Attachment D: Site Remediation Plan

24 – 30 Murray Street, Albert Park, SA

Site Remediation Plan (Version FR002)

DFJ Holdings

September 2021

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Document Status

Version	Doc type	Reviewed by	Approved by	Date issued
DR001	Report	Dr James Fox		Internal Review
DR002	Report	Dr James Fox	Dr James Fox	27 April 2021
DR003	Report	Dr James Fox	Dr James Fox	10 July 2021
FR001	Report	Dr James Fox	Dr James Fox	31 August 2021
FR002/A	Report	Dr James Fox	Dr James Fox	6/7 September 21

Project Details

Project Name	Site Remediation Plan (Version FR002)
Project Location	24 – 30 Murray Street, Albert Park, SA
Client	DFJ Holdings
Client Project Manager	Mr Don Totino
LWC Project Manager	Dr James Fox
LWC Project Director	Dr James Fox
Authors	Riley Martin
File Reference	LWC HO-26 Site Remediation Plan FR002/A_Issue

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SOUTH AUSTRALIA

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INDUCTION FORM

SITE REMEDIATION MANAGEMENT PLAN ACKNOWLEDGMENT RECORD LOG

All employees and contractors working in the subject area must sign the master copy of this document, indicating they have read and understand it. The signature indicates acceptance and compliance with the requirements of the Site Remediation Plan (SRP). Copies of this document must be made available for them review and readily available at the site.

Name/Job Title	Date Inducted	Signature of Acknowledgement

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EXECUTIVE SUMMARY

Context

Mr Don Totino of DFJ Holdings engaged Land & Water Consulting (LWC) to prepare this Site Remediation Plan (SRP) for 24 – 30 Murray Street, Albert Park, South Australia (the Site, Refer to the Executive Summary Figure ES1).

The Site is currently owned by DFJ Holdings (having purchased the Site in 2009).

The Site is rectangular in shape and covers an area of approximately 1.6 hectares (1.6 ha), with roads immediately adjoining the southern, eastern, and western sides of the property and with residential/ commercial adjoining the northern side of the Site. The Site consists of a series of commercial warehouse type buildings surrounded by predominantly sealed ground to the east and unsealed ground along the western boundary.

The Site is proposed to be developed as low density residential (sensitive land use) with all existing site infrastructure to be demolished during the re-development works.

The Site is subject to a site contamination audit (audit) by Mr Graeme Miller of Senversa (the Auditor) (Environment Protection Authority (EPA) Audit reference 61909) and may be potentially developed for use as low density residential (a sensitive land use as defined in Section 3(1) of the *Environment Protection Act 1993* (EP Act)). The Site is not currently a sensitive land use.

Nature and Extent of Site Contamination

Site contamination (as defined in Section 5B of the *Environment Protection Act 1993*) was identified in the Detailed Site Investigation (LWC, 2018b) and subsequently assessed further to refine the nature and extent of contamination and assess the risk profile with respect to on and offsite receptors (sensitive use). Refer to the Site Specific Risk Assessment (LWC, 2021) for further information. The nature and extent of site contamination is summarised in ES Table 1-1.

Further to LWC 2018a, The Environment Protection Authority is satisfied that DFJ Holdings is not responsible for causing the site contamination. The EPA (4 May 2018) determined that DFJ Holdings is not responsible for site contamination beyond the boundaries of the Site. However, EPA (4 May 2018) also noted that the site contamination audit must still consider the impacts of any on-site contamination to on and off-site receptors. This SRP is mindful of this directive with respect to mitigating the potential ongoing migration of site related contamination under offsite areas (in groundwater and soil vapour) based on the risks reported / assessed in EPA Assessment Area reports and LWC, 2021.

ES Table 1-1 Nature and extent of site contamination

Soils - (refer Executive Summary Figures ES2 (soil bores), ES3 and ES4 (for extent))	
Fill A Comprising the fill and chemicals (lead – human health and copper, zinc - ecology) in sample location SB09 at 0.0-0.2 m.	**Laterally –** The fill evident in SB09 is not evident in bores radial to such location unless counting SB16 to the south. The concentrations of metals reported maybe attributable to the fill itself (i.e. uncontrolled imported fill) or could be a function of loss of lead based paint from the northern warehouse, historically, noting the surface is sealed here. Alternatively it could be a function of processes / activities undertaken at the Site in Gadsdens days. **Vertically –** Copper and zinc are delineated to 0.2 m however elevated lead (relative to HIL A) is reported in the sample from natural at 0.2 m.
Fill B Comprising the copper, lead and zinc in location SB16.	**Laterally –** The fill evident in SB16 is not evident in bores radial to such location unless counting SB09. The concentrations of metals reported maybe attributable to the fill itself (i.e. uncontrolled imported fill) or could be a function of loss of lead based paint from the northern warehouse, historically, noting the surface is sealed here. Alternatively it could be a function of processes / activities undertaken at the Site in Gadsdens days. **Vertically –** Delineated to 0.2 m.
Fill C In the scaffold storage area – potentially associated with the former Gadsdens business. Characterised by black, grey gravelly sand / clayey gravel with occasional brick, bitumen, tar and glass and concentrations of metals (copper, lead, zinc) PAH (BaP TEQ) and TRH (Fraction C16-34) above human health and ecological / environmental protection criteria.	**Laterally –** Located to the west of the northern warehouse stretching from possibly SB19 in the north to SB25 in the south, note that these areas are unsealed. **Vertically –** SB20 reports a depth of 0.7 m although this is logged as clayey gravel. Elsewhere the fill is generally gravelly sand or silt and averages 0.2 m. Concentration wise the BaPTEQ in SB20 is not delineated however the fill reports tar fragments and it is considered that the reported BaP concentrations are synonymous with the fill layer on such basis. The area is characterised by unsealed surface used for commercial storage of scaffold and occasional metal (inert) waste. The older non scaffold metal items may be the source of metals in soils (i.e. metal flakes or shavings) or equally the fill itself could be the source, or even former use of the site by Gadsdens. What is evident is that the fill exceeds tier 1 criteria for residential land use (both human health – lead, BaP TEQ) and environment (copper, lead, zinc, BaP TEQ and Fraction C16-C34).
Soil vapour (Refer Executive Summary Figure ES5)	
Concentrations of ▪ Trichloroethene (TCE) ▪ cis 1,2 dichloroethene ▪ 1,2 dichloroethane	TCE was reported in soil vapour beneath the north-portion of the Site at concentrations greater than the adopted investigation levels (National Environment Protection (Assessment of Site Contamination) Measure 1999 as amended 2013 Health Investigation Levels for soil vapour in a low density residential land use setting ('HIL A'). The highest concentrations were reported under the northern end of the northern building (referred to in this document as "Building C") and adjacent to the central northern site boundary. TCE above the relevant criterion also is present as soil vapour immediately to the east and west of the Site. The presence of TCE contamination in soil vapour under the north-eastern portion of the Site generally coincides with: ▪ the inferred source of the contamination (former tin can manufacturing in the northern site building); and

	▪ the highest TCE concentrations in groundwater. The above-guideline concentrations of TCE under the northern portion of the site ranged from 25 µg/m³ to 7,900 µg/m³ (compared to a guideline value of 20 µg/m³). Screening of utilities under and adjacent to the Site did not indicate that TCE in soil vapour is accumulating or migrating within these structures – with the majority of PID readings being 0 parts per million (ppm) and a maximum recorded value of 0.2 ppm. Note that a similar exercise was undertaken by Golder (2020) as part of the EPA Assessment Area works and the same conclusion was reached. Other VOCs (1,2 dichloroethane and cis-1,2 dichloroethene) were also reported greater than the adopted investigation levels in soil vapour samples collected from nested soil vapour probes installed in the northern portion of the Site (locations AV-1S&D and AV-2S&D). TCE contamination in soil vapour was reported to the north, northeast and west of the site – across and down hydraulic gradient. The most recent investigation by JBS&G (16 April 2021) presents the results from the four rounds of soil vapour sampling completed in off-site areas. The most recent sampling at each location found the following: ▪ Above guideline TCE concentrations in shallow soil vapour probes ranged from < 7 µg/m³ to 11,000 µg/m³, which similar is a similar range to that reported under the northern portion of the site. ▪ Above guideline TCE concentrations were reported up to approximately 200 m to the north and 200 m to the west of the site. Above guideline TCE concentrations were also reported up to 120 m northeast of the site along Murray Street. ▪ Concentrations of TCE in deeper soil vapour probes were similar to and in some instances greater than those reported at the on-site deep soil vapour probes. The above guideline concentrations of TCE reported by JBS&G (3 December 2020) and LWC (6 July 2019) to the east, north and northeast of the Site are indicative of a source unrelated to the Site. Those to the west and northwest are considered likely to be associated with the Site and possibly another off-site source. Cis-1,2 dichloroethene was also reported JBS&G (16 April 2021) greater than the adopted assessment criteria in four soil vapour probes sampled to the north and northeast of the site.
Groundwater – Q1 Aquifer (refer Executive Summary Figure ES6)	
TCE (chlorinated hydrocarbons (CHC))	▪ TCE is present at concentrations greater than the adopted criterion in groundwater under the northern portion of the Site and to the northeast, north, northwest and west of the Site. ▪ The highest concentrations of TCE under the Site are reported at and down hydraulic gradient of the northern portion of the northern building. ▪ The maximum TCE concentration reported in groundwater under the Site across four rounds of groundwater sampling and analysis was 508 ug/L – at GW10, which is located in the north-western corner of the Site and is screened in the deeper portion of the Q1 Aquifer. TCE is also reported greater than the adopted criteria at GW06 – which is located along the up hydraulic gradient boundary of the Site. ▪ Similar and higher concentrations were reported as part of the EPA Assessment Area staged works, by JBS&G (11 February 2020) and Golder (3 December 2020) to the north (across hydraulic gradient) and west (up hydraulic gradient) of the Site (maximum of 1,130 ug/L approximately 100 m west of the site). The off-site wells are installed in the upper portion of the Q1-watertable unit (which is also targeted by the site Q1 water table unit monitoring wells – except GW10 and the well targeting the Q2 unit (GW09-Q2)). ▪ 1,1-dichloroethene, 1,1-dichloroethane, 1,2-dichloroethane, cis-1,2-dichloroethene, tetrachloroethene (PCE), chloroform and

	trans-1,2-dichloroethene were also detected in groundwater under the Site, but at concentrations less than the adopted assessment criteria. ▪ Most of these chemicals, as well as vinyl chloride, were detected in groundwater sampled from some of the off-site monitoring wells – and were present at concentrations generally less than the adopted criteria. The general absence or low concentrations of these chemicals (many of which represent degradation products of TCE) indicates limited bio-degradation of TCE and CHCs is occurring in groundwater within the Q1 water table unit. ▪ Potential (likely) sources are as follows: 1. The Site – former Gadsdens Pty Ltd tin can manufacturing plant in the northern building (Building C). 2. Off-site – current and former industrial activities identified in LBW Co (2020) to the northeast and east of the Site.
TRH	▪ TRH Fraction C_6-C_{10} was reported above LOR and greater than the direct contact criteria at site monitoring wells located adjacent and to the north and northwest of the northern building, and at offsite monitoring wells located to the northeast, northwest and west of the site. ▪ TCE reports in TRH Fraction C_6-C_{10}. Concentrations of Fraction C_6-C_{10} were similar to the concentrations to TCE reported at the same monitoring wells, suggesting that the TRH is representative predominantly of TCE. ▪ Longer chain TRH fractions were only detected greater than the LOR (and slightly above the guideline value) on one occasion in water sampled from on-site monitoring well GW05 – which is located in the southwestern portion of the Site, near to where small scale vehicle maintenance previously occurred and near to the electrical transformer. ▪ Potential (likely) sources are as follows: 1. The Site – former Gadsdens Pty tLd tin can manufacturing plant in the northern building (Building C). 2. Off-site – current and former industrial activities identified in LBW Co (2020) to the northeast and east of the Site.
PFAS	▪ The sum of PFHxS and PFOS was detected at concentrations greater than the adopted criteria in samples collected from monitoring wells located in the northern portion of the Site (adjacent and down hydraulic gradient of the north building) and along the eastern (up hydraulic gradient) boundary. The concentrations near the northern site building were higher than those reported along the upgradient (northern) portion of the Site boundary, but similar to those reported across and up hydraulic gradient – along the southern portion of the eastern boundary. Potential (likely) sources are as follows: 1. former Gadsdens Pty Ltd tin can manufacturing plant in the northern building (Building C). 2. Off-site – current and former industrial activities identified in LBW Co (2020) to the northeast and east of the Site.
Metals	▪ Boron was reported greater than the adopted criteria and at similar concentrations in the majority of monitoring wells sampled at on-site and off-site locations (0.08 mg/L to 1.74 mg/L on-site and 1.18 mg/L to 2.59 mg/L off-site). ▪ Manganese was reported greater than the adopted criteria at one monitoring well located adjacent to the northern site building and at one monitoring well located along the eastern site boundary – up hydraulic gradient of the northern building. It was not reported greater than the adopted criteria in

	groundwater in the one round it was tested (Golder, 2020) at off-site monitoring wells. ▪ Nickel - was reported slightly greater than the adopted criteria at monitoring wells located within and adjacent to the northern building (Building C), in the southwestern portion of the Site at one monitoring well, and at one monitoring well located along the eastern site boundary – up hydraulic gradient of the northern building. It was not reported greater than the adopted criteria in groundwater in the one round it was tested (Golder, 2020) at off-site monitoring wells. ▪ Selenium was reported slightly greater than the adopted criteria at three monitoring wells located within and adjacent to the northern site building (Building C), and at one monitoring well (at similar concentrations) more than 200 m northwest of the Site. ▪ Possible sources of manganese, nickel and selenium – is one or more of the following: o Ambient background water quality. o The Site – former tin can manufacturing plant in northern building. o Off-site – current and former industrial activities identified in LBW Co (16 June 2020) to the northeast and east of the Site. ▪ Boron is considered to be a function of ambient background.
Inorganics	▪ Total nitrogen and phosphorous were reported greater than the adopted criteria at monitoring wells located in the northern, western and eastern portions of the Site, including along the up hydraulic gradient boundary (at which some of the higher concentrations were reported). ▪ The source is considered to be ambient background.
Groundwater – Q2 Aquifer	
TCE	▪ TCE was reported at 2 ug/L in a sample collected from GW09. This is slightly greater than the LOR of 1 ug/L. This concentration is less than the adopted assessment criteria. No other CHCs were detected.
TRH	▪ TRH was reported in water sampled from the Q2 well at concentrations greater than the laboratory limit of reporting. It is noted that this well has been sampled on only one occasion and was drilled with mud techniques – which introduces fluids into the formation. Further sampling is required to assess whether the TRH represents groundwater contamination or an artifact of the drilling process. Note that silica gel clean-up notably reduced the initial reported concentration indicating a reasonable proportion of the TRH was biogenic.
Inorganics	▪ Total nitrogen and phosphorous were reported greater than the adopted criteria at generally similar concentrations to those reported in the Q1 water table unit at the site. ▪ The source is considered to be ambient background.

