the auditor has conservatively assumed the vapour concentrations at the source for BTEX are 3x the reported results in soil vapour.

¹ *Conceptual Model Scenarios for the Vapour Intrusion Pathway* (USEPA, Office of Solid Waste and Emergency Response, Feb 2012)

- Adding a building over a subsurface source of VOCs will generally change the distribution of VOCs in the subsurface under and in the vicinity of the building. There are no buildings in the vicinity of the south western boundary, so this scenario isn't relevant in the context of estimating source concentrations in groundwater beneath that part of the site and hasn't been considered further.

For this particular site, the auditor has run the model scenarios in RISC for a groundwater source, and then obtained estimates of the resulting vapour concentrations directly above the groundwater. Those source concentration estimates have then been modified to reflect possible attenuation of the vapours between the source and vapour bores installed at 2.5-3m depth. The assumed attenuation factors were based on the review of the conceptual model scenarios depicted in OSWER (2012) as noted in the previous set of dot points.

The model inputs / outputs are provided with the other auditor reviews in Appendix F. The following table provides a summary of the auditor's modelling results. Of the volatiles detected in soil vapour and run in the modelling scenario, the estimated groundwater concentrations for BTEX exceeded adopted screening criteria for at least one of the protected beneficial uses, but this was not the case for PCE, TCE and DCE. Although this is based on some highly conservative assumptions, this provides some technical basis to justify the auditor's assumption that groundwater is polluted and which chemicals are considered to be pollution. The auditor will also include the volatile TPH fractions (ie. C6-C10 and >C10-C16) in the list of pollutants, but will leave out trimethylbenzene as it is covered in any case by the inclusion of benzene.

Table 16. Estimated groundwater concentrations based on reported soil vapour data

Chemicals / analytes	Water Screening Criteria (µg/L)			Estimated concentration above groundwater corresponding to maximum reported soil vapour result – no attenuation of VOCs through soil profile (µg/L)	Estimated concentration above groundwater corresponding to maximum reported soil vapour result – with attenuation of VOCs through soil profile (µg/L)	Estimated groundwater concentration above any groundwater screening criteria?	Assumed pollution in groundwater?
	Aquatic waters (marine)	Stock	Water based recreation				
Benzene	700		10	0.215	215	Y	Y
Toluene	180		25	0.550	550	Y	Y
Ethylbenzene	5		3	0.045	45	Y	Y
Xylenes	200		20	0.344	344	Y	Y
PCE		50	300	0.072	0.215	N	N
TCE		20	200	0.060	0.180	N	N
DCE				0.100	0.300	N	N

Table 17. Current Groundwater Analytical Results Summary Table

As per EPA summary info requirements for CUTEF submissions (refer publications 840.2 and 759.3)

Contaminant	Concentration range (µg/L)			Guideline values (µg/L) Beneficial uses protected are shaded						
	Tertiary aged sediments (Moorabool Viaduct Formation) (approx. 5 - 10m depth to GW)			Water dependent ecosystems and species – Marine Water	Potable Water supply (acceptable)	Agriculture and irrigation (Stock)	Water-based recreation (primary contact recreation)	Agriculture and irrigation (irrigation)	Industrial and commercial	Buildings and structures
	Upgradient	Onsite	Downgradient							
ANALYTES CONSIDERED BY THE AUDITOR TO BE NATURAL AND HENCE NOT POLLUTION										
ANALYTES CONSIDERED BY THE AUDITOR TO BE SOURCED FROM THE SITE										
ANALYTES CONSIDERED BY THE AUDITOR TO BE FROM AN UPGRADIENT SOURCE										
TPH C6-C10		ND		600	600	600	600	600	-	-
TPH >C10-C16		ND		600	600	600	600	600	-	-
Benzene		ND		700	1	-	10	-	-	-
Toluene		ND		180	25 (A)	-	25	-	-	-
Ethylbenzene		ND		5	3 (A)	-	3	-	-	-
Xylene		ND		200	20 (A)	-	20	-	-	-
ANALYTES CONSIDERED BY THE AUDITOR TO BE REPRESENTATIVE OF REGIONAL POLLUTION										

ND – no data. Groundwater is assumed to be polluted based on lines of evidence as discussed elsewhere in the audit report.

(A) denotes a guideline value based on aesthetics / odour

Default sources of guidelines (unless indicated otherwise):-

Water dependent ecosystems and species – ANZECC (2000)

Potable water supply (acceptable) – ADWG (2011) (updated Nov 2016)

Agriculture and irrigation (stock) – ANZECC (2000)

Water based recreation – ADWG (2011) (as updated Nov 2016) values modified as per guidance in NHMRC (2008)

Agriculture and irrigation (irrigation) – ANZECC (2000) values for irrigation

(1) TCE screening values. Potable = WHO drinking water guideline. Recreation = 10 x potable value.

(2) PCE screening values. Potable = ADWG. Recreation = odour threshold as listed in WHO drinking water guidelines.

7. QUALITY AND COMPLETENESS OF INFORMATION

This section provides a general overview of the auditor's opinions of the overall quality and completeness of the assessment works. Reviews and communications by the auditor during the site assessment works are attached in Appendix F.

7.1 Soil Investigation and Clean Up Program

The following dot points summarise the auditor's review of the overall quality and completeness of the soil investigation information. Refer to the auditor's Data Quality Review in the audit report appendices for further details.

- **Rationale of sampling density and locations:** The initial investigation in 2016 was completed by Compass Environmental to achieve a grid based assessment of the site and to undertake a target the location of the former golf course clubhouse buildings and the asphalted car parking area. This approach was considered appropriate given the desktop historical assessment for the site giving limited indications of onsite potentially contaminating activities, with the exception of site filling, car park site use and potential contamination due building materials used in the club house construction. Subsequent assessment works completed by Compass during 2018 provided a more comprehensive overview of the thickness and composition of the fill on the site, in particular, the eastern portion of site where the former gully was located. Soil vapour bores and further soil investigation in the south-western portion of the site provided a greater level of confidence in the assessment and delineation of potential impacts associated with the up-gradient former service station site and fill along the southwestern site boundary. The number of samples collected is considered reasonable based on the site area, the history of the site, and the staged investigation completed by Compass. Overall, the sampling density and locations are considered sufficient in terms of characterising the site conditions.
- **Sampling methodology:** The initial grid and targeted based soil sampling in 2016 was completed via mechanical rigs (direct-push methods). This allowed for collection of undisturbed core samples, which is preferred for investigations where there are volatile chemicals may be present (given the unknown source and condition of site fill and neighbouring up-gradient former service station). Test pitting was later employed by Compass to investigate the deeper areas of fill in the eastern portion of the site. Test pitting is considered appropriate as it allows for extensive visual inspection of fill, in particular where demolition materials are present. Soil vapour sampling was considered appropriate to assess the impacted associated with the offsite service station, where the potential for volatile compound contamination of groundwater exists. These methods are considered suitable for the depths and types of contamination being targeted. Overall, the adopted sampling methods are likely to have provided results representative of the site conditions.

The overall soil analysis program included the following primary sample analyses: -

- Metals (Sb, As, Ba, B, Be, Cd, Cr (total), Co, Cu, Pb, Mn, Hg, Mo, Ni, Se, Ag, Sn, V and Zn) – 31 analyses.
- Hexavalent chromium – 4 analyses.
- TRH – 18 analyses.
- MAH – 10 analyses.
- PAH – 32 analyses.
- Total cyanide, fluoride, pH, phenols (halogenated and non-halogenated), herbicides, PCBs and asbestos – 4 analyses.
- TRH (silica gel) CEC and sulphate - 2 analyses.

- CHCs and OCPs – 26 analyses.
- HVOLs – 11 analyses.

Leachable concentrations of barium, lead, benzo(a)pyrene, naphthalene and total PAH were also analysed in three selected samples. The analytical schedule adopted was considered appropriate to identify the potential contaminants of concern as identified through the site history review.

- **Field screening:** the reports indicate a calibrated PID was routinely used to screen soils for VOCs and visual and olfactory indications of contamination were recorded in the field. PID readings and records of visual and olfactory inspection of the soils are entered on the drilling logs and summarized in Table 16 of the DSI.
- **Documented procedures:** The reporting of the soil assessment in the DSI report included adequate information regarding procedures for sample collection, labelling, handling, storage, and transport. The documented procedures are consistent with industry best practice and current guidelines including Vic EPA Publication 441, AS4482.1-2005 and AS4482.2-1999, with the exception of the temperature ranges of samples received by the laboratory in three batches of samples (representing 42 samples) which ranged in temperature between 12-15°C. Given the additional sampling in 2018, this is considered sufficient to offset any concerns regarding the integrity of the samples and the loss of volatiles in the initial phase of sampling that may have occurred as a result.
- **Analyte selection:** The range of laboratory analyses performed covered the main chemicals / substances of concern based on the site history and potential historical contamination. This included a reasonable number of broad screens for inorganics and organics, with the majority of samples being analysed for metals, PAH and OCPs (the main chemicals of interest based on the imported filling at the site and use as part of the golf course facility). An adequate number of samples were analysed for broader TPH, MAHs, HVOLs and VOCs. The range of analytes is considered appropriate based on the contamination sources identified during the course of the assessment, and guidance provided in the ASC NEPM (Amendment 2013) and AS4482.1-2005.
- **Plans and bore logs:** Site plans showing the general site layout and the sampling locations, along with bore logs are presented in the assessment and remediation reporting. The plans and logs were generally completed to a standard generally consistent with current guidelines and standards including the ASC NEPM (Amendment 2013) and AS4482.1-2005.
- **Accreditation of laboratories:** The current guidance to auditors (refer Vic EPA Publication 759.2) requires any laboratory analyses to be performed by laboratories with accreditation by the National Association of Testing Authorities (NATA). NATA accredited laboratories have demonstrated the ability to produce reliable, repeatable data for a range of parameters in a range of sample matrices. The accreditation is dependent on participation in NATA and other national and international proficiency programs, and performance against certified reference materials/standards. The laboratory reports included with the assessment and validation reporting indicated they held NATA accreditation for all analyses conducted.
- **Sample holding times:** There were no holding time issues evident for the various investigation and validation samples collected.
- **Analytical detection / reporting limits:** The detection limits for soil analyses were below the adopted soil assessment criteria. It is noted that the primary and secondary laboratories occasionally achieve different reporting limits for some analytes however,

since the detection limits were below the assessment criteria, this was not critical in terms of the overall interpretation of the results.

- **Field QA/QC samples – blind field replicate samples:** Blind replicates (also referred to as duplicate, triplicate or splits) are samples that are replicated in the field and sent to both the primary and second laboratories to assess the repeatability and variation of the laboratory data. The frequency of QA/QC sampling undertaken during the 2016 soil sampling is considered broadly in line with AS4482.1 (2005) and the ASC NEPM (Amendment 2013) requirements. However, no field replicate samples were collected for the 2018 sampling period and no information in relation to the lack of replicate sampling was provided by the assessor. It is acknowledged that the 2018 rounds of sampling were undertaken for the purposes of improving the assessment of depth and characterisation of the fill onsite. In the replicate samples analysed, inter and intra laboratory variation was evident, however this was mainly due to heterogeneity in the fill materials and was not considered a significant data quality issue. Overall the results were not indicative of any significant data quality issues.
- **Field QA/QC samples – blanks:** The soil assessment work included trip and rinsate blank samples for the 2016 soil sampling, however rinsate and trip blank were not consistently collected during the 2018 soil assessment works. Of the field blanks collected, results were not indicative of any issues regarding cross contamination or introduced contamination.
- **Laboratory QA/QC testing:** The auditor has reviewed the laboratory reports and considers the internal QA/QC reporting is not indicative of any significant internal laboratory QA/QC issues.
- **Auditor verification samples:** No auditor verification samples were collected as part of the soil investigation.
- **Assessment criteria:** The adopted soil assessment criteria and generic information on the application / relevance of these criteria are listed in the Compass DSI. The reports adopted ecological and health-based investigation levels from the ASC NEPM. As noted earlier in the audit report, the auditor considered some of the ecological investigation levels adopted by Compass were not calculated as per the ASC NEPM EIL calculation spreadsheet, and different values were therefore adopted in some cases.
- **Subsurface conditions and site characterisation – delineation of impacts, toxicity and mobility of contaminants of concern:** The interpretation of site conditions in the Compass DSI conveys a reasonable understanding of the subsurface lithology encountered. Characterisation of soils have been undertaken over a number of stages, taking into account the findings of earlier assessment works to address perceived data gaps (e.g. further investigation of fill depths and delineation of soil vapour impacts). While fill remains on the site, ASLP testing has been completed to ascertain the mobility of the contaminants that remain present (lead, PAH and B(a)P)). Calculations have been provided in based on the soil vapour results, indicating a negligible potential for NAPL to be present onsite due to up-gradient sources of contamination to the south-west.
- **Underground infrastructure:** No underground infrastructure (such as underground storage tanks or pipelines) were identified during site characterisation works, and based on the site history and supporting evidence provided, the auditor is comfortable that no such infrastructure is, or has been, present at the site.

- **Compliance with relevant IWRGs and policies regarding waste management:** It is understood that no soils were remediated or excavated and removed offsite during the Compass environmental assessment. Any future removal of fill from the site for offsite disposal should be completed in accordance with relevant IWRGs and policies regarding waste management.
- **Risk evaluation and impact assessment for chemicals/substances of concern:** The Compass DSI presents a reasonable review of the residual soil conditions and provides confidence that the soils remaining meet adopted screening values and/or can be appropriately managed for the proposed future redevelopment.

7.2 Soil Vapour Assessment – Quality & Completeness

The sampling and analysis of soil vapours is documented in Section 10 of the DSI Report. The following section provides an overview of the auditor's review of the soil vapour investigation:

- **Sampling rationale and scope.** The soil vapour investigation comprised the installation and sampling of two vapour bores targeting the area of site in closest proximity to the former service station, up-gradient of the site. The intention was to assess evidence of vapour impacts and a broad analysis suite was adopted (VOCs, TPH, TRH, MAH, PAH, HVOLs, CHCs and solvents). The auditor was consulted on the proposed approach for the vapour investigation, and considered it was reasonable based on the conceptual site model. Following receipt of the laboratory analysis data indicating TCE and benzene impacts in vapour, five additional soil vapour bores were installed to delineate the impacts reported at SV1, and additional vapour survey work was completed via deployment of passive diffusion samplers in these bores. The auditor agrees that this was an appropriate rationale to extend the scope of assessment and delineate the vapour impacts observed during initial monitoring.
- **Sampling methodology.** Soil vapour sampling was completed via two different methods. The sub-surface vapour points (SV1 and SV2) were sampled into a laboratory supplied canister. The five other locations (PSV1 to PSV5) were sampled using passive diffusion samplers deployed in the bores (Waterloo WMS-LU type). Both methods are appropriate for this type of screening level assessment.
- **Documented procedures.** The report of the vapour sampling indicates sample handling, storage and transport protocols employed during the vapour sampling event were appropriate. The COCs forms and field records are included in the DSI report appendices, and sample receipt advice forms accompanying the samples and the laboratory analysis reports both confirmed samples were received in appropriate containers and with appropriate preservation. Sampling was sub-contracted by Compass to SGS Leeder, who are acknowledged industry experts in this aspect of site assessment work.
- **Analyte selection.** Analyses were conducted for TPH and a broad suite of VOCs including BTEX. The auditor is satisfied the range of analytes is appropriate based on the potential contamination sources being assessed.
- **Accreditation of laboratories.** The vapour samples were analysed by SGS Leeder. The laboratory analysis reports indicated the laboratories had NATA accreditation for the analyses.