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Risk: Health

The conceptual site model formulated in the site specific risk assessment (SSRA, refer LWC, 2021) identified six source pathway receptor (SPR) linkages that represent potential harm to human health, accounting for a sensitive land use:

- SPR Linkages 1 – 4: Potential risk to human health from lead and carcinogenic polycyclic aromatic hydrocarbons (benzo(a)pyrene TEQ) in fill at concentrations above tier 1 soil screening levels for the protection of health considering a low density residential land use, and considering ingestion (including inhalation) and dermal contact exposure pathways. This fill must be managed to eliminate risk associated with exposure to these chemical substances.
- Linkages 5 and 6: Potential risk to human health from inhalation of TCE vapour in an indoor air environment (low density residential land use) for both on and offsite receptors (residents).

The highest concentration of TCE in groundwater within the Groundwater Prohibition Area (GPA) is associated with offsite monitoring location GW03 (located along Spencer Street) – 1,130 mg/L (upper Q1). This is double the highest concentration reported on site (508 mg/L in water sampled from groundwater monitoring well GW10 – note that GW10 is screening the lower Q1). TCE vapour at Spencer Street is significantly higher than on site (32,000 µg/m^3 versus 7,900 µg/m^3).

TCE in water sampled on site from groundwater monitoring well GW10 is thus considered to not represent a significant vapour risk (based on depth) noting TCE soil vapour in this location was below the soil vapour tier 1 criterion of 20 µg/m^3 (14 µg/m^3).

The vapour reported on site is indicative more-so of an actual vadose zone source rather than volatilisation from groundwater.

Rather than undertaking a new/ standalone vapour intrusion risk assessment (VIRA), the EPA commissioned VIRA concludes that TCE measured in several locations presents a potential risk to residential receptors where dwellings are crawlspace and/ or slab on ground construction.

On the Site, several TCE concentrations in the north central area (the assumed source area i.e. vapours monitoring locations AV1 and AV2) exceed the lowest TCE concentration identified in the Assessment Area VIRA that has been identified as a potential issue. Therefore when aligning with the EPA Assessment Area VIRA (and considering all other parameters (such as geological and soil factors) being equal) **then the soil vapour concentrations reported are unacceptable with respect to a proposed sensitive land use and remediation (elimination) of the TCE source is required.**

The Assessment Area VIRA included an assessment of trench workers being exposed to soil vapour in a subsurface trench environment, using concentrations of TCE vapour at least twice those reported on site and found no indication of unacceptable risk to such workers.

Field assessment of services external to the Site was undertaken within this scope (headspace screening) and also by Golder as part of the EPA commissioned Assessment Area studies. Such surveys did not find any indication that subsurface services are a significant pathway for the migration of TCE or other volatile organic compounds to residential areas external to the Site.

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Risk: Environment

There are no surface water bodies (fresh or marine) within 2 km of the Site. Therefore the assessment of site related groundwater contamination is not relevant to aquatic ecosystems (fresh / marine).

Risks to the environment (soil flora and fauna) are considered to be restricted to the fill zones discussed above (Fill Zones A, B and C) as identified in the Detailed Site Investigation. Risk to ecology are identified as SPR linkages 14 – 18 (direct contact with metals, total recoverable hydrocarbons and polycyclic aromatic hydrocarbons). Remediation of this fill is required (i.e. risks to both human health and ecology can be eliminated simultaneously).

Risk: Groundwater

Q1 water table unit

TCE, TRH, boron, manganese, nickel, phosphorous, selenium, nitrite / nitrate and PFAS (PFOS + PFHxS) were reported above tier 1 water quality criteria (or limits of reporting i.e. .with respect to TRH) for the environmental values identified, in water sampled from the Q1 water table unit.

Manganese, nickel and selenium are possibly associated with one or more of the following:

- Ambient background water quality.
- Site – former tin can manufacturing plant in northern building.
- Off-site – current and former industrial activities identified in LBW Co (16 June 2020) to the northeast and east of the site.

Boron, nitrogen and phosphorous are likely to be largely representative of background water quality.

TRH is considered to be representative of TCE concentrations (the TRH analysis reports TRH present in C_6-C_{10} fraction – TCE reports in this fraction).TCE is likely to be present as a result of historical site activities (cannery). There is no indication of PFAS sources on site or having been on the Site, though PFAS can be associated with cannery operations and so the presence of PFAS in groundwater beneath the Site may be associated with historical on site activities.

Q2 unit

Trace concentrations of bromomethane, total recoverable hydrocarbon and manganese and nickel were reported in water sampled from the Q2 unit, though these are considered to be trivial, and not representative of site contamination, and the Q2 unit is also covered by the GPA. A follow up monitoring event is required regarding the Q2 unit with respect to confirming the presence / absence of bromomethane in water sampled from the Q2 unit.

There are no aquatic ecosystems located down hydraulic gradient in a 2 km radius of the Site. Therefore, there is no apparent risk to surface water (groundwater dependant ecosystem) receptors from chemical substances reported in groundwater beneath the Site.

The source of the TCE may continue to contribute to contamination of the watertable-Q1 unit and therefore the specific location, format, and extent of the source (if a point source e.g. tank, pipe, sump) needs to be investigated (and removed) following the demolition of the northern warehouse.

Given the establishment of a GPA for the area in 2019, the abstraction and use of groundwater from the **Q1-watertable- and Q2 unit** beneath and down hydraulic gradient of the Site is precluded. This eliminates the risk to future sensitive or non-sensitive users of the Site, other than vapour intrusion/ inhalation associated with TCE.

Scope of Work

This SRP provides a detailed scope of works and methodology for the remediation of the Site, with respect to:

1. Locating and removing a potential primary source of trichloroethene (TCE) potentially located in the central northern footprint of the Site associated with the northern half of the northern warehouse ('Building C') post demolition of northern structures. Note that the northern building may form a source of other VOC reported in soil vapour and also a potential source of per and polyfluoroalkyl substances (PFAS), manganese, nickel, and selenium. Total Recoverable Hydrocarbons (TRH) is evident in groundwater also though this is considered to be representative of TCE.

2. Management of soils that may be identified following the removal of the potential TCE source infrastructure (secondary source) that are unsuitable for low density residential land use - Remediation of primary and secondary sources of TCE is also required to mitigate ongoing contamination of groundwater and associated site and off-site vapour intrusion sources and risks.

3. Management of known areas of soil ('fill') that do not meet the required tier 1 generic land use screening criteria for low density residential land.

4. Assessment of soils within the footprints of buildings located in the southern area of the Site. Although not expected to be an area prone to site contamination, due to occupancy, the footprint of these buildings has not been assessed. Validation samples are required to be collected from soil within such footprint.

5. Validation of soil vapour following primary and secondary TCE source removal, to re-assess the risk profile (and site suitability) respect to vapour intrusion noting TCE is also present in groundwater.

6. Implementation of a Groundwater Monitoring and Management Plan (GMMP) to monitor TCE in groundwater beneath the Site post remediation, noting that TCE is present in groundwater up-hydraulic gradient of the Site.

Remediation Goals and Objectives

The goals of the remediation are as follows:

- Remove site contamination associated with a vadose zone TCE source to:
    - make the site suitable for a sensitive land use; and
    - reduce the potential for ongoing groundwater contamination and associated soil vapour contamination beneath the Site and down hydraulic gradient offsite areas.
- Mitigate potential risks to human health and the environment posed by impacted shallow soils (copper, lead, zinc, benzo(a)pyrene toxicity equivalent quotient TEQ and total recoverable hydrocarbons)) to render the Site suitable for sensitive land use; and

- Undertake the remedial works such that:
  - The risks to human health, safety and the environment are mitigated; and
  - All works are undertaken in accordance with relevant regulatory provisions and guidance.

All remediation works are to be supervised by Land & Water Consulting. A validation report will be prepared by Land & Water Consulting for review by the appointed site contamination auditor following the completion of the remediation works.

Conclusions and Recommendations

Land & Water Consulting conclude that the Site in its current form / configuration is contaminated (as defined in Section 5B of the *Environment Protection Act 1993*) when accounting for a proposed sensitive land use. A process of remediation has been scoped and presented in this Site Remediation Plan, which Land & Water Consulting recommend is enacted at the Site in order to facilitate the suitability of the Site for a sensitive use, another use or range of uses.

This SRP has been prepared in accordance with the requirements of the South Australian Environment Protection Authority (2019) Guidelines for the Assessment and Remediation of Site Contamination (2019a).

A statement of limitations regarding this document and specifications presented is provided as Appendix E.

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Executive Summary (ES) Figures



Legend

Site Boundary

0 15 30 60 90 Meters

LWC Land & Water Consulting

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N

Date: March 2021

Projection: GDA 1994, Zone 54

Project:

Site Remediation Plan-
24 - 30 Murray Street, Albert Park,
South Australia

Site Address:

24 - 30 Murray Street, Albert Park, South Australia

Figure Title:

Site Location Plan

Appendix in Set 1 of 6

Figure 1

Scale: See Plan

Drawing Reference AAAA

Revision A



Legend

- Site Boundary
- Site Features
- Soil Bore Investigation Locations

Note: Basemap sourced from Nearmap dated October 2020

0 5 10 20 30 40 Meters

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Date: July 2021

Projection: GDA 1994, Zone 54

N

Project:

Detailed Site Investigation (SSRA)

Site Address:

24 - 30 Murray Street, Albert Park, South Australia

Figure Title:

Soil Bore Investigation Locations

Figure in Set 7 of 7

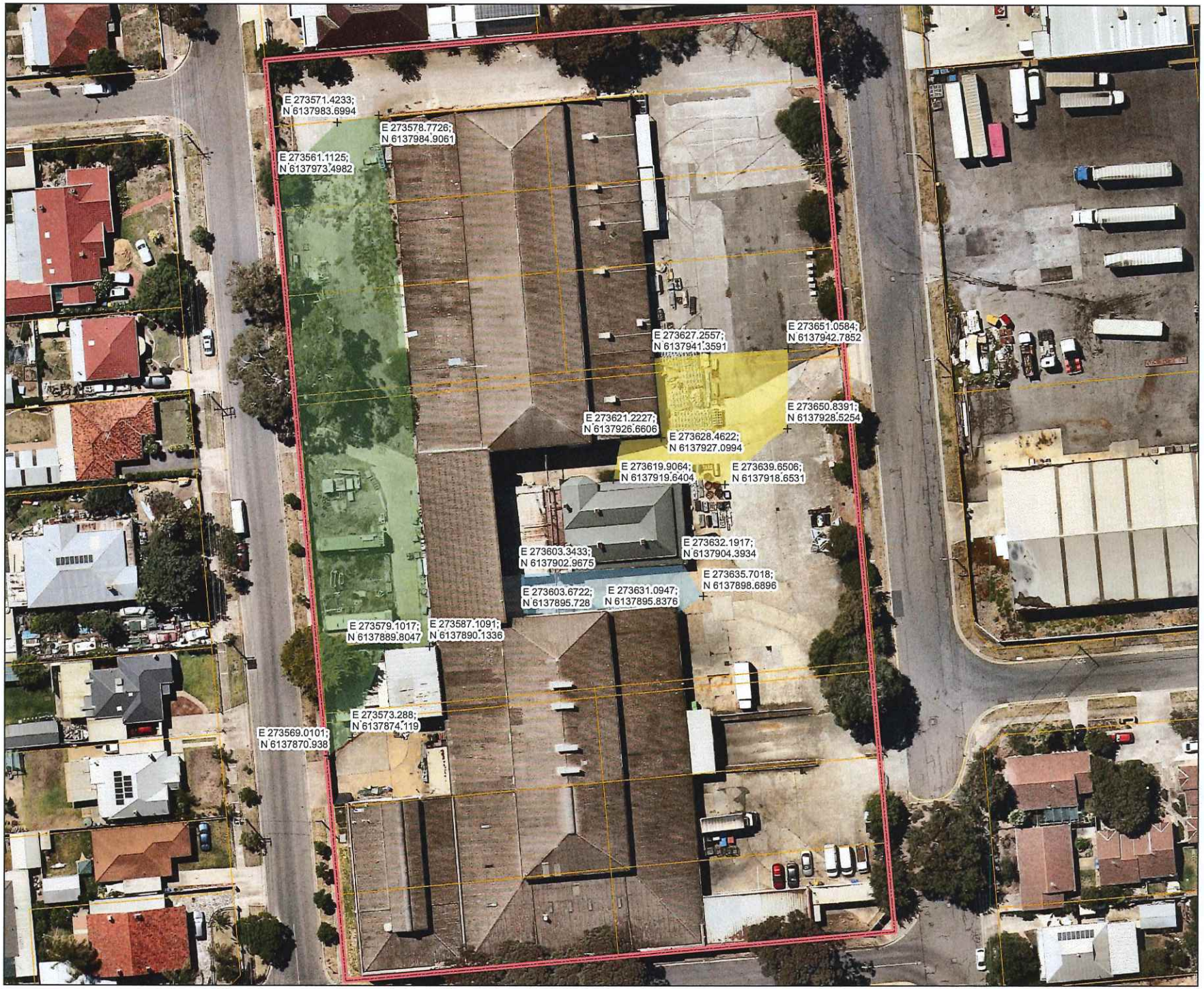
Scale: See Plan

Drawing Reference

A

Figure ES2

Revision A



Legend

- Cadastre
- Site Boundary

Fill Areas of Interest

Indicative Extent

- Area A
- Area B
- Area C



0 4.25 8.5 17 25.5 34

Metres

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Project:
Site Remediation Plan
Totino

Figure Title:
Indicative Extent of Fill Areas of Interest

Date: April 2021	Projection: GDA94 Z54
Scale: See Plan	Figure in Set: 3 of 6

Site Address:
24-30 Murray Street
Albert Park, SA 5014

Figure
ES3
Revision
A

Drawing Reference AAAA



Legend

- Cadastre
- Site Boundary

Fill Areas of Interest

Indicative Extent

- Area A
- Area B
- Area C



0 4.5 9 18 27 36

Metres

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Project:
Site Remediation Plan
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Figure Title:
Indicative Extent of Fill Areas of Interest

Date: April 2021	Projection: GDA94 Z54
Scale: See Plan	Figure in Set: 4 of 6

Site Address:
24-30 Murray Street
Albert Park, SA 5014

Figure
ES4

Revision
A

Drawing Reference AAAA



Legend

- Site Boundary
- Site Features
- Soil Vapour Investigation Location (Passive Sampler) (LWC, Aug 2020)
- Soil Vapour Location (Golder, 2019)
- Soil Vapour Investigation Location (Passive Sampler) (LWC, May 2018)
- Soil Vapour Investigation Location (Passive Sampler) (LWC, Dec 2017)
- Active Vapour Sampling Locations (June 2019)
- Inferred TCE Source Zone

Note: Basemap sourced from Nearmap dated October 2020

0 5 10 20 30 40 Meters

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Date: August 2021

Projection: GDA 1994, Zone 54

N

Project:

Detailed Site Investigation (SSRA)

Site Address:

24 - 30 Murray Street, Albert Park, South Australia

Figure Title:

TCE Soil Vapour Concentrations (All data)

Figure in Set 5 of 6

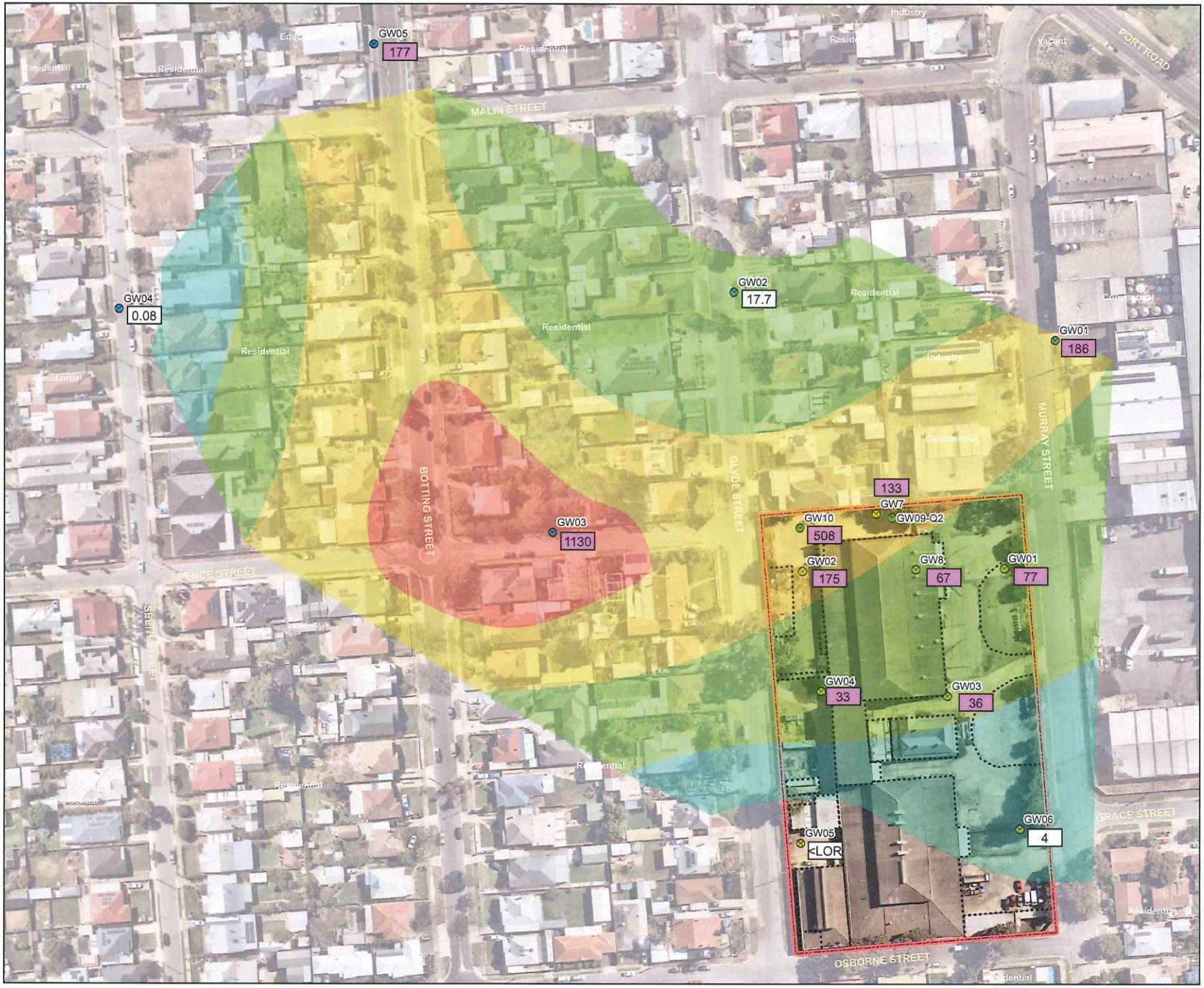
Scale: See Plan

Drawing Reference

A

Figure ES5

Revision A



Legend

- Site Boundary
- Railway
- Site Features
- Groundwater Investigation Location (LWC, 2020)
- Groundwater Investigation Location (Golder, 2019)
- Existing Groundwater Investigation Location

Inferred TCE Groundwater Plume (ug/L)

- 1000+
- 100-999
- 9-99
- 1-8

- Groundwater TCE Concentration (ug/L) not exceeding the WHO DWQG 4th Ed Criterion (8 ug/L)
- Groundwater TCE Concentration (ug/L) exceeding the WHO DWQG 4th Ed Criterion (8 ug/L)

Note:
GW01, GW02, GW03, GW04 and GW05 extracted from Golder Jan 2020

Basemap sourced from Nearmap dated October 2020

0 5 10 20 30 40 Meters

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Date: November 2020	N
Projection: GDA 1994, Zone 54	
Project: Detailed Site Investigation	
Site Address: 24 - 30 Murray Street, Albert Park, South Australia	
Figure Title: Groundwater Analytical Results Plan with Reported TCE Concentrations (September 2020) - Q1 Aquife	
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Drawing Reference A	Revision A

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1 INTRODUCTION

1.1 Background

This Site Remediation Plan (SRP) document has been prepared for 24 – 30 Murray Street, Albert Park, South Australia (the Site). A site locality and layout plan are provided as **Figure 1 (at rear)**.

The Site is proposed to be developed for low density residential land use; a sensitive land use as defined in Section 3-1 of the *Environment Protection Act 1993* (EP Act). There is a required open space area of approximately 2,500 m^2.

The Site is approximately 1.6 ha in area and all existing site infrastructure is to be demolished during the re-development works.

This SRP provides a detailed scope of works and methodology for the remediation of the Site, with respect to:

1. Locating and managing a potential primary source of trichloroethene (TCE) potentially located in the central northern footprint of the Site associated with the northern half of the northern warehouse ('Building C') post demolition of northern structures. Note that the northern building may form a source of other VOC reported in soil vapour and also a potential source of per and polyfluoroalkyl substances (PFAS), manganese, nickel, and selenium. Total Recoverable Hydrocarbons (TRH) is evident in groundwater also though this is considered to be representative of TCE.

2. Management of soils that may be identified following the removal of the potential TCE source infrastructure (secondary source) that are unsuitable for low density residential land use - Remediation of primary and secondary sources of TCE is also required to mitigate ongoing contamination of groundwater and associated site and off-site vapour intrusion sources and risks.

3. Management of known areas of soil ('fill') that do not meet the required tier 1 generic land use screening criteria for low density residential land.

4. Assessment of soils within the footprints of buildings located in the southern area of the Site. Although not expected to be an area prone to site contamination, due to occupancy, the footprint of these buildings has not been assessed. Validation samples are required to be collected from soil within such footprint.

5. Validation of soil vapour following primary and secondary TCE source removal, to re-assess the risk profile with respect to vapour intrusion noting TCE is also present in groundwater.

6. Implementation of a Groundwater Monitoring and Management Plan (GMMP) to monitor TCE in groundwater beneath the Site post remediation, noting that TCE is present in groundwater up-hydraulic gradient of the Site.

Based on the change to a more sensitive land use (i.e. from commercial/ industrial to low density residential) a South Australian Environment Protection Authority (EPA) accredited site contamination auditor is required. DFJ Holdings has engaged Mr. Graeme Miller (Senversa Pty Ltd) to undertake the Site Contamination Audit.

1.2 Purpose

The purpose of the SRP is to provide information about the project and document the remediation aims, chosen remediation option and procedures that must be implemented to achieve the remediation goals and objectives for the Site. The SRP details procedures and plans to eliminate human health risks accounting for the proposed sensitive land use and eliminate risk to both water and the environment to the extent reasonably practical.

The SRP also sets out environmental management protocols that must be implemented by all contractors/ employees, to ensure that remediation actions do not contravene Section 25 (General Environmental Duty) of the *Environment Protection Act 1993.* The remedial activities must be managed such that they do not adversely impact on the health and environment of surrounding human and ecological receptors.

1.3 Key Project Stakeholders

This project relates to the future development of the Site. Key project stakeholders are considered to comprise:

- DFJ Holdings – Site Owner and Developer;
- Land & Water Consulting (or similar environmental consultant) – SRP Manager/ Site Representative - direct and validate the remediation works;
- The appointed site contamination auditor (review of this SRP, review of the actual remediation works and validation process/ reporting and potentially the provision of a Site Contamination Audit Report (SCAR) stating that the Site is suitable for intended use); and
- Contractor – appointed by the Site Owner to undertake demolition and earthworks (remediation).

The Site is considered by the Environment Protection Authority (EPA) to be a source of contamination (Albert Park Assessment Area) and therefore the EPA also can be considered a stakeholder in the progress and completion of remediation of the Site (the mechanism for reporting to the EPA in this context is via the site contamination audit).

1.4 SRP Structure

The SRP has been prepared to direct remedial works accounting for:

- Section 2: Responsibilities;
- Section 3: Site Information;
- Section 4: Site Contamination;
- Section 5: Conceptual Site Model
- Section 6: Remediation Action Plan;
- Section 7: Environmental Management Plan;
- Section 8: Work Health and Safety Considerations; and
- Section 9: SRP Monitoring.

1.5 Guidelines

A number of relevant guidelines and reference documents were referred to in preparing the SRP and include:

- **South Australian EPA (2019a), Guidelines for the Assessment and Remediation of Site Contamination** ("GAR", see Appendix D for compliance with the GAR Remediation Reporting Checklist);
- *Environmental Protection Act 1993*, Regulations and Environment Protection Policies (EPPs):
  - Environmental Protection Regulations 2009.
  - Environmental Protection (Air Quality) Policy 2016.
  - Environmental Protection (Noise) Policy 2007.
  - Environment Protection (Water Quality) Policy 2015.
- South Australian EPA Guidelines, Technical Bulletins and Information Sheets for advice on items such as waste tracking and construction noise:
  - SA EPA, Guidelines for the Assessment of Underground Storage Systems, 2019c
  - SA EPA, General environmental noise, Updated May 2013 (EPA 424/13)
  - SA EPA, Waste Transport Certificate Guidelines, 2010.
  - SA EPA, Stormwater Pollution Prevention – Code of Practice for the Building and Construction Industry, 1999
  - SA EPA, Handbook for Pollution Avoidance on Commercial and Residential Building Sites, 2004
  - SA EPA, Guideline for Stockpile Management: Waste and Waste Derived Products for Recycling and Reuse, 2010 updated October 2020
  - SA EPA Environmental management of dewatering during construction activities (updated June 2021 – EPA 1093/21)
- Relevant South Australian Occupational, Health, Safety and Welfare legislation and guidelines:
  - *Work Health and Safety Act 2012* (South Australian State Legislation); and
  - Work Health and Safety Regulations 2012 (South Australian State Legislation).
- SA EPA, Waste Disposal Information Sheet - Current criteria for the classification of Waste – Including Industrial and Commercial Waste (Listed) and Waste Soil, March 2010;
- National Environmental Protection (Assessment of Site Contamination) Measure produced by the National Environment Protection Council, December 1999 (as amended 2013);
- AS 4976-2008 - The removal and disposal of underground petroleum storage tanks; and
- EPA Victoria, The Design, Installation and Management Requirements for Underground Petroleum Storage Systems (UPSS), 2015.

1.6 Relevant Documents

The requirements (scope) of the SRP were based on the conclusions / findings of the following assessment reports undertaken in relation to the Site:

- LWC (2018), Detailed Site Investigation 24 – 30 Murray Street, Albert Park, South Australia prepared by Land & Water Consulting for DFJ Holdings on 13 June 2018;
- LWC (2021) Site Specific Risk Assessment 24 – 30 Murray Street, Albert Park, South Australia prepared by Land & Water Consulting for DFJ Holdings 31 August 2021.

Offsite areas have been assessed within the EPA Assessment Area Framework and the following documents have been taken into account in interpretation of site specific contamination risk and how the Site may influence/ affect offsite areas:

- Golder (2020). Environmental Site Assessment – Albert Park Stage 2. Prepared for the Environment Protection Authority by Golder, 11 February 2020. 19131233-001-R-Rev0.
- JBS&G (2019). Albert Park Environmental Assessment, Albert Park SA. EPA Reference 05/24994, 23 August 2019 55976_122490_Rev0.
- JBS&G (2020). Albert Park Environmental Assessment – Stage 3 Prepared by JBS&G for the Environment Protection Authority 3 December 2020 59749, 133546, Rev_0.
- JBS&G (2021). Albert Park Stage 4 – Soil Vapour Monitoring Event – Albert Park Assessment Area. Prepared by JBS&G for the Environment Protection Authority 16 April 2021 60523, 136680, Rev_1.
- LBW Co (2020). Preliminary Environmental Assessment Development Plan Amendment Area Albert Park, South Australia. Report for Jensen Plus June 2020.

2 RESPONSIBILITIES

The SRP provides details of responsibilities and procedures for managing environmental issues during remediation works at the site, with consideration to contamination exposure risks and environmental impacts at the site.

A number of personnel will be responsible for the implementation of the SRP:

2.1 Environmental Consultant

Land & Water Consulting – SRP Manager and SRP Environmental Consultant

The SRP has been formulated by LWC. LWC is responsible for ensuring compliance with the SRP by all employees, site visitors and sub-contractors. LWC will document progress in terms of environmental compliance as required.

The SRP Manager is responsible for ensuring that all site works adhere to the requirements outlined in the SRP and ensure that any activity on the Site involving exposure to potentially contaminated areas is undertaken in a controlled and safe manner (including all necessary workplace health and safety (WHS) and environmental requirements). This is achieved by:

- Ensuring relevant parties are made aware of the content and requirements of the SRP, including the Site procedures and forms, and environmental awareness induction (including importance of incident reporting); and
- Implementing a formal process of approval and documentation.

The SRP Site Representative will supervise all remediation works and work collaboratively with the appointed Site Contamination Auditor and all sub-contractors.

The SRP Manager is required to verify on the completion of the works that works were undertaken in accordance with the SRP.

The SRP Manager is responsible for ensuring that all employees and contractors are made aware and act within the requirements of the SRP.

The environmental consultant is responsible for:

- Direction of the implementation of the remedial scope;
- Environmental monitoring during the remediation;
- Environmental incident documenting and reporting (to the site owner, the site contamination auditor and the Environment Protection Authority, including any regulatory notifications);
- Identification of corrective action;
- Oversight of implementation of corrective action;
- Validation of remedial works (sampling and analysis, environmental observations);
- Remediation Validation Reporting.

2.2 Site Contamination Auditor

Mr Graeme Miller (Senversa) - Site Contamination Auditor

The role of the Site Contamination Auditor (the Auditor) is to independently and objectively examine and review the accuracy and completeness of the remediation and/ or assessment work carried out by the SRP Manager/ Environmental Consultant and to complete a site contamination audit report (and statement), in accordance with the requirements of the EP Act, the EP Regulations and relevant guidelines issued or approved by the EPA. The Auditor is required to:

- Review and endorse the SRP;
- Confirm that the proposed remediation should achieve an acceptable outcome that will enable the completion of the audit;
- Confirm that the proposed strategies for environmental management of any on-site remediation adequately protects human health, property and the environment during remediation activities.

Further information regarding the roles and responsibilities of the Auditor are detailed in EPA (2015) Site contamination auditors information sheet (EPA 664/15).