- Adherence to Holding Times. Based on dates of samples and analyses indicated in the various laboratory reports, samples appear to have been analysed within recommended holding times.
- Analytical Detection Limits. Detection limits were below the respective vapour screening criteria.
- Assessment criteria. The DSI Report compared the soil vapour data against the NEPM Interim HILs (2013) for chlorinated compounds and HSLs for petroleum hydrocarbons. These are the current appropriate initial screening values. The petroleum hydrocarbon values adopted by Compass are considered reasonable and defensible. Compass proposed some alternative screening values and attenuation factors for PCE and other chlorinated hydrocarbons that were based on selected guidance from the USA. As noted elsewhere, the auditor does not consider some of those values to be defensible but ultimately this does not affect the overall assessment of risks (which are negligible in any case).
- At the auditor's request, Compass undertook an assessment based on the *Petroleum Hydrocarbon Vapour Intrusion: Australian Guidance*² and TCE solubility indicators³ to consider the likelihood of NAPL being present beneath the site. Based on the concentrations reported, the potential for either LNAPL or DNAPL being present beneath the site is negligible. This is supported by the auditor's modelling and estimates for groundwater concentrations beneath the site.
- Risk evaluation and impact assessment for chemicals/substances of concern. A Tier 1 vapour risk assessment was completed by Compass, with detected concentrations compared to the adopted assessment criteria, as defined in the NEPM ASC. The auditor does not agree with the rationale for adoption of some of the alternative screening values proposed by Compass for the chlorinated hydrocarbons, but ultimately this does not change the outcomes of the risk assessment – it is agreed the vapour intrusion risks are negligible in any case.

7.3 Overall Quality and Adequacy of Information

Overall the data provided by the assessor provides a dataset that is of appropriate quality and quantity to assess the condition of the site and complete the environmental audit.

² Wright, J. 2013. *Petroleum hydrocarbon vapour intrusion: Australian guidance*. CRC Care Technical Report No. 23. June 2013.

³ The solubility of TCE in water at 25 degrees Celsius 1,280 mg/L (reference: Horvath AL et al; *J Phys Chem Ref Data* 28: 449. 1999).

8. IMPACTS ON BENEFICIAL USES OF THE SITE

The following sections detail the auditor's evaluation of the environmental condition of the site, and risk to beneficial uses associated with the site. Detriment to protected beneficial uses of the site which are relevant (i.e. existing or likely) precludes the issue of a Certificate of Environmental Audit for that site. Where a Certificate can't be issued, a Statement of Environmental Audit would be issued which specifies the uses the site is considered suitable for, along with conditions for any clean up or ongoing management required.

8.1 Contamination Risks at and in the Vicinity of Audit Site

Soil Conditions

Some soil test results exceeded investigation levels that would allow for unrestricted use of the site, and on this basis the site does not qualify for a Certificate of Environmental Audit. Without exception the impacts were limited to the layer of fill materials. Natural soils were not found to be impacted by historical contamination.

From an ecological viewpoint, the results above adopted screening values were limited to lead, benzo(a)pyrene, and TRH >C16-C34. The screening values adopted are based on protection of terrestrial ecosystems. The results might be of concern in a more pristine location, but not in this older urban area which can be considered a highly modified ecosystem. Other potential adverse environmental effects from impacted soils such as those found on this site might include impacts to stormwater and downstream receiving aquatic ecosystems (via stormwater runoff into drains), impacts on vegetation in landscaped or garden areas, or impacts on native wildlife or pets coming into contact with the soils. The risks from these have not been quantified but are considered negligible, considering the majority of the site will be covered by either buildings or car park areas.

From a human health viewpoint, the impacts were limited to lead and PAHs, with the highest results exceeding adopted HIL values based on residential use (irrespective of whether there are accessible soils or not). All results were below the HIL values based on commercial / industrial land use. The chemicals / substances of concern will not degrade over time. They are however non-volatile and have limited environmental mobility. Potential exposures are therefore limited to direct contact and incidental ingestion, so the risks are considered negligible if access to the impacted soils was prevented.

In order to manage potential risks associated with the abovementioned impacts for future occupation / use of the site, the statement of environmental audit will include a condition requiring the provision and maintenance of a barrier over the existing site soils to limit potential adverse effects associated with exposure to the soils.

No additional management measures are considered warranted for the construction phase or future intrusive maintenance works. With results being below adopted screening values for commercial / industrial use, those values are considered sufficiently protective for workers involved in future construction and/or intrusive maintenance works, provided workers adhere to standard construction site practices in relation to personal protective equipment and personal hygiene.

Groundwater Conditions

As noted previously, no direct groundwater assessment has been undertaken at the site. The audit is being completed assuming groundwater is polluted due to an upgradient source. The assumed pollution includes TPH C6-C10 and >C10-C16 fractions, and BTEX. All beneficial uses protected in this groundwater segment are assumed to be precluded at the site.

There is no risk posed by these groundwater impacts unless the water was actually extracted and used. There is no indication of any current groundwater use at the site and future use is also highly unlikely based on the future redevelopment (childcare centre and sports rehabilitation facility). The impacts identified in groundwater do not pose any significant risks via indirect exposures, for example by migration of volatiles into overlying buildings (refer to earlier discussion regarding soil vapour assessment and results).

8.2 Impacts on Beneficial Uses of Land

This section provides an overview of the auditor's evaluation of the condition of land at the site, and potential impacts to beneficial uses of the site, including (but not limited to) the beneficial uses of land protected under the SEPP Prevention and Management of Contamination of Land.

Maintenance of Ecosystems

The SEPP (Prevention and Management of Contamination of Land) specifies 3 levels of ecosystems to be protected based on the land condition. 'Natural ecosystems' include parks and forested areas well away from urban areas, and are generally undisturbed by human activity. "Modified ecosystems" include ecosystems disturbed by human activity but with significant ecosystems remaining, such as public open spaces and low density residential allotments. "Highly modified ecosystems" include residential, public open space or commercial/ industrial areas with landscaping and lawn areas. The most applicable category for this site is considered to be a 'highly modified ecosystem'.

The site has been subject to over a century of human activities and disturbance, and may be considered to be a highly modified ecosystem. The only contamination identified in site soils was limited to the layer of fill material currently present across the audit site. This material contains concentrations of lead and PAHs that are deemed to pose a potential long term risk of adverse impacts to terrestrial ecosystems and other environmental receptors if left exposed in a future development scenario.

The site condition does not pose a significant limitation to ecosystems based on the future development scenario which involves the majority of the site being covered by buildings and paved car parking areas, with limited areas of landscaping. It is therefore concluded that the site condition is detrimental to the beneficial uses 'maintenance of ecosystems' ('natural ecosystems' and 'modified ecosystems'), but is not detrimental to 'maintenance of ecosystems' ('highly modified ecosystems').

Human Health

The SEPP (Prevention and Management of Contamination of Land) requires that land contamination should not pose a threat to human health.

The contamination identified in site soils was limited to the layer of fill material currently present

across the audit site. This material contains isolated zones with concentrations of carcinogenic PAHs and lead that are deemed to pose a potential long term health risk if left in areas of accessible soils in a future redevelopment scenario. In terms of the proposed future development (child care centre and sports medicine / rehabilitation centre), there is no land contamination at the site that poses a risk to human health on the proviso that direct access to the impacted fill materials is prevented. The audit Statement will be including a condition requiring provision and maintenance of a barrier over the existing site soils that comprises either a building, paving, or a minimum of 0.5m of certified clean imported soil in landscaped areas.

It is also noted that the levels of contamination identified in site soils do not warrant further site specific management measures or worker protective measures, over and above standard measures for construction sites.

Buildings and Structures

The SEPP (Prevention and Management of Contamination of Land) requires that land contamination should not cause the land to be corrosive to or adversely affect the integrity of structures or buildings. Based on reported soil pH and sulphate values, the soils at the site fall within the “non-aggressive” to “mild” category of soil conditions in terms of exposure classification for concrete piles, as defined in AS2159 ‘Pile Design and Installation’. There were no other impacts found in the remaining soils that might be indicative of a potential adverse effect on future buildings. It is concluded the site condition is not detrimental to the beneficial use ‘buildings and structures’.

Aesthetics

The SEPP (Prevention and Management of Contamination of Land) requires that land contamination should not cause the land to be offensive to the senses of human beings. The main aspect of concern from this viewpoint was the layer of fill material covering the site. Investigations noted this material was a sandy and/or gravelly clay, with limited secondary constituents noted including brick fragments and crushed rock. No asbestos containing materials or other wastes were noted in any of the boreholes or test pits. The secondary constituents in the fill layer may pose an aesthetic limitation in the context of future residential or open space use where there are gardens and landscaped areas with accessible soils, but the impacts are not considered significant in the context of the proposed redevelopment of this site where there will be limited directly accessible soils (and there will be a condition in the audit Statement requiring any landscaped / garden areas are provided with a layer of certified clean imported soils). It is concluded there is no land contamination remaining that may be considered as having aesthetic limitations for the proposed development.

The Statement of Environmental Audit will also note that because the asphalted car park has been left intact allowing investigations via boreholes at discrete locations only, and there is fill material present, it is not possible to rule out the possibility of encountering other wastes including (but not limited to) asbestos containing materials during future earthworks. There is a recommendation provided in the Statement noting the need to dispose of any wastes and/or surplus soils in accordance with relevant Industrial Waste Resource Guidelines (IRWGs) and Worksafe requirements.

Production of Food, Flora and Fibre

The SEPP (Prevention and Management of Contamination of Land) requires that land contamination should not affect the quality or yield of produce, or affect the level of an indicator in food that exceeds prevailing food quality standards. This beneficial use is protected in all sensitive land use scenarios with the exception of high density residential, and is also protected for 'agricultural' land use and 'parks and reserves' land use. There is land contamination present that would potentially preclude this beneficial use. It is therefore concluded that the site condition is detrimental to the beneficial use 'production of food, flora and fibre'.

Soils as a Source of Groundwater Pollution

The site investigation results were not indicative of there being any residual soil impacts that might be acting as a source of groundwater pollution at or in the vicinity of the site.

Soil as a Source of Air Pollution

There is no evidence of any historical impacts present in soils at the audit site that might be associated with significant levels of air pollution.

8.3 Impacts on Beneficial Uses of Groundwater

This section provides an overview of the auditor's evaluation of the condition of groundwater at the site, and potential impacts to beneficial uses of the site, including (but not limited to) the beneficial uses of groundwater protected under the SEPP Waters.

There is no indication that the site is a source of groundwater pollution and no direction groundwater assessment was undertaken at the site. The audit has been completed assuming groundwater is polluted by C6-C10 and >C10-C16 TPH fractions, and BTEX, which are likely attributed to an off-site upgradient source.

Water Dependent Ecosystems and Species

The current guidance for conducting environmental audits on a segment of the environment requires groundwater quality and the beneficial use 'Water Dependent Ecosystems and Species' to be considered in the context of groundwater impacting water dependent ecosystems. The purpose and intent outlined in the SEPP Waters is '*...that groundwater quality does not adversely affect surface water systems*'. Section 13.2 of EPA Publication 759.3 'Guidelines for Issue of Certificates and Statements of Environmental Audit' indicates the groundwater quality objectives for protection of aquatic ecosystems should be applied to groundwater at the point of discharge to a surface water body. Any consideration of 'maintenance of ecosystems' relating to groundwater therefore should take into account the groundwater quality, but also the likely point of discharge and surface water / groundwater interaction, and also the surface water quality (if that data is available).

Relevant factors for this audit site are as follows: -

- The nearest downgradient water body where groundwater might in theory discharge is Corio Bay, approximately 1.1 km east.
- Given the significant distance from the site to Corio Bay, and the relatively low bulk conductivity of the water table aquifer, this provides ample opportunity for any impacts in

groundwater in the vicinity of the audit site to be attenuated before they reach that water body at potentially harmful concentrations.

Groundwater is assumed to be impacted by C6-C10 and >C10-C16 TPH fractions, and BTEX which preclude this beneficial use at the site. The beneficial use is not precluded offsite at the nearest point of groundwater discharge for reasons noted above.

Potable Water supply

Not protected in this groundwater segment and not considered further.

Potable Mineral Water supply

Groundwater is assumed to be impacted by C6-C10 and >C10-C16 TPH fractions, and BTEX which preclude this beneficial use at the site. As noted earlier in the audit report, the site is not in a recognized mineral water supply area and therefore this beneficial use is not considered to be relevant (ie. existing or likely). It has not been considered further.

Agriculture and irrigation (irrigation)

Not protected in this groundwater segment and not considered further.

Agriculture and irrigation (stock watering)

Groundwater is assumed to be impacted by C6-C10 and >C10-C16 TPH fractions, and BTEX which preclude this beneficial use at the site. This beneficial use is not considered relevant (ie. existing or likely) either onsite or offsite as it is not compatible with the proposed future development of the site or land use in the surrounding area.

Industrial and commercial

Suitability of water supply for industrial purposes is very specific to the particular use. Basic water quality parameters such as salinity can preclude many industrial uses. The 1992 ANZECC guidelines discuss water quality in terms of the following broad industrial groups – generic processes (heating and cooling), hydro-electric power generation, textile industry, chemical and allied industry, food and beverage industry, iron and steel industry, tanning and leather industry, pulp and paper industry, and petroleum industry.

Groundwater is assumed to be impacted by C6-C10 and >C10-C16 TPH fractions, and BTEX which preclude this beneficial use at the site. This beneficial use is not considered relevant (ie. existing or likely) either onsite or offsite as it is not compatible with the proposed future development of the site and there is no indication groundwater in the surrounding area is being used for industrial or commercial purposes.

Water-based recreation (primary contact recreation)

Groundwater is assumed to be impacted by C6-C10 and >C10-C16 TPH fractions, and BTEX which preclude this beneficial use at the site. This beneficial use is not considered relevant (ie. existing or likely) at the site as it is not compatible with the proposed future development of the site. Although the search of registered bores showed one bore within 2 km of the site could potentially be in use or was listed for domestic use (and also potentially for recreational use), this beneficial use is not considered compatible with land use in the surrounding area. Other relevant factors

include the relatively high costs of installing a bore, and the fact the area is provided with a reliable reticulated potable water supply.