2.3 Demolition / Earth-moving Contractor

Employees and Contractors

Each employee and contractor shall be responsible for working within the requirements of this SRP, endeavour to avoid work practices that are damaging to the environment and identify and report any environmental problems to the SRP Manager. Each contractor and employee undertaking remediation works shall:

- be responsible for working within the requirements of the SRP;
- avoid work practices which may adversely impact on the health and environment of surrounding human and ecological receptors.; and
- identify and report any environmental problems to the SRP Manager.

Contractors, employees and anyone involved in undertaking or observing the remediation works will be required to be appropriately inducted on how the issue of exposure to any contamination will be managed (including any WHS and environmental precautions).

2.4 Environmental Awareness Induction

All parties/ personnel involved in remediation works shall be made aware of the requirements of the SRP including incident reporting and prior to commencing site works shall sign a compliance agreement.

The induction shall be facilitated by the SRP Manager and shall be undertaken by all site workers likely to be present during the bulk of the remediation works.

Subcontractors and other personnel that are likely to have only limited involvement with the remediation process shall undergo a site induction on arrival to site with the SRP Site Representative (appropriate person appointed by the SRP Manager).

Copies of the SRP, induction notes (and associated documents) shall be made available and accessible to all site personnel for reference and review.

The purpose of the induction is to ensure that employees and contractors are made aware of the environmental and health risks associated with remediation activities on-site and how best to manage these risks. The induction shall also address how to manage work practices that may adversely impact on the health and environment of surrounding human and ecological receptors. Records detailing training attendees and the content of the training/induction will be kept.

The induction shall cover:

- Schedule of activities and personnel responsibilities;
- Site control procedures;
- Contaminants and hazard identification;
- Exposure risk;
- Protective equipment usage;
- Decontamination procedures;
- Implementation of environmental controls;
- Incident reporting;
- Enterprise management (public relations);
- Designated areas and other requirements (e.g. parking, site access, etc.);
- Prohibitions (e.g. smoking, eating, etc.); and
- Emergency response.

3 SITE INFORMATION

3.1 Site identification

Please refer to Table 3-1 for site identification details.

Table 3-1 Site identification

Site Location	24-30 Murray Street, Albert Park, South Australia
Property Description	The Site is defined by the following Certificate of Title (CT): ▪ CT Volume 5957 Folio 139 ▪ CT Volume 5957 Folio 140 ▪ CT Volume 5957 Folio 141 ▪ CT Volume 5191 Folio 507 ▪ CT Volume 5191 Folio 397
Area of Site	The area of the Site is approximately 1.6 hectares (ha).
Local Government Authority	City of Charles Sturt
Zoning	Strategic employment
Ownership	DFJ Holdings
Current Land Use	The Site consists of a series of commercial warehouse type buildings surrounded by predominantly sealed ground to the east and unsealed ground along the western aspect. Refer to Section 3.2.
Proposed Land Use	Low density residential (sensitive land use as defined in Section 3(1) of the EP Act 1993)
Person requesting this work	Mr Don Totino representing DFJ Holdings
Site Contamination Audit Details	Mr Graeme Miller 2011031 Senversa Pty Ltd Ground Floor, 190 Flinders Street Adelaide SA 5000 EPA Audit Reference: 61909

3.2 Site Description

The Site is currently owned by DFJ Holding (purchased in 2009) and consists of a series of buildings surrounded by predominantly sealed ground, with hard waste (predominantly metal components) stockpiled in areas external to the buildings.

The locations and description/ use of the buildings are described in the following table (Table 3-2) and shown in Figure 2.

Table 3-2 Building Description/ Use (refer Figure 2, at rear)

Building Reference	Building Description/ Use
A	Southwestern brick built building used for car restoration. Southwestern corner of this building hosts a sub-station/ transformer belonging to SA Power Networks – has been embedded at the building for a long time as has own 'room'.
B	Shed – galvanised construction, empty.
C	Northern building – empty, cavernous warehouse style building with thick (200 mm) concrete slab. Not used.
D	(local) Heritage dwelling – used as an office during Gadsdens days. Now un-used.
E	Southern building – active cold store (limited occupation, ventilated building due to refrigeration).
F	Warehouse/ store. Used by a lease holder for storage of scaffold equipment.
G	Southern / southeast boundary: Offices used for courier / transport company (not termed 'G' on such Figure, but in text only)

3.3 Site Setting

The Site is situated approximately 8 km northwest of the Central Business District (CBD) of Adelaide, and is bounded by the following:

- North: Residential and commercial land use;
- East: Immediately adjacent Murray Street beyond which are commercial/ industrial land use;
- South: Immediately adjacent is Osborne Street, beyond which is residential land use; and
- West: Immediately adjacent is Glyde Street, beyond which is residential land use.

A site layout and features plan are provided as Figure 2.

3.4 Site History

Review of historical information indicates that between 1940 and 1984 the Site was owned and operated by J Gadsdens Pty Ltd and predominantly utilised for the manufacturing of containers (tin cans) and hessian bag/ tarpaulin, and possible small scale vehicle assembly. (LWC, 2017). This former (historical) use of the Site is considered the likely source of the chlorinated hydrocarbon contamination (LWC, 2018a).

SKM (2013) report noted that J Gadsden Pty Ltd was delisted from the Australian Securities Exchange (ASX) in 1986 (i.e. two years after divestment of the Site) and was taken over by SAB Investments Pty Ltd. Between 1984 and 1988, the Site was transferred successively between various parties. WellClass (Holding)

No. 2 Pty. Ltd. owned the Site between 1988 and 2006, with various lease arrangements during period. Andary Group owned the Site from 2006 to 2009 and according to mortgage records, DFJ Holdings purchased the Site in May 2009 as a going concern[1] (comprising recreational businesses, empty storage spaces and a refrigeration warehouse/ cold store) through a bank foreclosure process. A review of the relevant Certificate of Titles from this period corroborates this (LWC, 2018a).

These uses were continued by DFJ Holdings, with the exception that the indoor cricket and recreation centre occupying Building C ceased operations in approximately 2013 and has remained vacant since, and the cabinet maker in Building A moved and was replaced by a car restoration hobbyist.

Recent uses of the Site include offices for a courier firm (southern portion of the site), scaffold storage and minor car restoration. There is a substation occupying the southwest corner of the Site.

In 2019-2020 a building firm used the north-western corner of the Site as a 'lay-down' area for inert building materials. The building firm brought in a shipping container as a storage item and this obscured groundwater monitoring well GW02 in the 2020 ground water monitoring event. Based on inspection/ observation of this area at such time, there is no reason to suspect that the activities of the building firm presented any potential for site contamination.

A site history assessment was also undertaken in 1997 (Woodward Clyde, 1997). At such time the Site infrastructure comprised two main buildings (Northern and Southern), a house type structure in the centre of the Site, several sheds and an indoor concrete strip (cricket run). The 1997 and 1998 assessments considered the Site in terms of two portions:

1. Area A: northwest corner covering an area of approximately 0.2 ha
2. Area B: remainder of site covering an area of approximately 1.4 ha

The Site History report found that former activities identified at the Site and on adjacent land have the potential to cause adverse environment impacts including:

- Soil and groundwater contamination as result of potential leakage from a drum labelled "perchloroethylene" (PCE) located in Area A.
- Soil contamination due to minor spillage of lubricating oil from a small drum also located in Area A.

The 1997 Phase I Site History report concluded that given the potential for adverse environmental effects, a Phase II Environmental Site Assessment was required to establish the potential for soil and groundwater contamination beneath the Site (Area A).

The Phase II ESA undertaken in 1998 was focussed on resolution of the aforementioned potential environmental impacts in Area A, but also included assessment of potential hydrocarbon contamination adjacent a loading / unloading area in Area B. The existence of potentially contaminated fill was also assessed, but only in the smaller Area A.

A total of 42 samples were recovered from five bores, with only seven samples analysed. Analytical assessment of soil recovered in the vicinity of the PCE drum reported the concentration of PCE to be below the laboratory limit of reporting (note that analysis of these types of chemical substances in soils are of low to moderate reliability). The concentrations of heavy metals in soil samples identified as fill material were reported to be below the recreational use guideline criteria adopted at the time of the assessment (some of these criteria

[1] From at least 1997 the southern building was being used for cold storage and northern building for sporting facilities.

have now been amended or rescinded, these criteria less conservative than the required low density residential screening criteria applicable for proposed development to residential).

Concentrations of hydrocarbons were reported to be above the guideline criteria adopted at the time of the assessment (5,000 mg/kg, Dutch Intervention Levels1) in the vicinity of the waste oil storage area (Area B – specific location not known). It was reported that such concentrations were however localised to the upper 30 cm of the soil profile.

It is noted that both the 1997 Phase I and the 1998 Phase II assessment was completed ~20 years ago. Since the time of the assessment, industry standards have changed somewhat, and revised soil quality criteria and processes of assessment are available.

Further, the number of locations assessed in the 1998 assessment (6) is not sufficient for an area of 1.6 ha, (according to Australian Standard AS4482.2-2005). The potential for notable fill across the site exists, and we note the previous instances of encountering contaminated fill in the general area.

A report was commissioned by the City of Charles Sturt in 2013 (SKM, 2013) (i.e. rather than DFJ Holdings). It is understood that City of Charles Sturt was considering the potential purchase and use of the Site as recreational open space. It is understood that the potential sale did not progress due to differences in land valuation between DFJ Holdings and the City of Charles Sturt, rather than City of Charles Sturt withdrawing on the basis of any particular knowledge of site contamination beneath the Site. Indeed, the SKM report concludes with recommendations that further investigations were required, noting the assessment was desk-top only.

SKM reported that based on aerial imagery review up to 2002, the Site had not changed specifically since 1949. SKM concluded that the potentially contaminating activities (PCA) that were historically undertaken in the course of a business associated with the Site was:

- Motor Vehicle repair or maintenance (associated with the use of a forklift truck, Castrol drums on site, observed oil staining and machinery observed on Site).

SKM listed the following PCA in relation to domestic activities undertaken at the Site:

- Liquid organic chemical storage; and
- Fill or soil importation (associated with previous construction and development activities).
- Suspected presence of former above ground fuel storage tanks (ASTs) and possibly former and/ or current underground fuel storage tanks (USTs). The Site inspection "identified four items that are frequently associated with UST and AST infrastructure".

SKM noted that various chemicals including fuels, solvents, paints, degreasers and lubricants associated with the storage and use/ disposal of chemicals were observed on site. SKM noted a major limitation to the assessment was the lack of full site access. SKM did not identify the historical presence of a cannery at the Site. SKM concluded that further investigations were required at the Site.

In effect, there is nothing in the SKM report that would indicate that any party anywhere knew of actual site contamination beneath the northern building at such time (this being 4 years after purchase of the Site by DFJ Holdings).

A detailed summary of the previous on-site assessments is provided in Section 3.4 of LWC, 2017.

Of note, and as listed in the SKM (2013) report, the Section 7 reports from the EPA as issued at such time do not indicate any positive response to environmental records held by the EPA. Consequently, it is unlikely that any environmental related information would have been included in the Form 1 provided to DFJ holdings at

time of purchase of the Site in 2009. It is unlikely that DFJ Holdings knew of any site contamination issues at such time via such process.

A summary of site ownership and activity chronology is provided as Figure 2-3 in LWC 2021.

3.5 Proposed Development

LWC understands that the Site will potentially be redeveloped for low density residential (sensitive land use) with an approximate required open space area of 2,500 m^2.

3.6 Environmental Setting

3.6.1 Surrounding land use

A summary of the surrounding land use is presented as Table 3-3.

Table 3-3 Adjacent Land Use

Boundary	Description of Adjacent Land Use
North	Residential but also commercial and light industry to the northeast side of the northern boundary
East	Commercial – warehouses and light industry
South	Residential
West	Residential

3.6.2 Geology

Please refer to LWC 2021 for more detail regarding geology, however, soil assessments undertaken at the Site have identified fill material including silt, gravelly silt and sand across the majority of the Site, with inclusions of bitumen, bricks and glass in Fill Zones A - C. Natural soils are described as brown silty clay of low to medium plasticity with sand and gravel lenses.

For the purposes of this scope, external to the identified fill zones (A-C) the shallow lithology will comprise silt, gravelly silt and sand.

3.6.3 Hydrogeology

Staged assessments of the Site comprised groundwater bores drilled into the Q1 water table unit, up to 5.5 m below ground level (BGL) with standing water recorded at around 3.3 to 3.8 m BGL. A deeper water bearing zone within the Q1 Aquifer was intersected at approximately 10 m BGL. Groundwater flow in the Q1 Aquifer is interpreted to be towards the west/ northwest.

The Q2 Aquifer is present at approximately 25 mBGL and is separated from the Q1 Aquifer by approximately 6 m of firm to hard dry sandy and silty clay.

Total dissolved solids (TDS) concentrations and registered bore use in the vicinity of the site indicate groundwater in the Q1 Aquifer and Q2 Aquifer may be suitable for a range of uses, including: Drinking Water, Recreation and aesthetics, Primary Industry (irrigation and general water uses) and Industry.

The Site and surrounding area are located within a groundwater prohibition area (GPA) gazetted by the State Government 12 September 2019 (EPA, 2019b) – refer Figure 3-1 Groundwater Prohibition Area (Portions of Hendon, Royal Park, Seaton and Albert Park – EPA, 2019b) – this GPA covers the watertable-Q1 and Q2 units. The GPA prohibits extraction and use of groundwater within the Q1 and Q2 Aquifers.

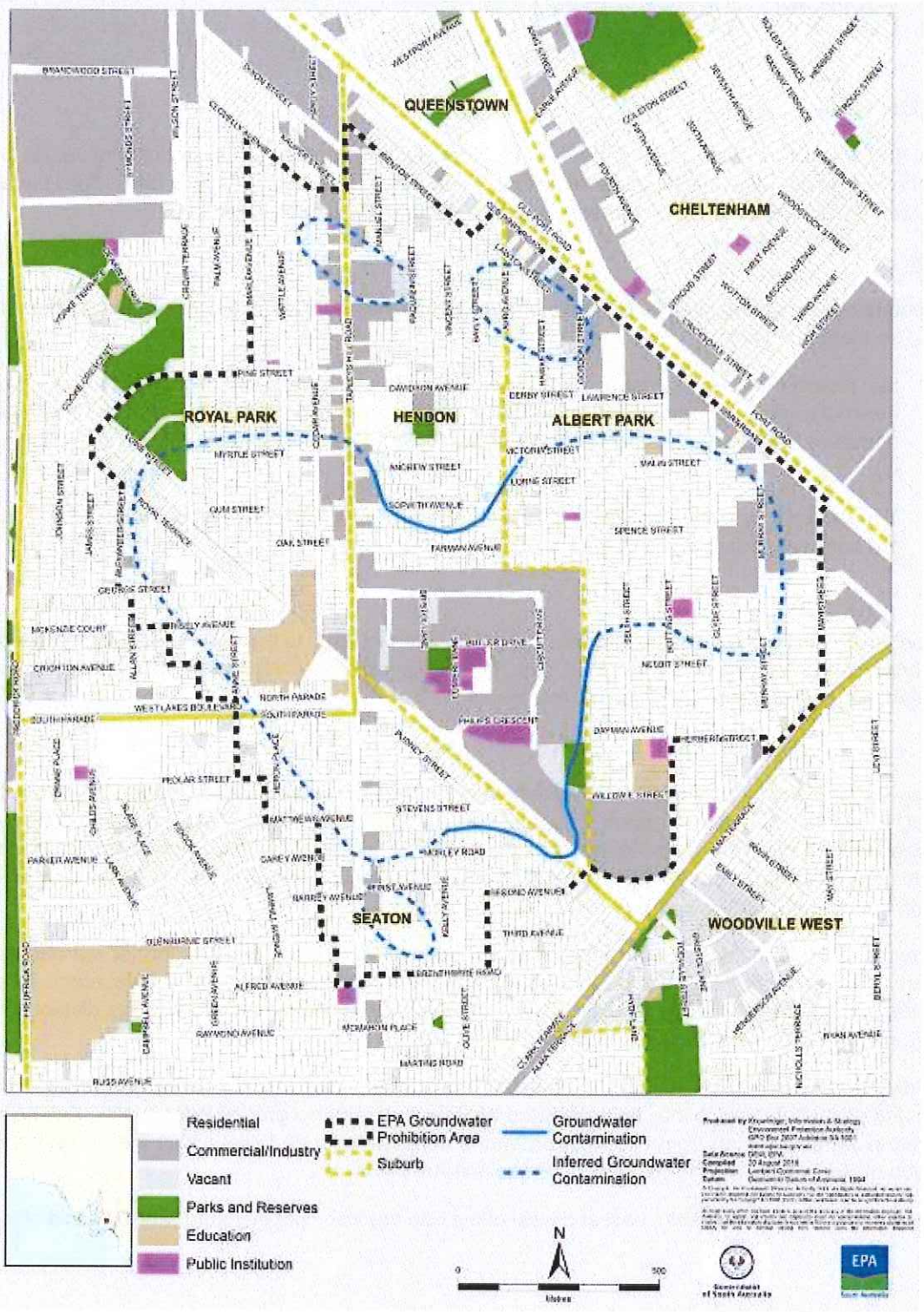


Figure 3-1 Groundwater Prohibition Area (Portions of Hendon, Royal Park, Seaton and Albert Park – EPA, 2019b) – this GPA covers the watertable-Q1 and Q2 units.

4 SITE CONTAMINATION

4.1 Overview

Accounting for the proposed sensitive use of the Site (low density residential), the environmental values of groundwater, the outcomes of the intrusive site investigations to date (refer LWC, 2018b & LWC, 2021), and in accordance with Section 5B of the *Environment Protection Act 1993*, it is considered that:

Human Health

- Site contamination is present at the Site with respect to potential harm to the health or safety of human beings, on the grounds of:
    - the reported concentrations of lead, carcinogenic polycyclic aromatic hydrocarbons (as benzo(a)pyrene toxicity equivalent quotient (TEQ)), accounting for the proposed land use (sensitive, low density residential), comprising three zones of shallow fill (Fill Zones A, B and C).
    - The reported concentrations of TCE and other VOC (refer Table 4-1) as soil vapour beneath the northern portion of the Site.

Environment

- Site contamination is present at the Site with respect to potential harm to the environment, with respect to reported concentrations of copper, lead, zinc, benzo(a)pyrene and TRH in soil, accounting for the proposed land use (sensitive, low density residential).

Water

- Ignoring the presence of the GPA, site contamination is present in groundwater under the site with respect to actual or potential harm to water, on the grounds of elevated concentrations of anthropogenic chemical substances trichloroethene (TCE), associated TCE degradation products (volatile organic compounds (VOC)) and perfluoroalkyl substances (PFAS) in the Q1 water table unit beneath the northern portion of the Site.
- The source of VOC contamination appears to be beneath/ associated with a former warehouse referred to by Land & Water Consulting as 'Building C'. The distribution of volatile range total recoverable hydrocarbons (TRH, Fraction C_6-C_{10}) appears to be commensurate with the distribution of TCE, noting TCE reports in said fraction of TRH.
- Groundwater is also contaminated with the metals boron, nickel, manganese, selenium and inorganics nitrate and phosphate, which may be associated with site and regional groundwater quality. Sulfate is elevated in water sampled from one location and is considered to be trivial within the context and definition of Section 5B of the *Environment Protection Act 1993.*

Groundwater and soil vapour to the north, east and west of the Site are also contaminated with TCE and other VOCs.

4.2 Building C (and surrounds to the north) – Soil Vapour

Soil vapour contamination (primarily TCE) is present under the norther portion of the site. The extent of soil vapour contamination is summarised in Table 4-1 and **Figure 4** and appears to be associated with the central northern portion of Building C possibly extending to the northern boundary.

Soil vapour contamination is also present off-site to the north, east and west of the site, some of which appears to be associated with off-site sources.

Table 4-1 Soil vapour Contamination Extent – cross reference with Figure 4 (and the attached EPA Assessment Area Stage 4 Soil Vapour Plan

Nature	Extent
Concentrations of ▪ Trichloroethene (TCE) ▪ cis 1,2 dichloroethene ▪ 1,2 dichloroethane	TCE was reported in soil vapour beneath the north-eastern quadrant of the Site at concentrations greater than the adopted investigation levels. The highest concentrations were reported under the northern end of the northern building and adjacent to the central northern site boundary. TCE above the relevant criterion was also reported in soil vapour immediately to the east of the Site along Murray Street. The presence of TCE contamination in soil vapour under the north-eastern portion of the Site generally coincides with: ▪ the inferred source of the contamination (former tin can manufacturing in the northern site building) – where primary and secondary (soil) sources may remain; and ▪ the highest TCE concentrations in groundwater (refer below). The above-guideline concentrations of TCE under the northern portion of the site ranged from 25 µg/m^3 to 7,900 µg/m^3 (compared to a guideline value of 20 µg/m^3). Screening of utilities under and adjacent to the Site did not indicate that TCE in soil vapour is accumulating or migrating within these structures – with the majority of PID readings being 0 parts per million (ppm) and a maximum recorded value of 0.2 ppm. Note that a similar exercise was undertaken by Golder (2020) as part of the EPA Assessment Area works and the same conclusion was reached. Other VOCs (1,2 dichloroethane and cis-1,2 dichloroethene) were also reported greater than the adopted investigation levels in soil vapour samples collected from nested soil vapour probes installed in the northern portion of the Site (locations AV-1S&D and AV-2S&D). TCE contamination in soil vapour was reported to the north, northeast and west of the site – across and down hydraulic gradient. The most recent investigation by JBS&G (16 April 2021) presents the results from the four rounds of soil vapour sampling completed in off-site areas. The most recent sampling at each location found the following: ▪ Above guideline TCE concentrations in shallow soil vapour probes ranged from < 7 µg/m^3 to 11,000 µg/m^3, which are similar to that reported under the northern portion of the site. ▪ Above guideline TCE concentrations were reported up to approximately 200 m to the north and 200 m to the west of the site. Above guideline TCE concentrations were also reported up to 120 m northeast of the site along Murray Street. ▪ Concentrations of TCE in deeper soil vapour probes were similar to and in some instances greater than those reported at the on-site deep soil vapour probes. The concentrations of TCE in soil vapour off-site were considered to pose a potential risk to residential occupants under a variety of building construction scenarios. The above guideline concentrations of TCE reported by JBS&G (3 December 2020) and LWC (6 July 2019) to the east, north and

	northeast of the Site are indicative of a source unrelated to the Site. Those to the west and northwest are considered likely to be associated with the Site and possibly another off-site source. Cis-1,2 dichloroethene was also reported JBS&G (16 April 2021) greater than the adopted assessment criteria in four soil vapour probes sampled to the north and north east of the site.

4.3 Fill Zones A, B and C – Soil Contamination

The nature and extent of soil contamination referred to as Fill Zones A, B and C are summarised in Table 4-2 and **Figures 5a and 5b**.

Table 4-2 Soil contamination nature and extent – cross reference with Figures 5a and 5b

Nature	Extent
Fill Zone A Comprising chemicals (lead – human health and copper, zinc - ecology) in sample location SB09 at 0.0-0.2 m. **Human health** lead **environment (ecology)** copper, zinc	**Laterally –** The fill evident in SB09 is not evident in bores radial to such location unless counting SB16 to the south. The concentrations of metals reported maybe attributable to the fill itself (i.e. uncontrolled imported fill) or could be a function of loss of lead based paint from the northern warehouse, historically, noting the surface is sealed here. Alternatively it could be a function of processes / activities undertaken at the Site in Gadsdens days. **Vertically –** Copper and zinc are delineated to 0.2 m however elevated lead (relative to HIL A) is reported in the sample from natural at 0.2 m – 0.4 m.
Fill Zone B Comprising copper, lead and zinc in location SB16. **Human health** lead **environment (ecology)** copper, lead, zinc	**Laterally –** The fill evident in SB16 is not evident in bores radial to such location unless counting SB09. The concentrations of metals reported maybe attributable to the fill itself (i.e. uncontrolled imported fill) or could be a function of loss of lead based paint from the northern warehouse, historically, noting the surface is sealed here. Alternatively it could be a function of processes / activities undertaken at the Site in Gadsdens days. **Vertically –** Delineated to 0.2 m.
Fill Zone C In the scaffold storage area on the western side of the Site – potentially associated with the former Gadsdens business. Characterised by black, grey gravelly sand / clayey gravel with occasional brick, bitumen, tar and glass and concentrations of metals (copper, lead, zinc) PAH (BaP TEQ) and TRH (Fraction C16-34) above human health and ecological / environmental protection criteria. Tier 1 criteria exceeded for residential land use **human health** lead, BaP_{TEQ} **environment (ecology)** copper, zinc, BaP and Fraction C16-C34.	**Laterally –** Located to the west of the northern warehouse stretching from SB19 in the north to SB25 in the south, note that these areas are unsealed. **Vertically –** SB20 reports a depth of 0.7 m although this is logged as clayey gravel. Elsewhere the fill is generally gravelly sand or silt and averages 0.2 m thick (deep). Concentration wise the BaP_{TEQ} in SB20 is not delineated however the fill reports tar fragments and it is considered that the reported BaP concentrations are synonymous with the fill layer. The area is characterised by unsealed surface used for commercial storage of scaffold and occasional metal (inert) waste. The older non scaffold metal items may be the source of metals in soils (i.e. metal flakes or shavings) or equally the fill itself could be the source, or even former use of the site by Gadsdens.

4.4 Groundwater Contamination

The nature and extent of groundwater contamination in the Q1 water table unit is summarised in Table 4-3. The extent of TCE in groundwater as at September 2020 is shown in **Figure 6**.

One monitoring well has been installed in the Q2 Aquifer, close to where the highest concentrations of TCE were reported in the Q1 Aquifer. Whilst only one Q2 monitoring well has been installed, the potential for contamination in the Q2 Aquifer is low - based on:

- The very low (trace) concentrations of the primary site-related chemical substance of interest (TCE) in water sampled from the one Q2 Aquifer well (and also the absence of PFAS) despite being near the inferred TCE source area.
- There is no indication of the presence of dense non-aqueous phase liquids (DNAPL) in the Q1 water table unit.
- The confined nature of the Q2 Aquifer relative to the Q1.

Trace concentrations of bromomethane, total recoverable hydrocarbons and the metals manganese and nickel were reported in water sampled from the Q2 unit, though these are considered to be trivial, and not representative of site contamination, and the Q2 unit is also covered by the GPA. However, Further sampling of the Q2 monitoring wells is required to confirm the presence of site (or-off-site) related contamination - based on the detection of TRH and bromomethane during the one occasion it was sampled.

There are no aquatic ecosystems located down hydraulic gradient in a 2 km radius of the Site. Therefore, there is no apparent risk to surface water (groundwater dependant ecosystem) receptors from chemical substances reported in groundwater beneath the Site.

The source of the TCE may continue to contribute to contamination of the Q1 water table unit and therefore the specific location, format, and extent of the source (if a point source e.g. tank, pipe, sump) needs to be investigated (and removed) following the demolition of the northern warehouse.

Given the establishment of a GPA for the area in 2019, the abstraction and use of groundwater from the watertable-Q1 and Q2 unit beneath and down hydraulic gradient of the Site is precluded. This eliminates the risk to future sensitive (or non-sensitive) users of the Site (and offsite receptors), other than vapour intrusion/ inhalation associated with TCE.

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Table 4-3 Groundwater contamination – Q1- water table unit (refer Figure 6)

Chemical substance in groundwater	Potential Source / Extent	Potentially associated with **offsite** source	Potentially associated with **onsite** source	Potential to move offsite and present a risk via vapour pathway? (Noting the presence of the GPA)
TCE and other VOC	TCE is present at concentrations greater than the adopted criterion of 8 ug/L in groundwater under the northern portion of the Site and to the northeast, north, northwest, and west of the Site. The highest concentrations of TCE under the Site are reported at and down hydraulic gradient of the northern portion of the northern building in water sampled from the lower portion of the watertable-Q1 unit (groundwater monitoring well GW10 – TCE concentration of 508 ug/L). Monitoring well GW10 is located in the north-western corner of the Site TCE is also reported greater than the adopted criterion along the up hydraulic gradient boundary of the Site (monitoring well GW06) Similar and higher concentrations were reported as part of the EPA Assessment Area staged works (Stage 2) to the north of the Site (across hydraulic gradient – concentration of 186 ug/L in water sampled from offsite monitoring well GW01 – refer Golder 2020) and west of the Site (down hydraulic gradient; maximum of 1,130 ug/L in water sampled from GW3 located approximately 100 m west of the Site). The off-site wells are all installed in the upper portion of the Q1-water table unit. All on site groundwater monitoring wells target the Q1-water table unit except GW10 and the well targeting the Q2 unit (GW09-Q2)). The highest reported concentration of TCE in groundwater on site in the upper portion of the Q1 water table unit was 175 ug/L (monitoring well GW02 – located near to GW10 in the north western corner of the Site). 1,1-dichloroethene, 1,1-dichloroethane, 1,2-dichloroethane, cis-1,2-dichloroethene, tetrachloroethene (PCE), chloroform and trans-1,2-dichloroethene were also detected in groundwater under the Site, but at concentrations less than the adopted assessment criteria. Most of these chemicals, as well as vinyl chloride, were detected in groundwater sampled from some of the off-site monitoring wells – and were present at concentrations generally less than the adopted criteria.	☑	☑	☑

Chemical substance in groundwater	Potential Source / Extent	Potentially associated with **offsite** source	Potentially associated with **onsite** source	Potential to move offsite and present a risk via vapour pathway? (Noting the presence of the GPA)
	The general absence or low concentrations of these chemicals (many of which represent degradation products of TCE) indicates limited bio-degradation of TCE and CHCs is occurring in groundwater within the Q1 water table unit. Potential (likely) sources of TCE in the watertable-Q1 unit are as follows: 1. Site – former tin can manufacturing plant in the northern building (Building C). 2. Off-site – current and former industrial activities identified in LBW Co (2020) to the northeast and east of the Site.			
TRH	▪ TRH Fraction C_6-C_{10} was reported above LOR and greater than the direct contact criteria at site monitoring wells located adjacent and to the north and northwest of the northern building, and at offsite monitoring wells located to the northeast, northwest and west of the Site. ▪ TCE reports in TRH Fraction C_6-C_{10}. Concentrations of Fraction C_6-C_{10} were similar to the concentrations to TCE reported at the same monitoring wells, suggesting that the TRH is representative predominantly of TCE. ▪ Longer chain TRH fractions were only detected greater than the LOR (and slightly above the guideline value) on one occasion in water sampled from on-site monitoring well GW05 – which is located in the southwestern portion of the Site, near to where small scale vehicle maintenance previously occurred and near to the electrical transformer. ▪ Potential (likely) sources are as follows: 1. Site – former tin can manufacturing plant in the northern building (Building C). 2. Off-site – current and former industrial activities identified in LBW Co (2020) to the northeast and east of the Site.	☑	☑	☑ - considered to be associated with TCE
boron	Offsite wells sampled by Golder as part of the Stage 2 assessment, boron at all five monitoring wells exceeded the adopted screening level for irrigation, **including the up hydraulic location GW01 (1.18 mg/L)**.	☑		No – not volatile