Traditional Owner Cultural Values

Groundwater is assumed to be impacted by C6-C10 and >C10-C16 TPH fractions, and BTEX which preclude this beneficial use at the site. This beneficial use is not considered relevant (ie. existing or likely) at the site as it is not likely to be extracted or utilised for these purposes. This beneficial use would apply at the point of discharge (i.e Corio Bay). As noted previously, the distance to this water is considered sufficient to limit any potential threat from the assumed groundwater impacts at the audit site.

Cultural and Spiritual Values

Groundwater is assumed to be impacted by C6-C10 and >C10-C16 TPH fractions, and BTEX which preclude this beneficial use at the site. This beneficial use is not considered relevant (ie. existing or likely) at the site as it is not likely to be extracted or utilised for these purposes. This beneficial use would apply at the point of discharge (i.e Corio Bay). As noted previously, the distance to this water is considered sufficient to limit any potential threat from the assumed groundwater impacts at the audit site.

Buildings and Structures

There is no indication to suggest the assumed groundwater impacts beneath the site due to an offsite up-gradient source is of relevance to protection of buildings / structures, and on this basis, it is concluded the groundwater is not polluted with respect to this beneficial use.

Geothermal Properties

The SEPP Waters indicates that for the purposes of geothermal uses that no activity must affect the geothermal properties of groundwater and the specific indicators include temperatures between 30 and 70 degrees Celsius. Based on general groundwater properties reported from other sites in the area, the natural temperature of groundwater beneath the site is not likely to be in this range so the groundwater would not support geothermal uses. In any case, the assumed groundwater impacts beneath the site are not considered likely to have an adverse effect on the geothermal properties of groundwater.

Groundwater as a Source of Air Pollution

The assumed pollution present in groundwater beneath the site has been assessed as not posing a significant risk of air pollution or via vapour intrusion into buildings for the proposed future development.

Summary of Precluded Beneficial Uses of Groundwater

The following table provides a summary of the precluded beneficial uses and contaminants exceeding the relevant screening criteria. The table is based on the EPA's standard format required to be included with any groundwater pollution assessment – as outlined in Appendix C of 'The Clean Up and Management of Polluted Groundwater' (EPA Publication 840.2, April 2016).

Table 18: Precluded beneficial use summary table

Precluded beneficial use	Contaminant(s)
Water dependent ecosystems and species Traditional Owner cultural values Cultural and spiritual values	C6-C10 TPH (b), >C10-C16 TPH (b), benzene (b), toluene (b), ethylbenzene (b), xylenes (b).
Potable water supply	NA
Potable mineral water	C6-C10 TPH (b), >C10-C16 TPH (b), benzene (b), toluene (b), ethylbenzene (b), xylenes (b).
Agriculture and irrigation (Irrigation)	NA
Agriculture and irrigation (Stock watering)	C6-C10 TPH (b), >C10-C16 TPH (b), benzene (b), toluene (b), ethylbenzene (b), xylenes (b).
Water-based recreation (Primary contact recreation)	C6-C10 TPH (b), >C10-C16 TPH (b), benzene (b), toluene (b), ethylbenzene (b), xylenes (b).
Industrial and commercial	C6-C10 TPH (b), >C10-C16 TPH (b), benzene (b), toluene (b), ethylbenzene (b), xylenes (b).
Buildings and structures	NE
Geothermal properties	NE

Notes:

(n) – naturally occurring

(b) – background / regional pollution

NA – Not applicable

NE – No exceedance

Note that the values listed above against the beneficial use 'water dependent ecosystems and species' are simply those results that exceeded the adopted screening criteria. As discussed in the previous section, the beneficial use is not considered to be precluded based on consideration of groundwater quality objectives at the nearest surface water where groundwater might in theory discharge.

8.4 Practicability of Further Groundwater Clean Up

The Victorian regulatory framework requires groundwater pollution to be cleaned up so that relevant (ie. existing and potential) beneficial uses of groundwater are restored. The framework recognises that in some cases this will not be possible or feasible, however, in all cases polluted groundwater must be cleaned up to the extent practicable. The concept of clean up to the extent practicable (CUTEP) is outlined in 'The Clean Up and Management of Polluted Groundwater' (Vic EPA Publication 840.2, April 2016).

In some circumstances only EPA can make the determination whether groundwater has been cleaned up to the extent practicable, but there are a limited number of circumstances where an auditor is able to make the determination. The auditor considers this site falls into the latter category (first and foremost because it is a "non-source" site), and has therefore determined that CUTEP has been achieved as per Section 13.7 of the current auditor guidelines (Vic EPA Publication 759.3, December 2015). The auditor notes that for a non-source site, there are 3 conditions that allow an auditor to determine CUTEP:-

- I. Site is not the source (or likely source) of the pollution. The pollution identified in groundwater under the audit site is considered likely to be associated with one or more up-gradient sources. Lines of evidence supporting this assertion were provided in Section 6.4.
- II. Beneficial uses of groundwater are not relevant (i.e. existing or likely). The relevance of the protected beneficial uses of groundwater has been assessed in Section 5.1 / Table 6 – none are considered relevant.
- III. Access to the site is not required to effect the only practicable clean up options to protect surface water from the effects of groundwater pollution. Active remediation to protect surface water quality is not considered warranted as there is no evidence to indicate surface water has been impacted or is under threat from the groundwater pollution (refer Section 8.3).

The following tables provide the auditor's CUTEP assessment against the requirements of EPA Publication 840.2. The review of clean up technologies has not identified any clean up approach that can be justified on technical, logistical and financial terms based on the combination of the hydrogeological setting, the nature of the pollution, and associated risks. A completed CUTEP information checklist is included with other auditor reviews in Appendix F.

Table 19. Auditor CUTEP Assessment

General Requirements	Auditor Comments
Characterisation of groundwater and aquifers. Prior to any clean up and/or management of polluted groundwater, the groundwater and aquifers should be characterized to assess the nature, extent and degree of pollution. The level of risk posed by the pollution should also be assessed.	The groundwater and aquifers have been adequately characterized, and the associated risks are well understood. Refer to Sections 3.2, 3.3, 4.2, 6.4 of this audit report. Groundwater is present under the site in the Moorabool Viaduct Sands formation at approx. 5-7m depth. Groundwater has been assumed to be polluted with TPH and BTEX. The most likely potential source is a former service station located across Ballarat Road to the south west. The pollutants identified are volatile organics. There is no evidence of NAPL. The service station (inferred source) has not been operational for a long time (at least 25 years). The impacts are therefore likely at steady state (if there is a source still present) or in a phase of retreat. Further migration of impacts onto the audit site is considered unlikely. The polluted groundwater does not pose any significant risk unless the groundwater was to be extracted and utilized – for example for domestic non-potable and potable uses, irrigation, recreation, or industrial uses. There is no current use of groundwater at the site or in the immediate area and future use is also considered unlikely. There is no risk of indirect exposures via vapour intrusion – this has been assessed via direct measurements of vapour under the site.
Source removal & control. Removal or control of the source/s is a necessary first step in any clean up of polluted groundwater. It may not be possible to meet	As noted above, the inferred likely source is a former serviced station across Ballarat Road to the south west. Therefore source removal and/or control are not going to be able to be achieved via any technology implemented at the site.

General Requirements	Auditor Comments
clean up objectives if there is a continuous supply of contaminants to the groundwater. Any NAPL present must be removed unless EPA is satisfied there is no unacceptable risk posed by the NAPL. In most cases, NAPL present in an aquifer must be removed. Where complete removal is impracticable, the source must be removed to the extent practicable and treatment / control measures implemented.	The best that could be achieved with clean up approaches at the site would be plume control measures to prevent further migration onto the audit site. As noted above, the impacts are considered likely at steady state or in a phase of retreat in any case. Removal and control of the source would only be achieved via a co-ordinated approach with the owner of the inferred source site (after appropriate characterisation to inform the strategy). As noted above, there is no evidence to suggest NAPL is present at or in the vicinity of the site.
Clean Up objectives. The ultimate goal for any clean up is to restore beneficial uses of groundwater, both onsite and offsite. Where clean up to meet the above objectives is not practicable, alternate clean up objectives should be derived that reflect clean up to the extent practicable, considering the extent and degree of pollution, likelihood of detriment to beneficial uses, and the efficiency of the selected clean up technology.	As clean up of the polluted groundwater to restore beneficial uses will not be able to be achieved because of one or more offsite sources remaining, objectives relating to restoration of beneficial uses and source removal / control are not achievable. The following alternative objectives are proposed for clean up and management of groundwater pollution at the site:- ○ Protect human health and the environment; ○ Reduce concentrations of dissolved phase impacts within the audit site; ○ Limit any further migration of groundwater pollution onto the audit site; As will be discussed below, the first objective can be met by simple controls on groundwater extraction and declaration of a Groundwater Quality Restricted Use Zone (GQRUZ) encompassing the site. The second and third objectives may not be able to be practically achieved and have been discussed further in the review of potential clean up technologies.
Review of Clean Up Technologies. Technologies for clean up should be reviewed on the basis of the groundwater and aquifer characterization (ie. the contaminants and the hydrogeological setting), and their ability to meet the clean up objectives. The review and assessment of practicability should include technical, logistical and financial considerations. The clean up measures adopted shall be cost effective and commensurate with the significance of the environmental issue being addressed.	Table 20 on the following page provides an initial screening of potential treatment technologies for the identified groundwater pollution at the audit site. This initial listing is based on technologies listed in the Federal Remediation Technologies Roundtable (FRTR) Treatment Technologies Screening Matrix. The FRTR is a collaboration of federal agencies in the USA, providing information resources and technology tools relating to environmental cleanup programs. The initial listing includes all technologies listed for treatment of organic contaminants (fuels) in groundwater, surface water and leachate. Only those technologies rated 'above average' were retained in the initial listing. None of the technologies implemented at the site would restore groundwater beneficial use or result in removal or control of the source. The data suggests there is a dilute

General Requirements	Auditor Comments
	dissolved phase plume encroaching under the south western boundary of the site and into the site for a short distance. It seems likely this may be the leading edge of an old petroleum hydrocarbon plume. The concentrations of BTEX are not high enough to pose a significant vapour intrusion risk in the unlikely event any buildings might be established on or near that SW boundary. This includes possible single level basements. It is noted the proposed development plan involves new buildings in the central and northern portion of the site, which are well away from the SW boundary in any case – and no basements are proposed either. The best that might potentially be achieved with further clean up efforts is plume treatment, and prevention of further migration of groundwater pollution onto the site. However, this would require continued pumping to capture impacted groundwater entering the site and treatment, or installing barriers to prevent further migration of polluted groundwater onto the site, and there would be no foreseeable end point. All of the potential clean up technologies have logistical and financial limitations, and implementing any of them would not be commensurate with the significance of the environmental issues being addressed. The implementation of any of the potential technologies would also not change the risk profile in relation to the groundwater pollution (which is acceptably low in any case).
Management of polluted groundwater. Groundwater pollution and use of groundwater should be managed to ensure protection of human health and the environment. Key components of any plan to manage polluted groundwater should include the following components:- - Setting objectives consistent with CUTEP requirements; - Groundwater monitoring; - Trigger levels; - Contingency plan; - Controls on use of polluted groundwater; - Periodic review of the practicability of groundwater clean up.	The auditor does not consider that a groundwater management plan is warranted for this particular site, as the risks posed by the groundwater pollution can be effectively managed by a Statement condition noting groundwater must not be extracted and utilised for certain beneficial uses, and designating the site to be a GQRUZ.
Regulatory requirements. Some clean up technologies will involve discharge to aquifer, surface water, land and/or air. Discharges during groundwater clean up must not pollute the receiving environment.	This is not applicable for this site as further clean up is not considered practicable.

Table 20. Review of Potential Groundwater Clean Up Technologies

Technologies	Ability to Meet Clean Up Objectives (assuming technology is implemented at the site)			Technical Considerations	Logistical Considerations	Financial Considerations	
	Restoration of beneficial uses in groundwater	Source reduction / control	Limit / prevent further migration of contaminants onto site				
In-situ Biological Treatment							
Enhanced bioremediation	No	No	Limited applicability	Potentially applicable purely on technical terms – suitable for source zone treatment and plumes	Would require targeted delivery of amendments. No likely constraints	Moderate to high	Moderate
Monitored natural attenuation	No	No	Potentially applicable	Potentially applicable purely on technical terms for source zones and plumes	Would require a network of monitoring wells to be established near SW boundary and within affected portion of site (limited to close to SW boundary)	Moderate	Moderate
In-site physical / chemical treatment							
Air sparging	No	No	No	Limited applicability for a dilute dissolved phase plume – more applicable for mass removal in source zones	Would require an array of sparging wells to be installed along upgradient site boundary. No obvious constraints logistically	Moderate to high	Moderate to high due to ongoing running costs
Bioslurping	No	No	No	Limited applicability for a dilute dissolved phase plume – more applicable for NAPL recovery in source zones	Absence of NAPL limits applicability of technology for the site	Moderate to high	Moderate to high due to ongoing running costs and disposal
Dual phase extraction	No	No	No	Limited applicability for a dilute dissolved phase plume – more applicable for mass removal in source zones	No obvious constraints logistically, but noting the system would not likely remove much mass for the efforts and cost involved	Moderate to high	Moderate to high due to ongoing running costs and disposal
Ex situ biological treatment (assuming pumping)							
Bioreactors	No	No	Potentially applicable	Potentially applicable purely on technical terms	Array of pumping wells would need to be established along upgradient boundary. No obvious constraints as this is a future car park	High	Moderate to high, due to ongoing pumping, treatment, and waste disposal

Technologies	Ability to Meet Clean Up Objectives (assuming technology is implemented at the site)			Technical Considerations	Logistical Considerations	Financial Considerations	
	Restoration of beneficial uses in groundwater	Source reduction / control	Limit / prevent further migration of contaminants onto site				
Ex-situ physical / chemical treatment (assuming pumping)							
Advanced oxidation processes	No	No	Potentially applicable	Potentially applicable purely on technical terms	Array of pumping wells would need to be established along upgradient boundary. No obvious constraints as this is a future car park	High	High, due to ongoing pumping, treatment, and waste disposal
Granulated activated carbon / liquid phase carbon adsorption	No	No	Potentially applicable	Potentially applicable purely on technical terms	Array of pumping wells would need to be established along upgradient boundary. No obvious constraints as this is a future car park	High	High, due to ongoing pumping, treatment and waste disposal
Separation	No	No	No	Not applicable for this scenario for treating a dilute dissolved phase plume with no NAPL	Not applicable given there is no NAPL and no likely need for physical separation of fuel product	Moderate to high	High, due to ongoing pumping and waste disposal
Containment							
Physical Barriers	No	No	Potentially applicable	Potentially applicable purely on technical terms	System would need to be installed around upgradient site boundary. No obvious constraints logistically. Depth is achievable.	Very high	Low

Technical considerations include the ability to remove the pollution within a reasonable timeframe. This will be influenced by the properties of the pollutants, the groundwater and aquifer characteristics, and the availability of the technology.