Chemical substance in groundwater	Potential Source / Extent	Potentially associated with **offsite** source	Potentially associated with **onsite** source	Potential to move offsite and present a risk via vapour pathway? (Noting the presence of the GPA)
	Golder concluded that the cause of the elevated boron concentration was not known and it may be naturally occurring. Note that the concentrations under the site are similar to those upgradient and in off-site areas, and that in the absence of an apparent site related source, boron appears to be representative of background conditions.			
manganese	Manganese was reported greater than the adopted criteria at one monitoring well located adjacent to the northern site building and at one monitoring well located along the eastern site boundary – up hydraulic gradient of the northern building. It was not reported greater than the adopted criteria in groundwater in the one round it was tested (Golder, 2020) at off-site monitoring wells.	☑	☑	No – not volatile
nickel	Nickel - was reported slightly greater than the adopted criteria at monitoring wells located within and adjacent to the northern building (Building C), in the southwestern portion of the Site at one monitoring well, and at one monitoring well located along the eastern site boundary – up hydraulic gradient of the northern building. It was not reported greater than the adopted criteria in groundwater in the one round it was tested (Golder, 2020) at off-site monitoring wells. Possible sources of nickel are one or more of the following: ▪ Ambient background water quality. ▪ Site – former tin can manufacturing plant in northern building. ▪ Off-site – current and former industrial activities identified in LBW Co (16 June 2020) to the northeast and east of the site.	☑	☑	No – not volatile
selenium	Selenium was reported slightly greater than the adopted criteria at three monitoring wells located within and adjacent to the northern site building (Building C), and at one monitoring well (at similar concentrations) more than 200 m northwest of the Site.	☑	☑	No – not volatile

Chemical substance in groundwater	Potential Source / Extent	Potentially associated with **offsite** source	Potentially associated with **onsite** source	Potential to move offsite and present a risk via vapour pathway? (Noting the presence of the GPA)
	Possible sources of selenium – are one or more of the following: ▪ Ambient background water quality. ▪ Site – former tin can manufacturing plant in northern building. ▪ Off-site – current and former industrial activities identified in LBW Co (16 June 2020) to the northeast and east of the site.			
PFAS	PFOS and PFHxS (PFAS) in the Q1 water at concentrations above the potable criterion. There is no known specific source of PFAS at the Site, current or historical, although noting that PFAS has been around since the 1940's and the industrial manufacturing nature of the Site, it is not unreasonable to consider that the Site has been a source of PFAS to groundwater beneath the Site. It is suggested by the auditor that tin can processing may have used PFAS. LWC were not able to identify a specific literature reference for this. Two of the highest PFAS concentrations were reported in water sampled from GW07 and GW10 (northern boundary), which is concomitant with the general area of TCE impact, and thus the PFAS could be related to the TCE distribution. The actual highest concentration of PFAS was reported in water sampled from GW06 in the southeast of the Site, which is up hydraulic gradient of the infrastructure / site improvements. Note that one of the highest TCE concentrations is associated with water sampled from monitoring well GW10 well (deeper Q1). The concentrations of PFAS in groundwater up hydraulic gradient of the Site are not known. PFAS is known to be present in groundwater to the east and southeast of the Site, along the Port Road corridor (EPA Woodville Assessment Area). Given the absence of a specific on site source, the presence of industrial activities up hydraulic gradient of the Site (viz. LBW 2020 PSA) and the	☑	☑	No – not volatile

Chemical substance in groundwater	Potential Source / Extent	Potentially associated with **offsite** source	Potentially associated with **onsite** source	Potential to move offsite and present a risk via vapour pathway? (Noting the presence of the GPA)
	known presence of PFAS in the Q1 aquifer to the east and southeast of the Site (up hydraulic gradient), PFAS in water sampled from beneath the Site could be a result of an onsite source, but could also equally be associated with ambient contribution. The presence of PFAS in groundwater at and potentially down hydraulic gradient of the Site does not necessarily change the risk profile of the Site with respect to abstraction of the groundwater for potable purposes, noting the presence of TCE at concentration above potable criterion and the presence of the GPA.			
nitrate	Nitrate was significantly elevated in one location only: 65 mg/L in water sampled from on-site monitoring well GW06. Nitrate elsewhere on the Site is an order of magnitude less than GW06 water. Registered groundwater well 6628-8813 (located up hydraulic gradient, Bunnings Warehouse car park, Port Road, Cheltenham), records four nitrate values, ranging from 434 mg/L to 10,683 mg/L (these were all reported in 1934). The upper value seems spurious. As nitrate elsewhere on the Site is an order of magnitude less than water from GW06, it would seem that water from GW06 is an anomaly perhaps from a leaking sewer connection, and not attributable to a widespread diffuse presence of nitrate beneath the Site. Based on some evidence of elevated nitrate up hydraulic gradient of the Site, and nitrate being very localised to one location (GW06), the risk of nitrate to receptors in the down hydraulic gradient area (being the GPA) is considered to be low (water is not abstractable). Offsite Stage 2 concentrations ranged from 3.4 to 25.7 mg/L.	☑	☑	No – not volatile
Nitrogen	Refer to the discussion presented above for nitrate. Also - this chemical substance is greater than the adopted criteria at all wells located in the northern portion of the site – as well as at GW06 (southeast of the site).	☑	☑	No – not volatile

Chemical substance in groundwater	Potential Source / Extent	Potentially associated with **offsite** source	Potentially associated with **onsite** source	Potential to move offsite and present a risk via vapour pathway? (Noting the presence of the GPA)
phosphorous	This was not analysed for in offsite sampling. The concentrations under the site are similar to those along the upgradient boundary, and may therefore be representative of background conditions, although on-site contributions cannot be excluded.	☑	☑	No – not volatile

5 RISKS POSED BY SITE CONTAMINATION

5.1 Overview

A detailed conceptual site model is presented in LWC, 2021 and is not re-iterated in its entirety here. A summary is presented in Section 5.2 highlighting those contaminant linkages that require remediation. It is assumed that any person reading this is of a sufficient technical background to understand the nature and purpose of a conceptual site model and the term 'linkages'.

5.2 Summary

Please refer to Table 5-1.

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Table 5-1 Conceptual site model derived linkages requiring remediation (LWC, 2021)

Receptors			Source (chemical/ medium)				Pathway	SSRA Linkage	Risk?
Receptor Group	**On site**	**Off site**	**Soil**	**Watertable Q1 unit**	**Q2 unit**	**Soil Vapour**			
Actual or Potential Harm to Human Health	Future sensitive receptors (residential) Open space users Intrusive Maintenance Workers		lead				Ingestion of soils - (including inhalation of soil particles both outside and inside as tracked back indoors).	1.	Yes – requires remediation
							Dermal contact with soils.	2.	Yes – requires remediation
			Benzo(a)pyrene TEQ				Ingestion of soils - (including inhalation of soil particles both outside and inside as tracked back indoors).	3.	Yes – requires remediation
							Dermal contact with soils.	4.	Yes – requires remediation
				TCE (vapour)			Intrusion and Inhalation of vapours (from soil or groundwater) – relevant to the site and in the future, off site residents if contamination migrates/ continue to migrate off site.	5.	Yes – requires remediation
						TCE (+other co-located VOC)		6.	Yes – requires remediation (remove risk to groundwater)
Actual or Potential Harm to the Environment (Ecology)	Soil ecology – flora / fauna		copper				Direct Contact (Ecology)	14.	Risk to ecology – will be eliminated when managing fill
			lead					15.	Risk to ecology – will be eliminated when managing fill
			zinc					16.	Risk to ecology – will be eliminated when managing fill
			Benzo(a)pyrene TEQ					17.	Risk to ecology – will be eliminated when managing fill
			TRH Fraction $C_{16}C_{34}$					18.	Risk to ecology – will be eliminated when managing fill

6 REMEDIATION ACTION PLAN

6.1 Remediation Objective

The primary objective of this remediation program is to remediate the Site in accordance with the definition of remediation provided in Section 3(1) of the EP Act.

The EP Act defines remediation as:

> Treat, contain, remove or manage chemical substances on or below the surface of the site so as to –
>
> *a) Eliminate or prevent actual or potential harm to the health and safety of human beings that is not trivial, taking into account current or proposed land uses; and*
>
> *b) Eliminate or prevent, as far as reasonably practicable –*
>
> *i. actual or potential harm to water that is not trivial; and*
>
> *ii. any other actual or potential environmental harm this is not trivial, taking into account current or proposed land uses.*

With reference to EPA (2019a), the works to be undertaken at the Site are considered to meet the definition of an active remediation approach ('remove').

6.2 Limit of Liability for Site Contamination

LWC undertook a site history assessment and set out a rationale that the current site owner (DFJ Holdings) was not responsible for causing the site contamination (LWC, 2018a). The EPA (4 May 2018) determined that DFJ Holdings is not responsible for site contamination beyond the boundaries of the Site. However, EPA (4 May 2018) also noted that the site contamination audit must still consider the impacts of any on-site contamination to on and off-site receptors. This SRP is mindful of this directive with respect to mitigating the potential ongoing migration of site related contamination under offsite areas (in groundwater and soil vapour) based on the risks reported / assessed in EPA Assessment Area reports and LWC, 2021.

6.3 Remediation Goals

The goals of the remediation works are to address the following:

1. Remove potential risks to the proposed sensitive land use posed by the presence of remnant structures and potential associated soil contamination to render the Site suitable for sensitive land use.

2. Eliminate on site risk to future human receptors in a sensitive land use setting that may occur via VOC (TCE and others) vapour intrusion. Validate that the post remediation soil vapour profile does not present a risk to such receptors following source removal, noting TCE is present in groundwater (i.e. post remediation vapour assessment will confirm / deny that groundwater TCE is not a risk to sensitive receptors via the vapour inhalation pathway).

3. Mitigate ongoing risk to offsite receptors with respect to future/ ongoing migration of TCE to groundwater from a site based source and ongoing future migration of TCE (and associated VOC) in groundwater to offsite down hydraulic gradient receptors (residents located offsite).

4. Mitigate ongoing risk to offsite receptors with respect to future/ ongoing migration of TCE (and other VOC) in the unsaturated zone (i.e. and soil vapour) from a site based source to offsite receptors (residents located offsite).
5. Mitigate potential risks to **human health** posed by impacted shallow soils (lead and benzo(a)pyrene TEQ) to render the Site suitable for sensitive land use.
6. Mitigate potential risks to the **environment** posed by impacted shallow soils (copper, zinc, benzo(a)pyrene and TRH) to render the Site suitable for sensitive land use; and
7. Undertake the remedial works such that:
   a) The risks to human health from such site contamination are eliminated;
   b) The risks to water and the environment are eliminated to the extent reasonably practicable; and
   c) All works are undertaken in accordance with relevant regulatory provisions and guidance.
8. Noting TCE is present in groundwater up-hydraulic gradient of the Site, a Groundwater Monitoring and Management Plan must be prepared and implemented post remediation to assess the potential for recontamination of the site over time, and how this may alter the assessed soil vapour risk profile following primary and secondary TCE source removal.

In essence, the remediation goals are to:

- **Eliminate or prevent risks posed to human health by soil and soil vapour contamination on and under the Site.**
- **Eliminate or prevent risks to water and the environment to the extent practicable.**

6.4 Remedial Options Assessment

CRC CARE (2018) notes that a screening exercise should be undertaken to assess what contaminants particular technologies can treat, and what medium they are effective in (i.e. soil, groundwater) to assemble a list of potential treatment options. Preliminary screening allows multiple remediation options to be appraised, and efficiently discounts those which are clearly not viable for the site, or will not meet the established remediation objectives.

6.4.1 Soil and Soil Vapour Remediation

For soil-borne contaminants, the following remedial options are considered **(including in relation to suspected soil borne TCE vapour)**:

- Containment
- Chemical immobilisation and solidification
- Bioremediation
- Soil washing
- Thermal desorption
- Excavation (and disposal)
- Soil vapour extraction.

The chemical substances requiring remediation in soil are:

- PAH (benzo(a)pyrene)
- Total Recoverable Hydrocarbons
- copper
- zinc
- lead
- **Soil borne VOC source (potential secondary source of TCE other than a primary source such as a tank, sump, pipe etc.)**

A detailed description of these remedial technologies can be found in Appendix A of CRC CARE (2018). A screening matrix of suitability of such technologies per chemical substance type is presented as Table 6-1.

- *Table 6-1 Remedial options summary (after CRC CARE, 2018) for groundwater and soil based contamination*

Media	Technology	Inorganics (including metals)	Petroleum hydrocarbons	Volatile organic compounds	Semi volatile organic compounds	PAHs
Soil	Bioremediation	?	Y	Y	Y	?
	Chemical immobilisation and solidification	Y	?	?	?	?
	Containment	Y	Y	Y	Y	Y
	Excavation	Y	Y	Y	Y	Y
	Soil vapour extraction	N	Y	Y	?	?
	Soil washing	?	?	?	?	?
	Thermal desorption	N	Y	Y	Y	Y
Groundwater	Barrier systems	Y	Y	Y	Y	?
	In-situ air sparging	N	Y	Y	Y	Y
	In-situ chemical oxidation	N	Y	Y	Y	?
	Monitored Natural Attenuation	?	Y	Y	?	Y
	Pump and treat	Y	Y	Y	Y	Y
	Skimming	N	Y	Y	N	N
Legend: Y - Viable remediation option ? - Potentially viable remediation option (less common or demonstrated) N - Not viable remediation option (or not known / demonstrated)						

6.4.1.1 Fill Zone Remediation

With respect to the fill material containing PAH, metals and non-volatile TRH, Table 6-1 indicates the following options may be appropriate when considering all three contaminant types:

1. Containment / excavation

Thus containment/ excavation (disposal) is the only method that suits all three chemical types due to the recalcitrance of these chemical substances (note that PAH and TRH can be susceptible to bioremediation ('degradation') though the metals are not suitable candidates for biodegradation).

Given that the proposed site layout design for the proposed development is not available (not yet formulated), and noting that there is a prescribed open space area that will be required, it may be possible to excavate the fill and contain within the open space area. This would then require a Site Management Plan to be developed to manage such area moving forward.

This containment option could be considered later (when development plans become available) and submitted to the auditor for review and approval.

6.4.1.2 Soil Vapour Source Remediation

The VOC (TCE and other VOC) source is not co-located with Fill Zones A – C and therefore may be treated separately to the Fill Zone areas.

The key risks that require elimination or mitigation with respect to TCE and other VOC are:

1. TCE (and other VOCs) in soil vapour (both on and offsite) with respect to a proposed sensitive land use
2. Elimination of offsite risk with respect to potential ongoing future migration of TCE (and other VOCs) to groundwater (and associated lateral migration of TCE in groundwater and associated soil vapour to offsite areas).

The installation of a vapour mitigation system could address on-site risks posed by soil vapour contamination, but will not address future potential risks to off-site receptors – which may continue to exist if the on-site source primary (if present) and secondary soil sources of soil vapour (and groundwater) contamination are not removed.

It is not yet clear as to what is the primary contributory source of TCE beneath the Site, though could be one or more of the following three sources:

1. A primary source in the vadose zone (e.g. tank, sump. Pipe etc.).
2. Secondary source (soils) around a former spill and/ or around a primary source.
3. TCE in groundwater.

With respect to remedial options for the VOC source (as per Table 6-1), the following four remedial options are indicated as being appropriate for remediation of VOC in the unsaturated zone:

1. Bioremediation
2. Containment/ Excavation
3. Soil vapour extraction
4. Thermal desorption

Bioremediation may be possible but is likely to require a long timeframe for satisfactory completion compared to excavation (and offsite disposal). Containment may still present a vapour source on site.

However, following excavation (and validation of the excavation) some form of bioremediation of the excavated soils may be possible if there is suitable space on site to stockpile and treat VOC impacted soils and a suitable timeframe (months).

Soil vapour extraction (SVE) would remove the soil vapour in the short to medium term but may not eliminate all ongoing vapour generation where a primary or secondary source exists. Nor would SVE eliminate (to extent practicable) ongoing risk of migration of VOC to groundwater.

Thermal desorption is a high cost and high energy option that is considered unlikely to be cost effective or cost achievable for this project.

Physical intervention is therefore considered to be the most appropriate option and in lieu of available certainty with respect to space and time, excavation and disposal is set out in this document as a default approach. The treatment may be revisited (and reviewed and endorsed by the appointed auditor) once the development has been refined in terms of timeframes and available space for on-site treatment.

Excavation and removal of the source is therefore considered to be the most effective option with respect to eliminating potential risk to a future sensitive site use and mitigating potential ongoing migration of TCE to groundwater at this time.

Once a primary and/ or secondary source is removed, the contribution of TCE in groundwater to the soil vapour flux will become apparent.

For this reason, soil vapour sampling is required to be undertaken AFTER TCE vadose located source removal has occurred so as to confirm / deny that groundwater borne TCE is not a risk to future land use via the vapour inhalation pathway.

If soil vapour contamination and risks to on-site receptors remain following removal of the suspected primary and secondary sources of soil vapour contamination under Building C, then vapour mitigation systems may still be required – if occupied structures are proposed in this portion of the site.

6.4.2 Groundwater Remediation

TCE (and representative TRH range) and PFAS along with boron, nickel, manganese and selenium and inorganics (nitrogen species and phosphate) are present in groundwater. Of these, only boron and the inorganics are considered likely to be not site sourced (Table 6-1). The other chemical substances could be attributable to both on-site and offsite sources.

Of the chemicals potentially attributable to the Site, TCE poses the **key risk** to both on and offsite receptors due to its recalcitrant characteristics, toxicity and its propensity (along with other associated VOC) to volatilise and present a vapour intrusion risk in indoor air environments. Direct exposure to TCE (and other VOCs and site related contaminants) by extraction and use of groundwater is currently mitigated by the GPA.

For groundwater borne contaminants, as per Table 6-1 the following remedial options are considered:

- In Situ Air Sparging (VOCs only).
- In Situ Chemical Oxidation (and surfactant enhanced in situ chemical oxidation) (VOCs only).
- Source removal and monitored natural attenuation.
- Barrier systems (permeable reactive barriers and cut off walls)
- Pump and treat.

It is noted that remediating groundwater under the site by means other than source removal and monitored natural attenuation is likely to be impracticable – particularly in the context of:

- Other sources – there are offsite sources (concentrations) of TCE of similar magnitude both up and down hydraulic gradient of the Site such that specific remediation of the groundwater beneath the Site would not eliminate TCE in groundwater in the Assessment Area or under the site.
- Benefits – up hydraulic gradient sources of TCE and TCE in groundwater from other sources in areas surrounding the site may re-contaminate the Site in the future and negate the benefits provided by any on-site groundwater remediation.
- Technical limitations – due to the complex hydrogeological conditions under the site and surrounding areas, which would make treatment by extraction or injection (of ameliorants) problematic and unlikely to be successful.
- Sustainability – due to the potential for recontamination of the Site in relation to offsite TCE in groundwater, energy expended and waste generated from remediation may be unsustainable to return the groundwater beneath the Site to a natural pristine condition.

Further consideration of significance of TCE in groundwater beneath the Site must be undertaken after removal (elimination) of the unsaturated zone TCE source, including accounting for potential recontamination of the Site by up-hydraulic gradient groundwater/ soil vapour contamination. This must be set out (managed) within a Groundwater Monitoring Management Plan, approved / endorsed by the auditor.

6.5 Preferred Remediation Options

6.5.1 Soil Contamination

Fill Zones A – C: the specific lay out / nature of future development is unknown at time of the development of this SRP therefore the proposed management option is removal of fill to a licensed facility.

Future development proposals may wish to consider amending this option to one of on-site retention either beneath high density dwellings or within a potential mandated open space area within the development, subject to site contamination auditor approval and implementation of a site management plan.

Soil contamination (secondary source) associated with TCE (and other VOC) is discussed under Section 6.5.2 ("Soil Vapour Contamination").

6.5.2 Soil Vapour Contamination

- Excavation and off-site disposal (if present) of primary source and associated secondary residual soil sources of TCE (and other VOCs) reported in soil vapour.
- Implementation of vapour validation program post remediation.
- Implementation of intrusion mitigation and monitoring measures, if required (following receipt and processing of post remediation soil vapour results against the provided soil vapour screening criteria). This may take the form of vapour intrusion membranes on residential dwellings, subject to the residual soil vapour profile post remediation. A site specific vapour intrusion mitigation plan (design, installation, verification) must be prepared and submitted to the auditor for review, where required.

6.5.3 Groundwater Contamination

- Excavation and off-site disposal (if present) of primary and residual soil sources of TCE (and other VOCs and possible PFAS, TRH and some metals) contamination in groundwater.
- Implementation of a groundwater management and monitoring plan following remediation – which is considered necessary to assess the impacts of source removal and whether natural attenuation is sufficient to address residual groundwater contamination.

6.6 Stakeholder Engagement

A number of residential properties are located in close proximity to the Site along Glyde and Osborne Street. Community Consultation is to be undertaken prior to the commencement of the Site demolition and redevelopment project.

All communication is to be undertaken in accordance with SA EPA (2018) Site Contamination: Guideline for Communication and Engagement. In the first instance, nearby residences are to be notified via a letter drop. A letter will be prepared by the SRP Manager in conjunction with the Site Owner and provided to the appointed site contamination auditor.

Additional community involvement and consultation may be necessary where possible nuisance or effects on the amenity of the locality, e.g. from noise, dust or odour might occur. Nuisances for short periods are generally more tolerable, but nuisance over periods of time can result in increased frustration. Hence additional measures to minimise impacts to the community may be required.

Stakeholder engagement should also include the EPA and City of Charles Sturt (Council) and consider relevant information on off-site contamination from the site.

6.7 Remediation Tasks

6.7.1 Preliminary works

The following preliminary works are to be undertaken prior to the commencement of the remediation works:

- A Site-specific Work Health and Safety Management Plan (WHSMP) including a Job Safety Environmental Assessment (JSEA) will be prepared for the remediation works **PRIOR TO MOBILISATION (See Appendix A)**.
- All underground services will be located prior to the inception of site works. Ground Penetrating Radar (GPR) will be utilised to assist in locating services and/ or the location of any underground tanks following removal of above ground buildings.
- A groundwater well decommissioning permit shall be sourced from the Department of Environment and Water in relation to decommissioning monitoring well GW08 within the northern building (Building C).

6.7.2 Site Preparation, Access and Security

Site access to the area of the proposed remediation works shall be restricted to personnel inducted into the SRP. The Site will be appropriately fenced off prior to commencement of works, using temporary fencing, bunting and warning signs, in order to restrict unnecessary workers and the general public from the work area. It is expected that the demolition contractor will affix a suitable safeworkSA approved notice board to the secure perimeter fencing alerting of relevant emergency contact numbers.

Where the chainage/ continuation of the permanent fencing is not complete, temporary fencing suitable to prevent site access must be installed.

6.7.3 Retention of Existing Groundwater Monitoring Wells

IMPORTANT

A period of groundwater monitoring (verification) is required to be undertaken post remediation. It is vital that every effort is made to protect and conserve the existing groundwater monitoring well network on the Site, **with exception of GW08 within the northern building (Building C)**. Well GW08 will likely fall within the Building C remediation zone and must be appropriately decommissioned in accordance with DEW permits conditions prior to demolition of the northern building (Building C) structure.

Groundwater monitoring well locations are shown in the Figures section. All locations must be protected to ensure future validity.

6.7.4 Demolition

All asbestos containing materials (ACM) and any other hazardous materials must be removed from the buildings by appropriately licensed practitioners and in accordance with relevant South Australian and National Guidance. The following resource should be consulted prior to works to ensure latest regulations and guidance are adhered to:

https://www.asbestos.sa.gov.au/

The remediation works will occur once the above ground improvements have been demolished and removed and all ACM and hazardous materials have been removed.

Appropriate ACM clearance certificates must be provided by the independent licensed ACM inspector by the licensed ACM practitioner undertaking the works, to the SRP Manager, prior to breaking ground so as to mitigate burial/ transfer of ACM to the subsurface.

6.7.5 Southern Buildings (Building G)

As access under the office buildings in the southern portion of the site was not possible during the investigations. Soils in this area must be inspected and sampled following demolition of site buildings. Additional sampling is also specified for Buildings D to F, as per Table 6-4.

6.7.6 Building C TCE Source

It is theorised that the source of TCE is beneath the northern portion of Building C possibly extending northwards to the northern boundary. Once the above ground improvements have been removed, the slab / foundation of Building C must be removed.

ENSURE GROUNDWATER WELL GW08 HAS BEEN APPROPRIATELY DECOMMISSIONED!

The Environmental Consultant must be present at the commencement of this action in order to observe, inspect and assist in identification of any indication of sub-floor source of TCE e.g. a sump, tank, drain, pipework, stained soil etc.

Where a tank or tanks or sump(s) are present, the contents of the tank(s) or sump(s) must be removed and disposed of to a licensed facility by a licensed operator.

Where a tank or tanks are present, these will be removed in accordance with guidelines and requirements detailed in:

1. *SA EPA (2019c) Guidelines for the Assessment of Underground Storage Systems.*
2. *AS 4976-2008 - The removal and disposal of underground petroleum storage tanks*:
3. *EPA Victoria (2015) The Design, Installation and Management Requirements for Underground Petroleum Storage Systems (UPSS).*

The following will occur should underground tanks be identified as the source:

a) The contractor will disconnect and remove all ancillary pipework connected to the infrastructure. Any openings in the infrastructure as a result of removing the associated pipework, must be sealed.

b) The contractor will excavate the infrastructure and remove them from the resultant excavation pits. Tanks and associated pipework will be relocated to a remote and sealed area of the Site. LWC will inspect and photograph each tank and associated infrastructure.

c) The contractor will dispose of infrastructure at an appropriately licensed disposal facility and provide records of disposal/ transfer of ownership as per Australian Standard AS 4976:2008 The Removal and Disposal of Underground Petroleum Storage Tanks.

d) Once the infrastructure has been removed, the resultant excavation will be cleared of backfill sands and collapsed soil such that the walls and base of the excavation may be easily inspected. Backfill sands will be stockpiled separately from other excavated material for validation.

e) The excavation extent will be inspected for evidence of contamination (i.e. staining) and the exposed soil lithology logged in accordance with Australian Standards.

f) Samples will be collected from the walls and base of all associated excavations using the excavator bucket (or where shallow excavations are relevant such as pipework, samples can be collected by clean gloved hand) and screened in the field for evidence of VOC contamination using a calibrated photo ionisation detector (PID). The PID must be capable of detecting both petroleum and chlorinated hydrocarbons.

g) Once LWC is satisfied that excavation need not be extended further, the final dimensions of each excavation will be measured and recorded. This is when validation samples will be collected.

h) The validation sample densities will be as follows:

   i. A minimum of two (2) samples per wall/ base and additional samples collected per 25 m^2 of exposed wall/ base i.e. if the western wall of an excavation is 30 m^2, two (2) evenly spaced samples will be collected from the western wall.

i) Where observation and PID screening indicate that soils are potentially contaminated to an extent unlikely to be suitable to remain in-situ (i.e. a PID over 5 ppm_v)[2], excavation will be extended to remove the contaminated soil prior to re-sampling.

j) All excavated soils will be stockpiled on site on a hardstand and bunded area. The stockpile of soil should be covered with an impermeable cover. All stockpiles will be appropriately bunded. Effort will be made to separate stockpiles according to levels of suspected contamination (to be inferred by visual/ olfactory evidence of potential impact).

k) Each distinct stockpile will be provided a unique identifier and described in terms of dimensions, volume, soil type and source and suspected contamination status.

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[2] In LWC experience, soil moisture can cause a PID ppm of up to ~10 ppm_v, therefore 50% of this is set for conservatism.

l) Excavation pits will be left open and surrounded by temporary fencing until laboratory results for the walls and base samples, and exhumed stockpile material, are received.

Where no specific physical infrastructure that may be the source of TCE is identified or surface soil staining, the following must occur:

m) Excavate 1 m deep trench (bucket width) at 1 m distances, running north – south from the former northern wall of Building C to the approximate former middle line of Building C. Repeat tasks (e) and (f) above. **Refer Figure 4**.

n) Samples of soil obtained from 1 wall of each trench must be screened using a PID at distances along each trench at a distance of no greater than 1 m.

AUDITOR HOLD POINT 1: Auditor (in the company of LWC) to observe the condition of the resultant tank pit/ other excavations/ remediation/ validation area immediately after validation sampling.

WHEN SATISFACTORY – PROCEED TO SECTION 6.9 (BACKFILL)

6.7.7 Fill Zone A, B and C Management

The proposed redevelopment includes residential land use. Soil contamination that exists at the Site will be managed by excavation of contaminated material for disposal off-site, as set out in Table 6-3 and in Figures 5a and 5b.

Please note, the final remedial extents shall be based on field observations and analytical results.

Soils that are considered to not be aesthetically suitable (**refer Section 6.8.4.4**) shall be excavated and stored on site separate to chemically impacted soils. This soil will be identified for re-use beneath future building slabs, footpaths, roadways.