Logistical considerations include the access to the site, availability of materials and infrastructure, and disposal of wastes.

Financial considerations include the cost of clean up, including equipment, installation, maintenance and waste treatment.

8.5 Groundwater Quality Restricted Use Zone (GQRUZ)

Because it has been assumed that groundwater is polluted from an offsite source, and there is indirect evidence from vapour data to support this assessment, the auditor recommends EPA give consideration declaring the site to be a Groundwater Quality Restricted Use Zone (GQRUZ).

9. AUDIT CONCLUSIONS

The environmental audit of the site at 1 – 5 Ballarat Road, North Geelong, was undertaken in accordance with Part IXD of the Environment Protection Act 1970 (the Act), and specifically Sections 53W and 53X which relate to an audit of the condition of a segment of the environment (the relevant segment being the site, as defined in Section 1 of this report). The audit is an independent review of the information relating to the condition of the site, and the potential for adverse impacts on beneficial uses of the site. The relevant legislation, guidelines and standards current at the time of the audit are listed in Section 10 of this audit report.

The site does not qualify for a Certificate of Environmental Audit, because its condition precludes some relevant beneficial uses associated with the site. Specifically, the layer of fill material covering the site has elevated concentrations of polycyclic aromatic hydrocarbons (PAH), lead and TPH C10-C36 exceeding adopted screening criteria for unrestricted land use. The fact there is also assumed to be groundwater pollution present under the site does not prevent a Certificate from being issued in this case because the site is not the source of the pollution, and because beneficial uses of groundwater assumed to be precluded by pollution are not relevant (i.e. existing or likely). A Statement of Environmental Audit has been issued and is attached to this audit report. The site is considered suitable for the following land uses:-

- Sensitive use (other)⁴;
- Sensitive use (high density residential);
- Commercial; and
- Industrial.

The Auditor has considered the need for future management of contamination with regard to the condition of the site, and the proposed and possible future land uses. Based on these factors, the following conditions have been imposed in the Statement of Environmental Audit:-

- a. Prior to commencement of the use of the site, a physical barrier must be provided across the entire site, comprising either a reinforced concrete slab or equivalent permanent paving, with the exception of landscaped areas or garden beds (refer condition b).
- b. Any landscaped area or garden bed must be constructed and maintained with at least 0.5m thickness of soil below the finished surface, which is demonstrated to be suitable for the site and consistent with EPA Publication IWRG 621 Soil Hazard Categorisation and Management as 'fill material'.
- c. All physical barriers (as prescribed in conditions a and b above) must be maintained on the site and if subsequently damaged or removed during development or occupation of the site, must be reinstated as soon as possible and to the same condition or better as they were prior to any disturbance.
- d. Groundwater at the site is presumed to be polluted. Groundwater must not be used for any beneficial use without prior testing and review of results by a suitably qualified professional to confirm its suitability for the proposed use. It may be extracted for the purpose of environmental monitoring or remediation.

⁴ The SEPP (Prevention and Management of Contamination of Land) defines "sensitive use (other)" to include residential uses (other than high density residential), child care centre, pre-school, or primary school.

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- e. If a basement of any description is incorporated in any proposed future development of the site, further assessment and the potential design and installation of mitigation measures to manage vapour risks is required. An environmental auditor appointed under Part IXD of the Environment Protection Act 1970 ("the Act") must be engaged to conduct an environmental audit of the site under Section 53X of the Act, to consider this use.

The terms and conditions that need to be complied with before a Certificate of Environmental Audit could be issued are set out as follows:-

- o The contaminated fill currently present on the site would need to be removed offsite, or remediated so that all beneficial uses are restored, or a risk assessment conducted to demonstrate that beneficial uses for all land uses defined the *SEPP (Prevention and Management of Contamination of Land)* are protected.

There are some related environmental issues that have arisen during the course of the environmental audit, but they do not affect the issue of a Certificate or Statement. The following items have been noted in the Statement of Environmental Audit in the section entitled 'other related information':

- o Groundwater at the site is presumed to be polluted with TPH C6-C10, TPH >C10-C16, benzene, toluene, ethylbenzene, and xylenes and is not suitable for the beneficial uses protected in this groundwater segment including water dependent ecosystems and species, potable mineral water supply, agriculture and irrigation (stock watering), commercial and industrial, water based recreation (primary contact recreation), traditional owner cultural values, cultural and spiritual values. The groundwater at the site is suitable for the beneficial use of 'buildings and structures'.
- o The auditor is satisfied that groundwater has been cleaned up to the extent practicable and recommends the Authority identify the site as a groundwater quality restricted use zone (also known as a GQRUZ).
- o In accordance with Clause 58(4) of the *SEPP (Waters)* the EPA may require periodic reassessment of the practicability of groundwater clean-up.
- o Any material excavated from the site and disposed off site should be classified and managed in accordance with relevant statutory regulations and EPA guidelines.
- o There has not been any evidence of asbestos containing materials found in soils during investigations at the site. However, environmental investigations rely on discrete sampling locations, so any site such as this where there is imported fill material from an unknown origin has some potential for asbestos containing material to be present in soils. If any materials suspected of containing asbestos are encountered during future redevelopment or use of the site, these should be handled and disposed of in accordance with relevant Worksafe Victoria requirements. Refer also to the note above regarding the need to dispose of any material excavated from the site in accordance with relevant regulations and EPA guidelines.
- o Any fill or soil imported to the site should be either virgin soil of natural origin from a site with no history of potentially contaminating land uses, and meeting the requirements for 'fill material' in accordance with relevant EPA guidelines.
- o In accordance with Section 53ZE of the Environment Protection Act 1970 the owner/occupier of the site must provide a copy of the Statement of Environmental Audit to any person who becomes or proposes to become an occupier of the site.

10. REFERENCES

- Environment Protection Act 1970
- Planning and Environment Act 1987
- State Environment Protection Policy (Prevention and Management of Contamination of Land), Victorian Government Gazette Publication No. S95, 2002
- State Environment Protection Policy (Ambient Air Quality), Victorian Government Gazette Publication No. S19, 1999
- State Environment Protection Policy (Air Quality Management), Victorian Government Gazette Publication No. S240, 2001
- State Environment Protection Policy (Waters), Victorian Government Gazette Publication No. S499, 2018.
- Environment Protection (Industrial Waste Resource) Regulations 2009
- National Environment Protection (Assessment of Site Contamination) Measure (NEPC, 1999) (as amended April 2013)
- Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites (ANZECC, 1992)
- Australian and New Zealand Water Quality Guidelines for Fresh and Marine Waters (Australian and New Zealand Environment and Conservation Council, ANZECC, 1992)
- Australian Standard, Guide to the investigation and sampling of sites with potentially contaminated soil, Part 1: Non-volatile and semi-volatile compounds. AS4482.1-2005.
- Australian Standard, Guide to the investigation and sampling of sites with potentially contaminated soil, Part 2: Volatile compounds. AS4482.2-1999.
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia, ANZECC/ARMCANZ, 2000)
- Australian Drinking Water Guidelines (National Health & Medical Research Council, and Natural Resource Management Ministerial Council, NHMRC/NRMMC, 2011)
- Guidelines for Issue of Certificates and Statements of Environmental Audit (Vic EPA Publication 759.3 December 2015)
- Sampling and Analysis of Waters, Wastewaters, Soils and Wastes (IWRG701 – June 2009)
- Hydrogeological Assessments (Water Quality) Guidelines, Vic EPA Publication 668, September 2006
- Groundwater Sampling Guidelines. Vic EPA Publication 669, April 2000.
- The Clean Up and Management of Polluted Groundwater (Vic EPA Publication 840.2, April 2016)
- Various guidance provided to auditors (unpublished) prior to the date of this audit report.

STATEMENT OF ENVIRONMENTAL AUDIT



ENVIRONMENT PROTECTION ACT 1970

STATEMENT OF ENVIRONMENTAL AUDIT

I, Mr Steven Jon Kirsanovs of Kirs Environmental Pty Ltd, a person appointed by the Environment Protection Authority ('the Authority') under the *Environment Protection Act 1970* ('the Act') as an environmental auditor for the purposes of the Act, having:-

1. been requested by Mr. Mick Nikolovski of B.I.M. Investments Pty Ltd, to issue a certificate of environmental audit in relation to the site located at 1-5 Ballarat Road, North Geelong (Lot S31 on Plan of Subdivision 647500) ('the site'), owned/occupied by B.I.M. Investments Pty Ltd,
2. had regard to, among other things,
 - i. guidelines issued by the Authority for the purposes of Part IXD of the Act
 - ii. the beneficial uses that may be made of the site
 - iii. relevant State environment protection policies/industrial waste management policies, namely
 - SEPP Prevention and Management of Contamination of Land
 - SEPP Waters
 - Environment Protection (Industrial Waste Resource) Regulations 2009in making a total assessment of the nature and extent of any harm or detriment caused to, or the risk of any possible harm or detriment which may be caused to, any beneficial use made of the site by any industrial processes or activity, waste or substance (including any chemical substance), and
3. completed an environmental audit report in accordance with Section 53X of the Act, a copy of which has been sent to the Authority and the relevant planning and responsible authority.

HEREBY STATE that I am of the opinion that:

The site is suitable for the beneficial uses associated with sensitive use (other)¹, sensitive use (high density residential), commercial and industrial use, subject to the following conditions attached thereto:-

- a. Prior to commencement of the use of the site, a physical barrier must be provided across the entire site, comprising either a reinforced concrete slab or equivalent permanent paving, with the exception of landscaped areas or garden beds (refer condition b).
- b. Any landscaped area or garden bed must be constructed and maintained with at least 0.5m thickness of soil below the finished surface, which is demonstrated to be suitable for the site and consistent with EPA Publication IWRG 621 Soil Hazard Categorisation and Management as 'fill material'.
- c. All physical barriers (as prescribed in conditions a and b above) must be maintained on the site and if subsequently damaged or removed during development or occupation of the site, must be reinstated as soon as possible and to the same condition or better as they were prior to any disturbance.
- d. Groundwater at the site is presumed to be polluted. Groundwater must not be used

¹ The SEPP (Prevention and Management of Contamination of Land) defines "sensitive use (other)" to include residential uses (other than high density residential), child care centre, pre-school, or primary school.

ENVIRONMENT PROTECTION ACT 1970

STATEMENT OF ENVIRONMENTAL AUDIT

for any beneficial use without prior testing and review of results by a suitably qualified professional to confirm its suitability for the proposed use. It may be extracted for the purpose of environmental monitoring or remediation.

- e. If a basement of any description is incorporated in any proposed future development of the site, further assessment and the potential design and installation of mitigation measures to manage vapour risks is required. An environmental auditor appointed under Part IXD of the Environment Protection Act 1970 ("the Act") must be engaged to conduct an environmental audit of the site under Section 53X of the Act, to consider this use.

The condition of the site is detrimental or potentially detrimental to any (one or more) beneficial uses of the site. Accordingly, I have not issued a certificate of environmental audit for the site in its current condition, the reasons for which are presented in the environmental audit report. The terms and conditions that need to be complied with before a certificate of environmental audit may be issued are set out as follows:-

- o The contaminated fill currently present on the site would need to be removed offsite, or remediated so that all beneficial uses are restored, or a risk assessment conducted to demonstrate that beneficial uses for all land uses defined the *SEPP (Prevention and Management of Contamination of Land)* are protected.

Other related information:-

- o Groundwater at the site is presumed to be polluted with TPH C6-C10, TPH >C10-C36, benzene, toluene, ethylbenzene, and xylenes and is not suitable for the beneficial uses protected in this groundwater segment including water dependent ecosystems and species, potable mineral water supply, agriculture and irrigation (stock watering), commercial and industrial, water based recreation (primary contact recreation), traditional owner cultural values, cultural and spiritual values. The groundwater at the site is suitable for the beneficial use of 'buildings and structures'.
- o The auditor is satisfied that groundwater has been cleaned up to the extent practicable and recommends the Authority identify the site as a groundwater quality restricted use zone (also known as a GQRUZ).
- o In accordance with Clause 58(4) of the *SEPP (Waters)* the EPA may require periodic reassessment of the practicability of groundwater clean-up.
- o Any material excavated from the site and disposed off site should be classified and managed in accordance with relevant statutory regulations and EPA guidelines.
- o There has not been any evidence of asbestos containing materials found in soils during investigations at the site. However, environmental investigations rely on discrete sampling locations, so any site such as this where there is imported fill material from an unknown origin has some potential for asbestos containing material to be present in soils. If any materials suspected of containing asbestos are encountered during future redevelopment or use of the site, these should be handled and disposed of in accordance with relevant Worksafe Victoria requirements. Refer also to the note above regarding the need to dispose of any material excavated from the site in accordance with relevant regulations and EPA guidelines.

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- Any fill or soil imported to the site should be either virgin soil of natural origin from a site with no history of potentially contaminating land uses, and meeting the requirements for 'fill material' in accordance with relevant EPA guidelines.
- In accordance with Section 53ZE of the Environment Protection Act 1970 the owner/occupier of the site must provide a copy of the Statement of Environmental Audit to any person who becomes or proposes to become an occupier of the site.

This Statement forms part of environmental audit report (*Environmental Audit Report, 1 – 5 Ballarat Road, North Geelong Vic. Kirsa Environmental Pty Ltd, Report Ref 6100, 13 May 2019*). Further details regarding the condition of the site may be found in the environmental audit report.

Dated: - 13 May 2019

Signed:- ... 

Steven Jon Kirsanovs
ENVIRONMENTAL AUDITOR

TABLES



TABLES (Soil)

Table 1 - Soil Results HIL and EIL

	Inorganics							Metals											
	% Moisture	CEC	pH (Lab)	% Clay Content	pH CaCl2	Sulphate (as SO4)	Cyanide Total	Fluoride	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Chromium (III+VI)	Chromium (hexavalent)	Cobalt	Copper	Lead
	%	meq/100g	pH Units	%	pH Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EOL	1		0.1		0.1	10	5	100	5	2	5	2	10	0.2	5	1	5	5	5
18053 NEPM 2013 EIL Fill (Urban Residential and Public Open Space) Fill									20 ^{#1}	100	330 ^{#2}	21 ^{#2}		10 ^{#3}	410	130 ^{#4}	50 ^{#1}	200	1,200
18053 NEPM 2013 EIL Natural (Urban Residential and Public Open Space) Natural									20 ^{#1}	100	330 ^{#2}	21 ^{#2}		10 ^{#3}	410	130 ^{#4}	50 ^{#1}	210	1,200
18053 NEPM 2013 EIL Fill (Commercial/Industrial) Fill									40 ^{#1}	160	330 ^{#2}	21 ^{#2}		22 ^{#3}	670		300 ^{#1}	290	1,800 ^{#11}
18053 NEPM 2013 EIL Natural (Commercial/Industrial) Natural									40 ^{#1}	160	330 ^{#2}	21 ^{#2}		22 ^{#3}	670		300 ^{#1}	300	1,900
NEPM 2013 Table 1A(1) HILs Res A Soil								3,100 ^{#12}	31 ^{#12}	100 ^{#13}	15,000 ^{#12}	60	4,500	20	120,000 ^{#14}	100	100	6,000	300 ^{#15}
NEPM 2013 Table 1A(1) HILs Res B Soil								3,100 ^{#12}	31 ^{#12}	500 ^{#13}	15,000 ^{#12}	90	40,000	150	120,000 ^{#14}	500	600	30,000	1,200 ^{#15}
NEPM 2013 Table 1A(1) HILs Rec C Soil								3,100 ^{#12}	31 ^{#12}	300 ^{#13}	15,000 ^{#12}	90	20,000	90	120,000 ^{#14}	300	300	17,000	600 ^{#15}
NEPM 2013 Table 1A(1) HILs Comm/Ind D Soil								47,000 ^{#12}	470 ^{#12}	3,000 ^{#13}	220,000 ^{#12}	500	300,000	900		3,600	4,000	240,000	1,500 ^{#15}

Location Code	Field ID	Date	Sample Code	Lab Report Number	Sample Type	Matrix Description																			
B1	B1/0.2	12/09/2016	16-42466_4916952	16-42466	Normal	Fill	-	-	-	-	-	-	-	< 5	14	55	< 5	< 10	< 0.2	20	-	11	11	17	
B2	B2/0.2	12/09/2016	16-42466_4916954	16-42466	Normal	Fill	-	-	-	-	-	-	-	< 5	< 5	7	< 5	< 10	< 0.2	< 5	-	< 5	< 5	5	
B3	B3/0.15	12/09/2016	16-42466_4916957	16-42466	Normal	Fill	-	-	-	-	-	-	-	< 5	< 5	140	< 5	< 10	< 0.2	36	-	11	< 5	9	
B4	B4/0.2	12/09/2016	16-42466_4916959	16-42466	Normal	Fill	-	-	-	-	-	-	-	< 5	< 5	30	< 5	< 10	< 0.2	10	-	< 5	< 5	10	
B5	B5/0.2	12/09/2016	16-42466_4916961	16-42466	Normal	Fill	-	-	-	-	-	-	-	< 5	5	68	< 5	< 10	< 0.2	14	-	5	9	110	
B5	B5/0.6	12/09/2016	16-42466_4916962	16-42466	Normal	Natural	-	-	-	-	-	-	-	< 5	< 5	620	< 5	< 10	< 0.2	43	-	37	< 5	8	
B6	B6/0.2	12/09/2016	16-42466_4916963	16-42466	Normal	Fill	-	-	-	-	-	-	-	< 5	5	19	< 5	< 10	< 0.2	11	-	< 5	< 5	< 5	
B7	B7/0.2	12/09/2016	16-42466_4916966	16-42466	Normal	Fill	-	-	-	-	-	-	-	< 5	8	72	< 5	< 10	< 0.2	19	-	9	10	38	
B8	B8/0.2	12/09/2016	16-42466_4916969	16-42466	Normal	Fill	-	-	-	-	-	-	-	< 5	16	25	< 5	< 10	< 0.2	38	-	18	21	10	
B9	B9/1.4	12/09/2016	16-42466_4916974	16-42466	Normal	Fill	16	-	9.0	-	-	-	< 5	140	< 5	< 5	73	< 5	< 10	< 0.2	36	< 1	14	9	12
B10	B10/0.2	12/09/2016	16-42466_4916975	16-42466	Normal	Fill	-	-	-	-	-	-	-	< 5	26	94	< 5	< 10	< 0.2	28	-	10	6	18	
B10	B10/0.8	12/09/2016	16-42466_4916976	16-42466	Normal	Fill	-	-	-	-	-	-	-	< 5	11	210	< 5	< 10	< 0.2	41	-	19	17	74	
B10	B10/1.3	12/09/2016	16-43458_4926848	16-43458	Normal	Fill	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
B11	B11/0.3	12/09/2016	16-42466_4916978	16-42466	Normal	Fill	-	-	-	-	-	-	-	< 5	8	59	< 5	< 10	< 0.2	26	-	12	10	22	
B12	B12/0.2	12/09/2016	16-42466_4916980	16-42466	Normal	Fill	-	-	-	-	-	-	-	< 5	11	270	< 5	< 10	< 0.2	43	-	22	7	30	
B13	B13/0.4	12/09/2016	16-42466_4916985	16-42466	Normal	Fill	-	9.5	-	-	7.9	< 50	-	< 5	9	21	< 5	< 10	< 0.2	20	-	6	< 5	11	
B13			16-42466_4917011	16-42466	Normal	Fill	-	-	-	-	25	-	-	-	-	-	-	-	-	-	-	-	-	-	
B13	B13/0.9	12/09/2016	16-42466_4916986	16-42466	Normal	Natural	-	17	-	-	7.8	< 250	-	< 5	18	780	< 5	< 10	< 0.2	34	-	10	< 5	8	
B13			16-42466_4917012	16-42466	Normal	Natural	-	-	-	-	47	-	-	-	-	-	-	-	-	-	-	-	-	-	
B14	B14/0.2	12/09/2016	16-42466_4916987	16-42466	Normal	Fill	-	-	-	-	-	-	-	< 5	5	77	< 5	< 10	< 0.2	33	-	8	6	13	
B15	B15/0.3	12/09/2016	16-42466_4916990	16-42466	Normal	Fill	-	-	-	-	-	-	-	< 5	< 5	230	< 5	< 10	< 0.2	36	-	20	10	39	
B15	B15/2.5	12/09/2016	16-42466_4916992	16-42466	Normal	Fill	-	-	-	-	-	-	-	< 5	6	81	< 5	< 10	< 0.2	24	-	20	15	12	
B15	B215/2.5	12/09/2016	M16-Se12402	515598	Interlab_D	Fill	14	-	-	-	-	-	-	< 10	33	73	< 2	< 10	< 0.4	39	-	19	16	13	
B15	B120916	12/09/2016	16-42466_4916999	16-42466	Field_D	Fill	-	-	-	-	-	-	-	< 5	14	71	< 5	< 10	0.2	24	-	14	14	46	
B16	B16/0.45	12/09/2016	16-42466_4916994	16-42466	Normal	Fill	13	-	8.3	-	-	< 5	110	< 5	< 5	15	< 5	< 10	< 0.2	< 5	< 1	< 5	9	12	
B17	B17/0.2	12/09/2016	16-42466_4916996	16-42466	Normal	Fill	-	-	-	-	-	-	-	< 5	9	99	< 5	< 10	< 0.2	22	-	9	8	14	
SV1	SV1/3.5	17/05/2018	18-23938_5661170	18-23938	Normal	Natural	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
SV2	SV2/0.25	17/05/2018	18-23938_5661171	18-23938	Normal	Fill	11	-	8.3	-	-	< 5	< 100	-	9	-	-	-	< 0.2	-	< 1	-	< 5	12	
SV2	SV202/0.25	17/05/2018	M18-My24475	599068	Interlab_D	Fill	9.8	-	-	-	-	-	-	< 10	7.4	41	< 2	< 10	< 0.4	18	-	6.7	7.7	28	
SV2	SV170518	17/05/2018	18-23938_5661172	18-23938	Field_D	Fill	-	-	-	-	-	-	-	< 5	6	38	< 5	< 10	< 0.2	10	-	5	6	18	
SV2	SV2/0.5	17/05/2018	18-23938_5661173	18-23938	Normal	Fill	-	-	-	-	-	-	-	< 5	6	51	< 5	< 10	< 0.2	12	-	6	6	17	
SV2	SV2/3.0	17/05/2018	18-23938_5661177	18-23938	Normal	Natural	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
TP1	TP1/4.0	17/05/2018	18-23938_5661182	18-23938	Normal	Natural	-	-	-	-	-	-	-	< 5	37	16	< 5	< 10	< 0.2	12	-	7	< 5	8	
TP2	TP2/3.0	17/05/2018	18-23938_5661184	18-23938	Normal	Fill	-	-	-	-	-	-	-	< 5	11	100	< 5	< 10	< 0.2	13	-	10	12	340	
TP3	TP3/2.0	17/05/2018	18-23938_5661188	18-23938	Normal	Fill	-	-	-	-	-	-	-	< 5	18	90	< 5	< 10	< 0.2	24	-	20	19	49	
TP4	TP3/3.0	17/05/2018	18-23938_5661189	18-23938	Normal	Natural	10	-	8.7	-	-	< 5	< 100	-	37	-	-	-	< 0.2	-	< 1	-	< 5	< 5	
TP4	TP4/4.0	17/05/2018	18-23938_5661196	18-23938	Normal	Fill	-	-	-	-	-	-	-	< 5	40	40	< 5	< 10	< 0.2	19	-	13	9	74	
TP5	TP5/4.0	17/05/2018	18-23938_5661201	18-23938	Normal	Fill	-	-	-	-	-	-	-	< 5	17	140	< 5	< 10	< 0.2	31	-	13	< 5	32	
PSV 4	PSV4/2.75	26/07/2018	18-34356_5747698	18-34356	Normal	Fill	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
BH1	BH1/1.0	18/09/2018	18-42351_5812923	18-42351	Normal	Fill	-	-	-	-	8.2	-	-	-	12	-	-	-	< 0.2	-	-	-	19	110	
BH1	BH1/2.5	18/09/2018	18-42351_5812924	18-42351	Normal	Fill	-	-	-	-	8.2	-	-	-	-	-	-	-	< 0.2	-	-	-	14	48	

Comments
#1 Based on CCME 1991
#2 US EPA 2005 ECO SSL
#3 Based on CCME 1999
#4 ECO SSL 2008 - Protection of Mammalian Wildlife
#5 NEPC 1999. NEPM Interim Urban Ecological Investigation Level.
#6 Based on EPA IWRG 621 Clean Fill Criteria
#7 Based on CCME 1997
#8 US EPA 2007 ECO SSL - Based on high molecular weight PAHs
#9 Based on Ministry of Infrastructure and Environment, Dutch Target Intervention Value (2013 Circular)
#10 Based on US EPA Region 4 Soil Screening Value (All Receptors)- revised 2015
#11 Generic, conservative value based on ACL from NEPM 2013, Schedule B1, Table 1B(4) and ABCprovided for an old Victorian suburb with low traffic (Olszowy et al 1995).
#12 Based on US EPA Regional Screening Levels (RSLs) (TR= 1 E-6, HQ= 1.0), revised May 2018
#13 Arsenic: HIL assumes 70% oral bioavailability. Site-specific bioavailability maybe important and should be considered where appropriate (refer shedule B7).
#14 Based on US EPA Regional Screening Levels (RSLs) (TR= 1 E-6, HQ= 1.0), revised May 2018 - Chromium insoluble salts criteria has been adopted
#15 Lead: HILs A,B,C based on blood lead models (IEUBK & HIL D on adult lead model for where 50% bioavailability considered.
Site-specific bioavailability should be considered where appropriate.
#16 Elemental mercury: HIL does not address elemental mercury, a site specific assessment should be considered if elemental mercury is present, or suspected to be present.
#17 Total PAHs: Based on sum of 16 most common reported (WHO 98). HIL application should consider presence of carcinogenic PAHs (should meet BaP TEQ HIL) & naphthalene (should meet relevant HSL)
#18 PCBs: HIL refers to non-dioxin like PCBs only. Where PCB source is known, or suspected at a site, a site-specific assessment of exposure to all PCBs (inc dioxin like PCBs) should be undertaken

Table 1 - Soil Results HIL and EIL

	Metals									TRH														
	Manganese	Mercury	Molybdenum	Nickel	Selenium	Silver	Tin	Vanadium	Zinc	C6 - C9	C10 - C14	C15 - C28	C29-C36	C10 - C36 (Sum of total)	C6-C10	TRH C6-C10 less BTEX (F1)	C10-C16	TRH>C10-C16 less Napthalene (F2)	C16-C34	C34-C40	C10 - C40 (Sum of total)	C10-C14 NON POLAR	C15-28 NON POLAR	
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	
EOL	5	0.05	5	5	2	0.2	5	5	5	20	20	50	50	50	20	20	20	20	50	50	50	20	50	
18053 NEPM 2013 EIL Fill (Urban Residential and Public Open Space) Fill	500 ^{#5}	6.6 ^{#3}	10 ^{#1}	180	10 ^{#6}	20 ^{#1}	50 ^{#1}	130 ^{#7}	450															
18053 NEPM 2013 EIL Natural (Urban Residential and Public Open Space) Natural	500 ^{#5}	6.6 ^{#3}	10 ^{#1}	230	10 ^{#6}	20 ^{#1}	50 ^{#1}	130 ^{#7}	650															
18053 NEPM 2013 EIL Fill (Commercial/Industrial) Fill	500 ^{#5}	24 ^{#3}	40 ^{#1}	300	10 ^{#6}		300 ^{#1}	130 ^{#7}	670															
18053 NEPM 2013 EIL Natural (Commercial/Industrial) Natural	500 ^{#5}	24 ^{#3}	40 ^{#1}	390	10 ^{#6}		300 ^{#1}	130 ^{#7}	950															
NEPM 2013 Table 1A(1) HILs Res A Soil	3,800	40 ^{#16}	390 ^{#12}	400	200	390 ^{#12}	47,000 ^{#12}	390 ^{#12}	7,400															
NEPM 2013 Table 1A(1) HILs Res B Soil	14,000	120 ^{#16}	390 ^{#12}	1,200	1,400	390 ^{#12}	47,000 ^{#12}	390 ^{#12}	60,000															
NEPM 2013 Table 1A(1) HILs Rec C Soil	19,000	80 ^{#16}	390 ^{#12}	1,200	700	390 ^{#12}	47,000 ^{#12}	390 ^{#12}	30,000															
NEPM 2013 Table 1A(1) HILs Comm/Ind D Soil	60,000	730 ^{#16}	5,800 ^{#12}	6,000	10,000	5,800 ^{#12}	700,000 ^{#12}	5,800 ^{#12}	400,000															

Location Code	Field ID	Date	Sample Code	Lab Report Number	Sample Type	Matrix Description																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
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Comments
#1 Based on CCME 1991
#2 US EPA 2005 ECO SSL
#3 Based on CCME 1999
#4 ECO SSL 2008 - Protection of Mammalian Wildlife
#5 NEPC 1999. NEPM Interim Urban Ecological Investigation Level.
#6 Based on EPA IWRG 621 Clean Fill Criteria
#7 Based on CCME 1997
#8 US EPA 2007 ECO SSL - Based on high molecular weight PAHs
#9 Based on Ministry of Infrastructure and Environment, Dutch Target Intervention Value (2013 Circular)
#10 Based on US EPA Region 4 Soil Screening Value (All Receptors) - revised 2015
#11 Generic, conservative value based on ACL from NEPM 2013, Schedule B1, Table 1B(4) and ABC provided for an old Victorian suburb with low traffic (Olszowy et al 1995)
#12 Based on US EPA Regional Screening Levels (RSLs) (TR= 1 E-6, HQ= 1.0), revised May 2018
#13 Arsenic: HIL assumes 70% oral bioavailability. Site-specific bioavailability may be important and should be considered where appropriate (refer shedule B7).
#14 Based on US EPA Regional Screening Levels (RSLs) (TR= 1 E-6, HQ= 1.0), revised May 2018 - Chromium insoluble salts criteria has been adopted
#15 Lead: HILs A,B,C based on blood lead models (IEUBK & HIL D on adult lead model for where 50% bioavailability considered.
Site-specific bioavailability should be considered where appropriate.
#16 Elemental mercury: HIL does not address elemental mercury, a site specific assessment should be considered if elemental mercury is present, or suspected to be present.
#17 Total PAHs: Based on sum of 16 most common reported (WHO 98). HIL application should consider presence of carcinogenic PAHs (should meet BaP TEQ HIL) & naphthalene (should meet relevant HSL)
#18 PCBs: HIL refers to non-dioxin like PCBs only. Where PCB source is known, or suspected at a site, a site-specific assessment of exposure to all PCBs (inc dioxin like PCBs) should be undertaken

Table 1 - Soil Results HIL and EIL

	TRH Speciation						MAH										PAH										
	TPH C29-C36 Fraction after Silica Cleanup	TRH >C10-C16 Fraction after Silica Cleanup	TRH>C10-C16 less Naph. after Silica Gel Cleanup	TRH >C16-C34 Fraction after Silica Cleanup	TRH >C34-C40 Fraction after Silica Cleanup	Sum of TRH>C10-C40 after Silica Gel Cleanup	Benzene	Toluene	Ethylbenzene	Xylene (m & p)	Xylene (o)	Xylene Total	BTEX (Sum)	Isopropylbenzene	Styrene	1,2,4-trimethylbenzene	Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(a) pyrene	Benzo(a)pyrene TEQ (LOR)	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(b+k)fluoranthene	Benzo(k)fluoranthene	Chrysene
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EOL	50	20	20	50	50	50	0.5	0.5	0.5	1	0.5	0.5	1	0.5	0.5	0.5	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1
18053 NEPM 2013 EIL Fill (Urban Residential and Public Open Space) Fill																											
18053 NEPM 2013 EIL Natural (Urban Residential and Public Open Space) Natural																											
18053 NEPM 2013 EIL Fill (Commercial/Industrial) Fill																											
18053 NEPM 2013 EIL Natural (Commercial/Industrial) Natural																											
NEPM 2013 Table 1A(1) HILs Res A Soil																						3					
NEPM 2013 Table 1A(1) HILs Res B Soil																						4					
NEPM 2013 Table 1A(1) HILs Rec C Soil																						3					
NEPM 2013 Table 1A(1) HILs Comm/Ind D Soil																						40					

Location Code	Field ID	Date	Sample Code	Lab Report Number	Sample Type	Matrix Description																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						</
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Comments
#1 Based on CCME 1991
#2 US EPA 2005 ECO SSL
#3 Based on CCME 1999
#4 ECO SSL 2008 - Protection of Mammalian Wildlife
#5 NEPC 1999. NEPM Interim Urban Ecological Investigation Level.
#6 Based on EPA IWRG 621 Clean Fill Criteria
#7 Based on CCME 1997
#8 US EPA 2007 ECO SSL - Based on high molecular weight PAHs
#9 Based on Ministry of Infrastructure and Environment, Dutch Target Intervention Value (2013 Circular)
#10 Based on US EPA Region 4 Soil Screening Value (All Receptors)- revised 2015
#11 Generic, conservative value based on ACL from NEPM 2013, Schedule B1, Table 1B(4) and ABCprovided for an old Victorian suburb with low traffic (Olszowy et al 1995)
#12 Based on US EPA Regional Screening Levels (RSLs) (TR= 1 E-6, HQ= 1

Table 1 - Soil Results HIL and EIL

	PAH								Phenols Halogenated												Phenols Non-Halogenated							
	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-c,d)pyrene	Naphthalene	Phenanthrene	Pyrene	PAHs (Sum of total)	2,3,4,5-tetrachlorophenol	2,3,4,6-tetrachlorophenol	2,3,5,6-Tetrachlorophenol	2,4,5-trichlorophenol	2,4,6-trichlorophenol	2,4-dichlorophenol	2,6-dichlorophenol	2-chlorophenol	4-chloro-3-methylphenol	Pentachlorophenol	Phenols (Total Halogenated)	Cresol Total	2,4-dimethylphenol	2,4-dinitrophenol	2-nitrophenol	4,6-Dinitro-2-methylphenol	4,6-Dinitro-o-cyclohexyl phenol	4-nitrophenol		
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg		
EOL	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	0.5	30	0.5	10	30	0.5		
18053 NEPM 2013 EIL Fill (Urban Residential and Public Open Space) Fill					170			18 ^{NS}																				
18053 NEPM 2013 EIL Natural (Urban Residential and Public Open Space) Natural					170			18 ^{NS}																				
18053 NEPM 2013 EIL Fill (Commercial/Industrial) Fill					370																							
18053 NEPM 2013 EIL Natural (Commercial/Industrial) Natural					370																							
NEPM 2013 Table 1A(1) HILs Res A Soil								300 ^{#17}										100		400								
NEPM 2013 Table 1A(1) HILs Res B Soil								400 ^{#17}										130		4,700								
NEPM 2013 Table 1A(1) HILs Rec C Soil								300 ^{#17}										120		4,000								
NEPM 2013 Table 1A(1) HILs Comm/Ind D Soil								4,000 ^{#17}										660		25,000								

Location Code	Field ID	Date	Sample Code	Lab Report Number	Sample Type	Matrix Description																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		</
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Comments
#1 Based on CCME 1991
#2 US EPA 2005 ECO SSL
#3 Based on CCME 1999
#4 ECO SSL 2008 - Protection of Mammalian Wildlife
#5 NEPC 1999. NEPM Interim Urban Ecological Investigation Level.
#6 Based on EPA IWRG 621 Clean Fill Criteria
#7 Based on CCME 1997
#8 US EPA 2007 ECO SSL - Based on high molecular weight PAHs
#9 Based on Ministry of Infrastructure and Environment, Dutch Target Intervention Value (2013 Circular)
#10 Based on US EPA Region 4 Soil Screening Value (All Receptors) - revised 2015
#11 Generic, conservative value based on ACL from NEPM 2013, Schedule B1, Table 1B(4) and ABC provided for an old Victorian suburb with low traffic (Olszowy et al 1995)
#12 Based on US EPA Regional Screening Levels (RSLs) (TR= 1 E-6, HQ= 1.0), revised May 2018
#13 Arsenic: HIL assumes 70% oral bioavailability. Site-specific bioavailability may be important and should be considered where appropriate (refer shedule B7).
#14 Based on US EPA Regional Screening Levels (RSLs) (TR= 1 E-6, HQ= 1.0), revised May 2018 - Chromium insoluble salts criteria has been adopted
#15 Lead: HILs A,B,C based on blood lead models (IEUBK & HIL D on adult lead model for where 50% bioavailability considered.
Site-specific bioavailability should be considered where appropriate.
#16 Elemental mercury: HIL does not address elemental mercury, a site specific assessment should be considered if elemental mercury is present, or suspected to be present.
#17 Total PAHs: Based on sum of 16 most common reported (WHO 98). HIL application should consider presence of carcinogenic PAHs (should meet BaP TEQ HIL) & naphthalene (should meet relevant HSL)
#18 PCBs: HIL refers to non-dioxin like PCBs only. Where PCB source is known, or suspected at a site, a site-specific assessment of exposure to all PCBs (inc dioxin like PCBs) should be undertaken

Table 1 - Soil Results HIL and EIL

	Phenols		Halogenated Vol. Organics																									
	Phenol	Phenols (Total Non Halogenated)	1,1,1,2-tetrachloroethane	1,1,1-trichloroethane	1,1,2,2-tetrachloroethane	1,1,2-trichloroethane	1,1-dichloroethane	1,1-dichloroethene	1,1-dichloropropene	1,2,3-trichloropropene	1,2-dibromo-3-chloropropane	1,2-dibromoethane	1,2-dichloroethane	1,2-dichloropropene	1,3-dichloropropene	2,2-dichloropropene	2-chlorotoluene	4-chlorotoluene	Bromobenzene	Bromochloromethane	Bromodichloromethane	Bromoform	Carbon tetrachloride	Chlorobenzene	Chlorodibromomethane	Chloroform	cis-1,2-dichloroethene	
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	
EOL	0.5	30	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5		
18053 NEPM 2013 EIL Fill (Urban Residential and Public Open Space) Fill																												
18053 NEPM 2013 EIL Natural (Urban Residential and Public Open Space) Natural																												
18053 NEPM 2013 EIL Fill (Commercial/Industrial) Fill																												
18053 NEPM 2013 EIL Natural (Commercial/Industrial) Natural																												
NEPM 2013 Table 1A(1) HILs Res A Soil	3,000																											
NEPM 2013 Table 1A(1) HILs Res B Soil	45,000																											
NEPM 2013 Table 1A(1) HILs Rec C Soil	40,000																											
NEPM 2013 Table 1A(1) HILs Comm/Ind D Soil	240,000																											

Location Code	Field ID	Date	Sample Code	Lab Report Number	Sample Type	Matrix Description	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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Comments
#1 Based on CCME 1991
#2 US EPA 2005 ECO SSL
#3 Based on CCME 1999
#4 ECO SSL 2008 - Protection of Mammalian Wildlife
#5 NEPC 1999. NEPM Interim Urban Ecological Investigation Level.
#6 Based on EPA IWRG 621 Clean Fill Criteria
#7 Based on CCME 1997
#8 US EPA 2007 ECO SSL - Based on high molecular weight PAHs
#9 Based on Ministry of Infrastructure and Environment, Dutch Target Intervention Value (2013 Circular)
#10 Based on US EPA Region 4 Soil Screening Value (All Receptors) - revised 2015
#11 Generic, conservative value based on ACL from NEPM 2013, Schedule B1, Table 1B(4) and ABCprovided for an old Victorian suburb with low traffic (Olszowy et al 1995
#12 Based on US EPA Regional Screening Levels (RSLs) (TR= 1 E-6, HQ= 1.0), revised May 2018
#13 Arsenic: HIL assumes 70% oral bioavailability. Site-specific bioavailability may be important and should be considered where appropriate (refer shedule B7).
#14 Based on US EPA Regional Screening Levels (RSLs) (TR= 1 E-6, HQ= 1.0), revised May 2018 - Chromium insoluble salts criteria has been adopted
#15 Lead: HILs A,B,C based on blood lead models (IEUBK & HIL D on adult lead model for where 50% bioavailability considered.
Site-specific bioavailability should be considered where appropriate.
#16 Elemental mercury: HIL does not address elemental mercury, a site specific assessment should be considered if elemental mercury is present, or suspected to be present.
#17 Total PAHs: Based on sum of 16 most common reported (WHO 98). HIL application should consider presence of carcinogenic PAHs (should meet BaP TEQ HIL) & naphthalene (should meet relevant HSL)
#18 PCBs: HIL refers to non-dioxin like PCBs only. Where PCB source is known, or suspected at a site, a site-specific assessment of exposure to all PCBs (inc dioxin like PCBs) should be undertaken

Project: 18053
Client: BIM Investments
Site: 1 - 5 Ballarat Road, North Geelong VIC

Table 1 - Soil Results HIL and EIL

	Organochlorine Pesticides								Organochlorine Pesticides																	
	4,4-DDE	p-BHC	Aldrin	Aldrin + Dieldrin	p-BHC	Chlordane	Chlordane (cis)	Chlordane (trans)	p-BHC	DDD	DDT	DDT+DDE+DDD	Dieldrin	Endosulfan	Endosulfan I	Endosulfan II	Endosulfan sulphate	Toxaphene	Endrin	Endrin aldehyde	Endrin ketone	p-BHC (Lindane)	Heptachlor	Heptachlor epoxide	Methoxychlor	Oxychlordane
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQI	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	1	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
18053 NEPM 2013 EIL Fill (Urban Residential and Public Open Space) Fill						4 ^{#9}	0.27 ^{#10}					180											1.2 ^{#9}			
18053 NEPM 2013 EIL Natural (Urban Residential and Public Open Space) Natural						4 ^{#9}	0.27 ^{#10}					180											1.2 ^{#9}			
18053 NEPM 2013 EIL Fill (Commercial/Industrial) Fill						4 ^{#9}	0.27 ^{#10}					640											1.2 ^{#9}			
18053 NEPM 2013 EIL Natural (Commercial/Industrial) Natural						4 ^{#9}	0.27 ^{#10}					640											1.2 ^{#9}			
NEPM 2013 Table 1A(1) HILs Res A Soil				6		50						240		270				20	10				6		300	
NEPM 2013 Table 1A(1) HILs Res B Soil				10		90						600		400				30	20				10		500	
NEPM 2013 Table 1A(1) HILs Rec C Soil				10		70						400		340				30	20				10		400	
NEPM 2013 Table 1A(1) HILs Comm/Ind D Soil				45		530						3,600		2,000				160	100				50		2,500	

Location Code	Field ID	Date	Sample Code	Lab Report Number	Sample Type	Matrix Description	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
B1	B1/0.2	12/09/2016	16-42466 4916952	16-42466	Normal	Fill	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
B2	B2/0.2	12/09/2016	16-42466 4916954	16-42466	Normal	Fill	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
B3	B3/0.15	12/09/2016	16-42466 4916957	16-42466	Normal	Fill	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
B4	B4/0.2	12/09/2016	16-42466 4916959	16-42466	Normal	Fill	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
B5	B5/0.2	12/09/2016	16-42466 4916961	16-42466	Normal	Fill	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
B5	B5/0.6	12/09/2016	16-42466 4916962	16-42466	Normal	Natural	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
B6	B6/0.2	12/09/2016	16-42466 4916963	16-42466	Normal	Fill	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
B7	B7/0.2	12/09/2016	16-42466 4916966	16-42466	Normal	Fill	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
B8	B8/0.2	12/09/2016	16-42466 4916969	16-42466	Normal	Fill	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
B9	B9/1.4	12/09/2016	16-42466 4916974	16-42466	Normal	Fill	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
B10	B10/0.2	12/09/2016	16-42466 4916975	16-42466	Normal	Fill	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
B10	B10/0.8	12/09/2016	16-42466 4916976	16-42466	Normal	Fill	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
B10	B10/1.3	12/09/2016	16-43458 4926848	16-43458	Normal	Fill	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
B11	B11/0.3	12/09/2016	16-42466 4916978	16-42466	Normal	Fill	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
B12	B12/0.2	12/09/2016	16-42466 4916980	16-42466	Normal	Fill	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
B13	B13/0.4	12/09/2016	16-42466 4916985	16-42466	Normal	Fill	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
B13	B13/0.9	12/09/2016	16-42466 4917011	16-42466	Normal	Fill	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
B13	B13/0.9	12/09/2016	16-42466 4916986	16-42466	Normal	Natural	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
B13	B13/0.9	12/09/2016	16-42466 4917012	16-42466	Normal	Natural	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
B14	B14/0.2	12/09/2016	16-42466 4916987	16-42466	Normal	Fill	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
B15	B15/0.3	12/09/2016	16-42466 4916990	16-42466	Normal	Fill	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06
B15	B15/2.5	12/09/2016	16-42466 4916992	16-42466	Normal	Fill	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06
B15	B215/2.5	12/09/2016	M16-Se12402	515598	Interlab_D	Fill	< 0.05	< 0.05	< 0.05	-	< 0.05	< 0.1	-	-	< 0.05	< 0.05	< 0.05	-	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
B15	B120916	12/09/2016	16-42466 4916999	16-42466	Field_D	Fill	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06
B16	B16/0.45	12/09/2016	16-42466 4916994	16-42466	Normal	Fill	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06
B17	B17/0.2	12/09/2016	16-42466 4916996	16-42466	Normal	Fill	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	<				

Table 1 - Soil Results HIL and EIL

	Herbicides		Polychlorinated Biphenyls							
	Dinoseb	Arochlor 1221	Arochlor 1232	Arochlor 1016	Arochlor 1242	Arochlor 1248	Arochlor 1254	Arochlor 1260	PCBs (Sum of total)	
	m g/kg	m g/kg	m g/kg	m g/kg	m g/kg	m g/kg	m g/kg	m g/kg	m g/kg	m g/kg
EOL	10	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
18053 NEPM 2013 EIL Fill (Urban Residential and Public Open Space) Fill										
18053 NEPM 2013 EIL Natural (Urban Residential and Public Open Space) Natural										
18053 NEPM 2013 EIL Fill (Commercial/Industrial) Fill										
18053 NEPM 2013 EIL Natural (Commercial/Industrial) Natural										
NEPM 2013 Table 1A(1) HILs Res A Soil										1 ^{#18}
NEPM 2013 Table 1A(1) HILs Res B Soil										1 ^{#18}
NEPM 2013 Table 1A(1) HILs Rec C Soil										1 ^{#18}
NEPM 2013 Table 1A(1) HILs Com m/Ind D Soil										7 ^{#18}

Location Code	Field ID	Date	Sample Code	Lab Report Number	Sample Type	Matrix Description										
B1	B1/0.2	12/09/2016	16-42466_4916952	16-42466	Normal	Fill	-	-	-	-	-	-	-	-	-	-
B2	B2/0.2	12/09/2016	16-42466_4916954	16-42466	Normal	Fill	-	-	-	-	-	-	-	-	-	-
B3	B3/0.15	12/09/2016	16-42466_4916957	16-42466	Normal	Fill	-	-	-	-	-	-	-	-	-	-
B4	B4/0.2	12/09/2016	16-42466_4916959	16-42466	Normal	Fill	-	-	-	-	-	-	-	-	-	-
B5	B5/0.2	12/09/2016	16-42466_4916961	16-42466	Normal	Fill	-	-	-	-	-	-	-	-	-	-
B5	B5/0.6	12/09/2016	16-42466_4916962	16-42466	Normal	Natural	-	-	-	-	-	-	-	-	-	-
B6	B6/0.2	12/09/2016	16-42466_4916963	16-42466	Normal	Fill	-	-	-	-	-	-	-	-	-	-
B7	B7/0.2	12/09/2016	16-42466_4916966	16-42466	Normal	Fill	-	-	-	-	-	-	-	-	-	-
B8	B8/0.2	12/09/2016	16-42466_4916969	16-42466	Normal	Fill	-	-	-	-	-	-	-	-	-	-
B9	B9/1.4	12/09/2016	16-42466_4916974	16-42466	Normal	Fill	< 10	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
B10	B10/0.2	12/09/2016	16-42466_4916975	16-42466	Normal	Fill	-	-	-	-	-	-	-	-	-	-
B10	B10/0.8	12/09/2016	16-42466_4916976	16-42466	Normal	Fill	-	-	-	-	-	-	-	-	-	-
B10	B10/1.3	12/09/2016	16-43458_4926848	16-43458	Normal	Fill	-	-	-	-	-	-	-	-	-	-
B11	B11/0.3	12/09/2016	16-42466_4916978	16-42466	Normal	Fill	-	-	-	-	-	-	-	-	-	-
B12	B12/0.2	12/09/2016	16-42466_4916980	16-42466	Normal	Fill	-	-	-	-	-	-	-	-	-	-
B13	B13/0.4	12/09/2016	16-42466_4916985	16-42466	Normal	Fill	-	-	-	-	-	-	-	-	-	-
B13			16-42466_4917011	16-42466	Normal	Fill	-	-	-	-	-	-	-	-	-	-
B13	B13/0.9	12/09/2016	16-42466_4916986	16-42466	Normal	Natural	-	-	-	-	-	-	-	-	-	-
B14			16-42466_4917012	16-42466	Normal	Natural	-	-	-	-	-	-	-	-	-	-
B14	B14/0.2	12/09/2016	16-42466_4916987	16-42466	Normal	Fill	-	-	-	-	-	-	-	-	-	-
B15	B15/0.3	12/09/2016	16-42466_4916990	16-42466	Normal	Fill	-	-	-	-	-	-	-	-	-	-
B15	B15/2.5	12/09/2016	16-42466_4916992	16-42466	Normal	Fill	-	-	-	-	-	-	-	-	-	-
B15	B215/2.5	12/09/2016	M16-Se12402	515598	Interlab_D	Fill	-	-	-	-	-	-	-	-	-	-
B15	B120916	12/09/2016	16-42466_4916999	16-42466	Field_D	Fill	-	-	-	-	-	-	-	-	-	-
B16	B16/0.45	12/09/2016	16-42466_4916994	16-42466	Normal	Fill	< 20	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
B17	B17/0.2	12/09/2016	16-42466_4916996	16-42466	Normal	Fill	-	-	-	-	-	-	-	-	-	-
SV1	SV1/3.5	17/05/2018	18-23938_5661170	18-23938	Normal	Natural	-	-	-	-	-	-	-	-	-	-
SV2	SV2/0.25	17/05/2018	18-23938_5661171	18-23938	Normal	Fill	< 10	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
SV2	SV202/0.25	17/05/2018	M18-My24475	599068	Interlab_D	Fill	-	-	-	-	-	-	-	-	-	-
SV2	SV170518	17/05/2018	18-23938_5661172	18-23938	Field_D	Fill	-	-	-	-	-	-	-	-	-	-
SV2	SV2/0.5	17/05/2018	18-23938_5661173	18-23938	Normal	Fill	-	-	-	-	-	-	-	-	-	-
SV2	SV2/3.0	17/05/2018	18-23938_5661177	18-23938	Normal	Natural	-	-	-	-	-	-	-	-	-	-
TP1	TP1/4.0	17/05/2018	18-23938_5661182	18-23938	Normal	Natural	-	-	-	-	-	-	-	-	-	-
TP2	TP2/3.0	17/05/2018	18-23938_5661184	18-23938	Normal	Fill	-	-	-	-	-	-	-	-	-	-
TP3	TP3/2.0	17/05/2018	18-23938_5661188	18-23938	Normal	Fill	-	-	-	-	-	-	-	-	-	-
TP3	TP3/3.0	17/05/2018	18-23938_5661189	18-23938	Normal	Natural	< 10	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
TP4	TP4/4.0	17/05/2018	18-23938_5661196	18-23938	Normal	Fill	-	-	-	-	-	-	-	-	-	-
TP5	TP5/4.0	17/05/2018	18-23938_5661201	18-23938	Normal	Fill	-	-	-	-	-	-	-	-	-	-
PSV_4	PSV4/2.75	26/07/2018	18-34356_5747698	18-34356	Normal	Fill	-	-	-	-	-	-	-	-	-	-
BH1	BH1/1.0	18/09/2018	18-42351_5812923	18-42351	Normal	Fill	-	-	-	-	-	-	-	-	-	-
BH1	BH1/2.5	18/09/2018	18-42351_5812924	18-42351	Normal	Fill	-	-	-	-	-	-	-	-	-	-

Comments
#1 Based on CCME 1991
#2 US EPA 2005 ECO SSL
#3 Based on CCME 1999
#4 ECO SSL 2008 - Protection of Mammalian Wildlife
#5 NEPC 1999. NEPM Interim Urban Ecological Investigation Level.
#6 Based on EPA IWRG 621 Clean Fill Criteria
#7 Based on CCME 1997
#8 US EPA 2007 ECO SSL - Based on high molecular weight PAHs
#9 Based on Ministry of Infrastructure and Environment, Dutch Target Intervention Value (2013 Circular)
#10 Based on US EPA Region 4 Soil Screening Value (All Receptors) - revised 2015
#11 Generic, conservative value based on ACL from NEPM 2013, Schedule B1, Table 1B(4) and ABC provided for an old Victorian suburb with low traffic (Olszowy et al 1995)
#12 Based on US EPA Regional Screening Levels (RSLs) (TR= 1 E-6, HQ= 1.0), revised May 2018
#13 Arsenic: HIL assumes 70% oral bioavailability. Site-specific bioavailability may be important and should be considered where appropriate (refer schedule B7).
#14 Based on US EPA Regional Screening Levels (RSLs) (TR= 1 E-6, HQ= 1.0), revised May 2018 - Chromium insoluble salts criteria has been adopted
#15 Lead: HILs A,B,C based on blood lead models (IEUBK & HIL D on adult lead model for where 50% bioavailability considered.
Site-specific bioavailability should be considered where appropriate.
#16 Elemental mercury: HIL does not address elemental mercury, a site specific assessment should be considered if elemental mercury is present, or suspected to be present.
#17 Total PAHs: Based on sum of 16 most common reported (WHO 98). HIL application should consider presence of carcinogenic PAHs (should meet BaP TEQ HIL) & naphthalene (should meet relevant HSL)
#18 PCBs: HIL refers to non-dioxin like PCBs only. Where PCB source is known, or suspected at a site, a site-specific assessment of exposure to all PCBs (inc dioxin like PCBs) should be undertaken

Table 2 - Soil Results HSL and ESL

Client: BIM Investments
Site: 1 - 5 Ballarat Road, North Geelong VIC

Table 2 - Soil Results HSL and ESL

							TRH												TPH		TRH Speciation						MAH				
							C6 - C9	C10 - C14	C15 - C28	C29-C36	+C10 - C36 (Sum of total)	C6-C10	TRH C6-C10 less BTEX (F1)	C10-C16	TRH>C10-C16 less Napthalene (F2)	C16-C34	C34-C40	C10 - C40 (Sum of total)	C10-C14 NON POLAR	C15-28 NON POLAR	TPH C29-C36 Fraction after Silica Cleanup	TRH >C10-C16 Fraction after Silica Cleanup	TRH>C10-C16 less Naph. after Silica Gel Cleanup	TRH >C16-C34 Fraction after Silica Cleanup	TRH >C34-C40 Fraction after Silica Cleanup	Sum of TRH>C10-C40 after Silica Gel Cleanup	Benzene	Toluene	Ethylbenzene		
							mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQL							20	20	50	50	50	20							50	50	50	50	50	50	50	50	50	0.5	0.5	0.5	
NEPM 2013 Table 1B(6) ESLs for Urban Res, Coarse Soil 0-2m													180 ^{#1}	120	120 ^{#2}	300	2,800											50	85	70	
NEPM 2013 Table 1B(6) ESLs for Comm/Ind, Coarse Soil 0-2m													215 ^{#1}	170	170 ^{#2}	1,700	3,300											75	135	165	
NEPM 2013 Table 1A(3) Res A/B Soil HSL for Vapour Intrusion, Sand (0-1 m)													45 ^{#1}		110 ^{#2}														0.5	160	55
NEPM 2013 Table 1A(3) Rec C Soil HSL for Vapour Intrusion, Sand (0-1 m)													NL ^{#3}		NL ^{#3}														NL ^{#3}	NL ^{#3}	NL ^{#3}
NEPM 2013 Table 1A(3) Comm/Ind D Soil HSL for Vapour Intrusion, Sand (0-1 m)													260 ^{#1}		NL ^{#3}														3	NL ^{#3}	NL ^{#3}
NEPM 2013 Table 1B(7) Management Limits in Res / Parkland, Coarse Soil												700 ^{#4}				1,000 ^{#4}	10,000														
NEPM 2013 Table 1B(7) Management Limits Comm / Ind, Coarse Soil												700 ^{#4}				5,000	10,000														
Location Code	Field ID	Date	Sample Code	Lab Report Number	Sample Type	Matrix Description																									
B1	B1/0.2	12/09/2016	16-42466_4916952	16-42466	Normal	Fill	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
B1	B2/0.2	12/09/2016	16-42466_4916954	16-42466	Normal	Fill	< 20	< 20	< 50	< 50	-	< 20	< 20	< 20	< 20	< 50	< 50	< 50	-	-	-	-	-	-	-	-	-	< 0.5	< 0.5	< 0.5	
B3	B3/0.15	12/09/2016	16-42466_4916957	16-42466	Normal	Fill	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
B4	B4/0.2	12/09/2016	16-42466_4916959	16-42466	Normal	Fill	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
B5	B5/0.2	12/09/2016	16-42466_4916961	16-42466	Normal	Fill	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
B5	B5/0.6	12/09/2016	16-42466_4916962	16-42466	Normal	Natural	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
B6	B6/0.2	12/09/2016	16-42466_4916963	16-42466	Normal	Fill	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
B7	B7/0.2	12/09/2016	16-42466_4916966	16-42466	Normal	Fill	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
B7	B7/0.2	12/09/2016	16-42466_4917007	16-42466	Normal	Fill	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
B8	B8/0.2	12/09/2016	16-42466_4916969	16-42466	Normal	Fill	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
B8	B8/0.2	12/09/2016	16-42466_4917008	16-42466	Normal	Fill	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
B9	B9/0.2	12/09/2016	16-42466_4917009	16-42466	Normal	Fill	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
B9	B9/1.4	12/09/2016	16-42466_4916974	16-42466	Normal	Fill	< 20	< 20	< 50	< 50	-	< 20	< 20	< 20	< 20	< 50	< 50	< 50	-	-	-	-	-	-	-	-	-	< 0.5	< 0.5	< 0.5	
B10	B10/0.2	12/09/2016	16-42466_4916975	16-42466	Normal	Fill	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
B10	B10/0.8	12/09/2016	16-42466_4916976	16-42466	Normal	Fill	< 20	< 20	450	140	-	< 20	< 20	< 20	< 20	580	< 50	580	-	-	-	-	-	-	-	-	-	< 0.5	< 0.5	< 0.5	
B10	B10/1.3	12/09/2016	16-43458_4926848	16-43458	Normal	Fill	< 20	< 20	< 50	< 50	-	< 20	< 20	< 20	< 20	< 50	< 50	< 50	-	-	-	-	-	-	-	-	-	-	-	-	
B11	B11/0.3	12/09/2016	16-42466_4916978	16-42466	Normal	Fill	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
B12	B12/0.2	12/09/2016	16-42466_4916980	16-42466	Normal	Fill	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
B12	B12/0.2	12/09/2016	16-42466_4917010	16-42466	Normal	Fill	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
B13	B13/0.4	12/09/2016	16-42466_4916985	16-42466	Normal	Fill	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
B13	B13/0.4	12/09/2016	16-42466_4917011	16-42466	Normal	Fill	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
B13	B13/0.9	12/09/2016	16-42466_4916986	16-42466	Normal	Natural	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
B13	B13/0.9	12/09/2016	16-42466_4917012	16-42466	Normal	Natural	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
B14	B14/0.2	12/09/2016	16-42466_4916987	16-42466	Normal	Fill	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
B15	B15/0.3	12/09/2016	16-42466_4916990	16-42466	Normal	Fill	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
B15	B15/2.5	12/09/2016	16-42466_4916992	16-42466	Normal	Fill	< 20	< 20	65	110	-	< 20	< 20	< 20	< 20	170	< 50	170	-	-	-	-	-	-	-	-	-	< 0.5	< 0.5	< 0.5	
B15	B15/2.5	12/09/2016	M16-Se12402	515598	Interlab_D	Fill	< 20	< 20	< 50	73	73	< 20	< 20	< 50	< 50	< 100	< 100	-	-	-	-	-	-	-	-	-	-	-	-	-	
B15	B120916	12/09/2016	16-42466_4916999	16-42466	Field_D	Fill	< 20	< 20	< 50	< 50	-	< 20	< 20	< 20	< 20	< 50	< 50	< 50	-	-	-	-	-	-	-	-	-	-	-	-	
B16	B16/0.45	12/09/2016	16-42466_4916994	16-42466	Normal	Fill	< 20	< 20	< 50	< 50	-	< 20	< 20	< 20	< 20	< 50	< 50	< 50	-	-	-	-	-	-	-	-	-	< 0.5	< 0.5	< 0.5	
B17	B17/0.2	12/09/2016	16-42466_4916996	16-42466	Normal	Fill	< 20	< 20	< 50	< 50	-	< 20	< 20	< 20	< 20	< 50	< 50	< 50	-	-	-	-	-	-	-	-	-	< 0.5	< 0.5	< 0.5	
PSV 4 1816-AN-LU-055	PSV4/2.75	26/07/2018	18-34356_5747698	18-34356	Normal	Fill	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
SV1	SV1/3.5	17/05/2018	18-23938_5661170	18-23938	Normal	Natural	< 20	< 20	< 50	< 50	-	< 20	< 20	< 20	< 20	< 50	< 50	< 50	-	-	-	-	-	-	-	-	-	< 0.5	< 0.5	< 0.5	
SV2	SV2/0.5	17/05/2018	18-23938_5661173	18-23938	Normal	Fill	< 20	< 20	< 50	< 50	-	< 20	< 20	< 20	< 20	< 50	< 50	< 50	-	-	-	-	-	-	-	-	-	-	-	-	
SV2	SV2/0.25	17/05/2018	18-23938_5661171	18-23938	Normal	Fill	< 20	< 20	< 50	< 50	-	< 20	< 20	< 20	< 20	< 50	< 50	< 50	-	-	-	-	-	-	-	-	-	< 0.5	< 0.5	< 0.5	
SV2	SV2/3.0	17/05/2018	18-23938_5661177	18-23938	Normal	Natural	< 20	< 20	< 50	< 50	-	< 20	< 20	< 20	< 20	< 50	< 50	< 50	-	-	-	-	-	-	-	-	-	< 0.5	< 0.5	< 0.5	
SV2	SV202/0.25	17/05/2018	M18-My24475	599068	Interlab_D	Fill	< 20	< 20	< 50	< 50	< 50	< 20	< 20	< 50	< 50	< 100	< 100	-	-	-	-	-	-	-	-	-	-	-	-	-	
SV2	SV170518	17/05/2018	18-23938_5661172	18-23938	Field_D	Fill	< 20	< 20	< 50	< 50	-	< 20	< 20	< 20	< 20	< 50	< 50	< 50	-	-	-	-	-	-	-	-	-	-	-	-	
TP1	TP1/4.0	17/05/2018	18-23938_5661182	18-23938	Normal	Natural	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
TP2	TP2/3.0	17/05/2018	18-23938_5661184	18-23938	Normal	Fill	< 20	< 20	< 50	< 50	-	< 20	< 20	< 20	< 20	< 50	< 50	< 50	-	-	-	-	-	-	-	-	-	-	-	-	
TP3	TP3/2.0	17/05/2018	18-23938_5661188	18-23938	Normal	Fill	< 20	< 20	< 50	< 50	-	< 20	< 20	< 20	< 20	56	< 50	56	-	-	-	-	-	-	-	-	-	-	-	-	
TP3	TP3/3.0	17/05/2018	18-23938_5661189	18-23938	Normal	Natural	< 20	< 20	< 50	< 50	-	< 20	< 20	< 20	< 20	< 50	< 50	< 50	-	-	-	-	-	-	-	-	-	-	-	-	
TP4	TP4/4.0	17/05/2018	18-23938_5661196	18-23938	Normal	Fill	< 20	< 20	< 50	< 50	-	< 20	< 20	< 20	< 20	< 50	< 50	< 50	-	-	-	-	-	-	-	-	-	< 0.5	< 0.5	< 0.5	
TP5	TP5/4.0	17/05/2018	18-23938_5661201	18-23938	Normal	Fill	< 20	< 20	< 50	< 50	-	< 20	< 20	< 20	< 20	< 50	< 50	< 50	-	-	-	-	-	-	-	-	-	-	-	-	
BH1	BH1/1.0	18/09/2018	18-42351_5812923	18-42351	Normal	Fill	< 20	-	-	-	-	< 20	< 20	-	-	-	-	-	< 20	< 50	< 50	< 20	< 20	< 50	< 50	< 50	< 50	-			

Comments

#1 To obtain F1 subtract the sum of BTEX concentrations from the C6 - C10 fraction.

#2 To obtain F2 subtract naphthalene from the > C10 - C16 fraction.

#3 Derived soil HSL exceeds soil saturation concentration

#4 Separate management limits for BTEX & naphthalene are not available hence should not be subtracted from the relevant fractions to obtain F1 & F2

Table 2 - Soil Results HSL and ESL

[illegible][illegible]

Comments

#1 To obtain F1 subtract the sum of BTEX concentrations from the C6 - C10 fraction.

#2 To obtain F2 subtract naphthalene from the > C10 - C16 fraction.

#3 Derived soil HSL exceeds soil saturation concentration

#4 Separate management limits for BTEX & naphthalene are not available hence should not be subtracted from the relevant fractions to obtain F1 & F2

TABLES (Soil Vapour)

Project: 18053
Client: BIM Investments Pty Ltd
Site: North Geelong

Table 1 - Tabulated Soil Vapour Results

	TRH		MAH															PAH	
	C6-C10	TRH C6-C10 less BTEX (F1)	Benzene	Toluene	Ethylbenzene	Xylene (m & p)	Xylene (o)	Xylene Total	Isopropylbenzene	1,2,4-trimethylbenzene	1,3,5-trimethylbenzene	Styrene	1-methyl-4 ethyl benzene	Isopropylbenzene	n-butylbenzene	n-propylbenzene	sec-butylbenzene	tert-butylbenzene	Naphthalene
	mg/m3	mg/m3	µg/m 3	µg/m 3	µg/m 3	µg/m 3	µg/m 3	µg/m 3	µg/m 3	µg/m 3	µg/m 3	µg/m3	µg/m3	µg/m3	µg/m3	µg/m3	µg/m3	µg/m3	µg/m 3
EQI	0	0	2.4	0	2.9	4.1	4.1	4.1	1.9	0	0	2.9	2.9	3.9	3.9	3.4	3.9	3.9	4.9
NEPM 2013 Table 1A(2) Res A Soil Vap VOCCHILs																			
NEPM 2013 Table 1A(2) Res B Soil Vap VOCCHILs																			
NEPM 2013 Table 1A(2) Comm/Ind D Soil Vap VOCCHILs																			
NEPM 2013 Table 1A(5) Res Soil Vapour HSL A/B for Vapour Intrusion, Sand																			
0-1m		180 ^{#1}	1,000	1,300,000	330,000			220,000											800
1-2m		640 ^{#1}	3,000	3,800,000	1,100,000			750,000											3,000
2-4m		1300 ^{#1}	6,000	7,300,000	2,200,000			1,500,000											6,000
NEPM 2013 Table 1A(5) Comm/Ind D Soil Vapour HSL, Sand																			
0-1m		680 ^{#1}	4,000	4,800,000	1,300,000			840,000											3,000
1-2m		2800 ^{#1}	10,000	16,000,000	4,600,000			3,200,000											15,000
2-4m		7000 ^{#1}	30,000	39,000,000	11,000,000			8,000,000											35,000
USEPA RSLs Resident Air (May 2018) THQ=1.0, adjusted for AF = 0.005										12,600	12,600								
USEPA RSLs Industrial Air (May 2018) THQ=1.0, adjusted for AF=0.005										52,000	52,000								
Explosive/ Flammable Limits - Lower Limit	50699 ^{#3}		35130000 ^{#3}	43409000 ^{#4}	41440000 ^{#3}			47750000 ^{#3}											57649000 ^{#3}
Explosive/ Flammable Limits - Upper Limit	359967 ^{#3}		226750000 ^{#3}	308207000 ^{#4}	267479000 ^{#3}			286503000 ^{#3}											309211000 ^{#3}

Location Code	Date	Sample Code	Lab Report Number	Sample Type	Matrix Description																	
IPA Shroud 4094	1/06/2018	2018005262	M180398	Normal	GAS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SV-1 SC4210	1/06/2018	2018005257	M180398	Normal	GAS	1.6	1.6	<2.4	4.6	<2.9	11	8.1	19.1	-	26	15	<2.9	<2.9	<3.9	<3.9	<3.4	<3.9
SV-2 Field Dup SC4222	1/06/2018	2018005259	M180398	Field D	GAS	1.6	1.5	4.1	3.5	16	22	7.1	29.1	-	19	45	<3.1	<3.1	<4.1	<4.1	<3.6	<4.1
SV-2 SC4236	1/06/2018	2018005258	M180398	Normal	GAS	1.9	1.6	45	12	130	67	24	91	-	22	31	<2.9	<2.9	<3.9	<3.9	<3.4	<3.9
PSV 1 1816-AN-LU-056	1/08/2018	2018007771	M180505R1	Normal	GAS	-	-	< 7.4	< 5	< 4	< 4.1	< 4.1	< 4.1	< 1.9	-	< 2.7	-	-	-	-	-	< 4.9
PSV 2 1816-AN-LU-054	1/08/2018	2018007772	M180505R1	Normal	GAS	-	-	< 7.4	< 5	< 4	< 4.1	< 4.1	< 4.1	< 1.9	-	< 2.7	-	-	-	-	-	< 4.9
PSV 3 1816-AN-LU-059	1/08/2018	2018007773	M180505R1	Normal	GAS	-	-	16	7.7	< 4	7.3	< 4.1	7.3	< 1.9	-	< 2.7	-	-	-	-	-	< 5
PSV 4 1816-AN-LU-055	1/08/2018	2018007774	M180505R1	Normal	GAS	-	-	< 7.4	< 5	< 4	17	11	28	< 1.9	-	19	-	-	-	-	-	< 5
PSV 5 1816-AN-LU-061	1/08/2018	2018007775	M180505R1	Normal	GAS	-	-	< 7.4	< 5	< 4	< 4.1	< 4.1	< 4.1	< 1.9	-	< 2.7	-	-	-	-	-	< 5

Env Stds Comments
#1:To obtain F1 subtract the sum of BTEX concentrations from the C6 - C10 fraction.□
#2:Adjusted for a cancer risk of 1E-05
#3:Lower and Upper EL based on Ground Gas Handbook (2009)
#4:Limit adopted from worst case EL across BTEX limits

Table 1 - Tabulated Soil Vapour Results

Site: North Geelong

Table 1 - Tabulated Soil Vapour Results

	Halogenated Vol. Organics								Halogenated Vol. Organics						Chlorinated Hydrocarbons					Solvents			Alcohols
	Halothane	1,1,1-trichloroethane	1,1,2-trichloroethane	1,1-dichloroethane	1,1-dichloroethene	1,2-dichloroethane	Dichlorodifluoromethane	Carbon tetrachloride	Chlorobenzene	Chloroform	cis-1,2-dichloroethene	Tetrachloroethene	Trichloroethene	Vinyl chloride	1,2,3-trichlorobenzene	1,2,4-trichlorobenzene	1,2-dichlorobenzene	1,3-dichlorobenzene	1,4-dichlorobenzene	Hexane	MTBE	Methyl Ethyl Ketone	2-Propanol
	µg/m ³	µg/m ³	µg/m ³	µg/m ³	µg/m ³	µg/m ³	µg/m ³	µg/m ³	µg/m ³	µg/m ³	µg/m ³	µg/m ³	µg/m ³	µg/m ³	µg/m ³	µg/m ³	µg/m ³	µg/m ³	µg/m ³	µg/m ³	µg/m ³	µg/m ³	µg/m ³
EQL	33	3.9	3.9	3.4	2.9	4.8	1.9	4.8	2.9	4.4	3.9	4.4	4.6	1.9	2.3	3.9	2.3	2.7	2.6	0	2.9	14	0
NEPM 2013 Table 1A(2) Res A Soil Vap VOCCHILs		60,000									80	2,000	20	30									
NEPM 2013 Table 1A(2) Res B Soil Vap VOCCHILs		60,000									80	2,000	20	30									
NEPM 2013 Table 1A(2) Comm/Ind D Soil Vap VOCCHILs		230,000									300	8,000	80	100									
NEPM 2013 Table 1A(5) Res Soil Vapour HSL A/B for Vapour Intrusion, Sand																							
0-1m																							
1-2m																							
2-4m																							
NEPM 2013 Table 1A(5) Comm/Ind D Soil Vapour HSL, Sand																							
0-1m																							
1-2m																							
2-4m																							
USEPA RSLs Resident Air (May 2018) THQ=1.0, adjusted for AF = 0.005										240 ^{#2}													
USEPA RSLs Industrial Air (May 2018) THQ=1.0, adjusted for AF=0.005										1,060 ^{#2}													
Explosive/ Flammable Limits - Lower Limit														97106000 ^{#3}									
Explosive/ Flammable Limits - Upper Limit														792182000 ^{#3}									

Location Code	Date	Sample Code	Lab Report Number	Sample Type	Matrix Description	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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Env Stds Comments
#1:To obtain F1 subtract the sum of BTEX concentrations from the C6 - C10 fraction.□
#2:Adjusted for a cancer risk of 1E-05
#3:Lower and Upper EL based on Ground Gas Handbook (2009)
#4:Limit adopted from worst case EL across BTEX limits