Table 6-2 Fill Management

Nature	Extent	Approximate Area / Volume	Management Action
Fill Zone A Comprising chemicals (lead – human health and copper, zinc - ecology) in sample location SB09 at 0.0-0.2 m. **Human health** lead **environment (ecology)** copper, zinc,	**Laterally –** The fill evident in SB09 is not evident in bores radial to such location unless counting SB16 to the south. The concentrations of metals reported maybe attributable to the fill itself (i.e. uncontrolled imported fill) or could be a function of loss of lead based paint from the northern warehouse, historically, noting the surface is sealed here. Alternatively it could be a function of processes / activities undertaken at the Site in Gadsdens days. **Vertically –** Copper and zinc are delineated to 0.2 m however elevated lead (relative to HIL A) is reported in the sample from natural at 0.2 m – 0.4 m.	Refer Figure 5a and 5b 517 m^2 / 207 m^3	Excavate the material to the extent shown in Figure 5a/5b, to a depth of 0.4 m and transport / dispose to a licensed facility under SA EPA waste transfer protocol (Section 7.4). Validate area as per Section 6.8.1
Fill Zone B Comprising copper, lead and zinc in location SB16. **Human health**	**Laterally –** The fill evident in SB16 is not evident in bores radial to such location unless counting SB09. The concentrations of metals reported maybe attributable to	Refer Figure 5a and 5b 219 m^2 / 44 m^3	Excavate the material to the extent shown in Figure 5a/5b, to a depth of 0.2 m and transport / dispose to a licensed facility under SA EPA waste transfer protocol (Section 7.4).

Nature	Extent	Approximate Area / Volume	Management Action
lead **environment (ecology)** copper, lead, zinc	the fill itself (i.e. uncontrolled imported fill) or could be a function of loss of lead based paint from the northern warehouse, historically, noting the surface is sealed here. Alternatively it could be a function of processes / activities undertaken at the Site in Gadsdens days. **Vertically –** Delineated to 0.2 m.		Validate area as per Section 6.8.1.
Fill Zone C In the scaffold storage area on the western side of the Site – potentially associated with the former Gadsdens business. Characterised by black, grey gravelly sand / clayey gravel with occasional brick, bitumen, tar and glass and concentrations of metals (copper, lead, zinc) PAH (BaP TEQ) and TRH (Fraction C16-34) above human health and ecological / environmental protection criteria. Tier 1 criteria exceeded for residential land use **human health** lead, BaP_{TEQ} **environment (ecology)** copper, zinc, BaP and Fraction C16-C34.	**Laterally –** Located to the west of the northern warehouse stretching from SB19 in the north to SB25 in the south, note that these areas are unsealed. **Vertically –** SB20 reports a depth of 0.7 m although this is logged as clayey gravel. Elsewhere the fill is generally gravelly sand or silt and averages 0.2 m thick (deep). Concentration wise the BaP_{TEQ} in SB20 is not delineated however the fill reports tar fragments and it is considered that the reported BaP concentrations are synonymous with the fill layer. The area is characterised by unsealed surface used for commercial storage of scaffold and occasional metal (inert) waste. The older non scaffold metal items may be the source of metals in soils (i.e. metal flakes or shavings) or equally the fill itself could be the source, or even former use of the site by Gadsdens.	Refer Figure 5a and 5b 1,916 m^2 / 383 m^3	Excavate the material to the extent shown in Figure 5a/5b, to an average depth of 0.2 m and transport / dispose to a licensed facility under SA EPA waste transfer protocol (Section 7.4). Inspect area in and around soil bore SB20 to assess whether fill is present at greater depth and should be removed. Validate area as per Section 6.8.1.

6.8 REMEDIATION VALIDATION

6.8.1 Soil Contamination Validation

6.8.1.1 VOC Validation (Building C)

IMPORTANT!

The sampler should ensure that samples are collected and forwarded to the nominated appropriately accredited laboratories in accordance with PFAS sampling protocols set out in HEPA (2020). These measures should be acknowledged in the Remediation Validation Report.

All excavations and associated stockpiles undertaken/ generated as a result of works set out in Section 6.7 shall be validated as follows:

- The **Environmental Consultant** will collect validation samples from the **walls and base** of excavations. Samples will be collected directly from the centre of the excavator bucket by hand - a fresh clean nitrile glove must be used for the collection of each sample. Additional sampling will be undertaken along/ beneath and excavations for associated pipework that extends outside of the footprint covered by the excavations. Sampling will be conducted in accordance with the National Environment Protection (Assessment of Site Contamination) Measure 1999 as amended 2013 (ASC NEPM).
- LWC will sample exhumed (**stockpiled**) material to determine classification for either reuse as backfill or for offsite disposal.
- The validation sample densities will be as follows:
    - A minimum of two (2) samples per wall/ base and additional samples collected per 25 m^2 of exposed wall/ base i.e. if the western wall of an excavation is 30 m^2, two (2) evenly spaced samples will be collected from the western wall.
    - The stockpile sampling density is based on ASC NEPM rates and will be 1 sample per 25 m^3 of stockpiled material and a minimum of three (3) samples collected per stockpile. Sufficient samples will also be collected (and placed on hold at the laboratory) to facilitate statistical assessment of stockpiled material, if required.
- Validation and stockpile soil samples will be collected using a fresh pair of nitrile disposable gloves and screened with a PID fitted with a lamp that can detect chlorinated and petroleum hydrocarbons. This will help guide remedial extents for all areas. in order to detect the presence of VOC. Soils will be logged in accordance with Australian Standard 1726:2017 Geotechnical Site Investigations.
- Soil samples must be collected in accordance with Standards Australia 1999, 4482.2-1999 Guide to the Sampling and Investigation of Potentially Contaminated Soil. Part 2: Volatile Substances (Standards Australia AS4482.2-1999). Soil samples must be sent under chain of custody protocol to appropriately accredited laboratories.
- Field QA/QC samples will include the following:
    - A minimum of one blind coded intra-laboratory duplicate, and one blind coded inter-laboratory duplicate (i.e. 1:20 intra-laboratory and 1:20 inter-laboratory duplicates).
    - Laboratory supplied trip blanks will accompany both the primary and secondary samples for testing of volatile analysis (TRH Fraction C6-C10). The purpose of a trip blank is to confirm that no contamination is being introduced during shipping and field handling procedures and are typically only analysed for volatile compounds.
    - Noting that samples are to be collected directly from the excavator bucket utilising a fresh pair of disposable gloves per sample, it is considered that the potential of cross-contamination

between sample locations will be mitigated and, as such, no rinsate samples are required to be collected/ analysed.

- LWC will submit validation samples to a National Association of Testing Authorities (NATA) accredited laboratory. Analysis will cover relevant contaminants of concern to determine suitability of soils to remain in-situ in accordance with the ASC NEPM (1999, as amended 2013).
- LWC will submit stockpile samples for analysis by a NATA accredited laboratory. Analysis will cover relevant contaminants of concern to allow for onsite reuse in accordance with the ASC NEPM (1999, as amended 2013) or offsite disposal in accordance with the SA EPA waste classification guidelines (2010) i.e. one sample per stockpile to be analysed for the broad SA Waste Screen with all remaining samples to be analysed for contaminants of concern.

AUDITOR HOLD POINT 2: LWC must provide an email update summarising the validation results of each staged remediation/ validation area. Auditor to provide comment regarding the adequacy of the validation results for the respective staged remediation/ validation area.

Table 6-3 Building C Excavation and Stockpile Validation Sampling Density and Analysis

Area / Feature	Approximate Area / Volume	Sample number	Analysis
Excavation(s)	Unknown – density / rate of sampling is provided.	5 samples from across the surface of the base of the excavation or if large excavation one sample every 2 m^2. 1 sample every 5 linear metres and every 0.5 vertical metre from the wall of the excavation (Per excavation)	VOCs arsenic, cadmium, chromium (total), copper, nickel, lead, manganese, zinc, mercury, selenium Organochlorine pesticides and organophosphate herbicides TRH/ BTEXN PAH PFAS (short suite, standard limit of reporting) Leach testing of PFAS from 25% of samples as sometimes PFAS is undetectable in soil. ACM if observed
Associated stockpiles removed from excavation(s)	Unknown – density / rate of sampling is provided.	Undertake sampling density / rate in accordance with Table 4 of Schedule B2 of the ASC NEPM: **Stockpile volume, (m^3) / No. of samples** <75 – 3 75 – <100 – 4 100 – <125 – 5 125 – <150 – 6 150 – <175 – 7 175 – <200 – 8 (Per stockpile)	VOCs arsenic, cadmium, chromium (total), copper, nickel, lead, manganese, zinc, mercury, selenium Organochlorine pesticides and organophosphate herbicides TRH/ BTEXN PAH PFAS (short suite, standard limit of reporting) Leach testing of PFAS from 25% of samples as sometimes PFAS is undetectable in soil. ACM if observed Minimum 1 sample for SA EPA waste screen if proposed to dispose off-site. Leach testing to allow disposal to landfill as required

6.8.1.2 Source Validation "Shallow Fill"

Following the removal of the fill (Fill Zones A, B and C), the exposed fresh surface of soil must be sampled using the sampling density presented in Table 6-5, which is based on Table E1 of AS4482.5-2005.

Table 6-4 Validation Sampling Density and Analysis per Fill Zone

Nature	Approximate Area / Volume	Sample number	Analysis
Fill Zone A Comprising chemicals (lead – human health and copper, zinc - ecology) in sample location SB09 at 0.0-0.2 m. **Human health** lead **environment (ecology)** copper, zinc,	Refer Figure 5a and 5b 517 m^2 / 207 m^3	5 samples from across the surface 1 sample every 5 m from the edge of the excavation (101 m perimeter = 20 samples). Edge samples collected from the upper 0.2 m of the excavation face and every 0.5 m down face thereafter (as required).	arsenic, cadmium, chromium (total), copper, nickel, lead, manganese, zinc, mercury, selenium Organochlorine pesticides and organophosphate herbicides TRH/ BTEXN PAH PFAS (short suite, standard limit of reporting) Leach testing of PFAS from 25% of samples as sometimes PFAS is undetectable in soil. ACM if observed
Fill Zone B Comprising copper, lead and zinc in location SB16. **Human health** lead **environment (ecology)** copper, lead, zinc	Refer Figure 5a and 5b 219 m^2 / 44 m^3	5 samples from across the surface 1 sample every 5 m from the edge of the excavation (77 m perimeter = 16 samples) Edge samples collected from the upper 0.2 m of the excavation face and every 0.5 m down face thereafter (as required).	arsenic, cadmium, chromium (total), copper, nickel, lead, manganese, zinc, mercury, selenium Organochlorine pesticides and organophosphate herbicides TRH/ BTEXN PAH PFAS (short suite, standard limit of reporting) Leach testing of PFAS from 25% of samples as sometimes PFAS is undetectable in soil. ACM if observed
Fill Zone C In the scaffold storage area on the western side of the Site – potentially associated with the former Gadsdens business. Characterised by black, grey gravelly sand / clayey gravel with occasional brick, bitumen, tar and glass and concentrations of metals (copper, lead, zinc) PAH (BaP TEQ) and TRH (Fraction C16-34) above human health and ecological / environmental protection criteria. Tier 1 criteria exceeded for residential land use **human health**	Refer Figure 5a and 5b 1,916 m^2 / 383 m^3	7 samples from across the surface 1 sample every 5 m from the edge of the excavation (50 samples). Edge samples collected from the upper 0.2 m of the excavation face and every 0.5 m down face thereafter (as required).	arsenic, cadmium, chromium (total), copper, nickel, lead, manganese, zinc, mercury, selenium Organochlorine pesticides and organophosphate herbicides TRH/ BTEXN PAH PFAS (short suite, standard limit of reporting) Leach testing of PFAS from 25% of samples as sometimes PFAS is undetectable in soil. ACM if observed

Nature	Approximate Area / Volume	Sample number	Analysis
lead, BaP_{TEQ} **environment (ecology)** copper, zinc, BaP and Fraction C16-C34.			
Building D Footprint **(Figure 2)**	Apparent footprint of 330 m^2 = requirement for 5 samples pursuant to Table E1 of AS 4482.1-2005	5 – grid based	arsenic, cadmium, chromium (total), copper, nickel, lead, zinc, mercury in every sample Organochlorine pesticides and organophosphate herbicides in every three samples TRH / BTEXN in every two samples PAH in every sample ACM if observed
Building E Footprint **(Figure 2)**	Apparent footprint of 2,500 m^2 = requirement for 8 samples pursuant to Table E1 of AS 4482.1-2005 Three undertaken in 2018.	5 – grid based	VOCs arsenic, cadmium, chromium (total), copper, nickel, lead, zinc, mercury in every sample Organochlorine pesticides and organophosphate herbicides in every three samples TRH / BTEXN in every two samples PAH in every sample PFAS (short suite, standard limit of reporting) in every two samples Leach testing of PFAS from 25% of samples as sometimes PFAS is undetectable in soil. ACM if observed
Building F Footprint **(Figure 2)**	Apparent footprint of 440 m^2 = requirement for 5 samples pursuant to Table E1 of AS 4482.1-2005 One undertaken in 2018	4 – grid based	VOCs arsenic, cadmium, chromium (total), copper, nickel, lead, zinc, mercury in every sample Organochlorine pesticides and organophosphate herbicides in every three samples TRH /BTEXN in every two samples PAH in every sample PFAS (short suite, standard limit of reporting) in every two samples Leach testing of PFAS from 25% of samples as sometimes PFAS is undetectable in soil. ACM if observed
Building G Footprint (Offices) **(Figure 2)**	Apparent footprint of 270 m^2 = requirement for 5 samples pursuant to Table E1 of AS 4482.1-2005	5 – grid based	arsenic, cadmium, chromium (total), copper, nickel, lead, zinc, mercury in every sample

<table>
<tr><th>Nature</th><th>Approximate Area / Volume</th><th>Sample number</th><th>Analysis</th></tr>
<tr><td></td><td></td><td></td><td>Organochlorine pesticides and organophosphate herbicides in every three samples
TRH/BTEXN in every two samples
PAH in every sample
PFAS (short suite, standard limit of reporting) in every two samples
Leach testing of PFAS from 25% of samples as sometimes PFAS is undetectable in soil.
ACM if observed</td></tr>
<tr><td>Associated stockpiles removed from excavation(s)</td><td>Unknown – density / rate of sampling is provided.</td><td>Undertake sampling density / rate in accordance with Table 4 of Schedule B2 of the ASC NEPM:
<table><tr><th>Stockpile volume, (m^3)</th><th>No. of samples</th></tr><tr><td><75</td><td>3</td></tr><tr><td>75 – <100</td><td>4</td></tr><tr><td>100 – <125</td><td>5</td></tr><tr><td>125 – <150</td><td>6</td></tr><tr><td>150 – <175</td><td>7</td></tr><tr><td>175 – <200</td><td>8</td></tr></table>(Per stockpile)</td><td>VOCs
arsenic, cadmium, chromium (total), copper, nickel, lead, manganese, zinc, mercury, selenium
Organochlorine pesticides and organophosphate herbicides
TRH/ BTEXN
PAH
PFAS (short suite, standard limit of reporting)
Leach testing of PFAS from 25% of samples as sometimes PFAS is undetectable in soil.
ACM if observed
Minimum 1 sample for SA EPA waste screen if proposed to dispose off-site.
Leach testing to allow disposal to landfill as required</td></tr>
</table>

Validation and stockpile soil samples will be collected using a fresh pair of nitrile disposable gloves and screened with a PID (capable of detecting VOC and TRH) in order to detect the presence of VOC. Soils will be logged in accordance with Australian Standard 1726:2017 Geotechnical Site Investigations.

Soil samples will be placed into chilled clean laboratory jars and sent under chain of custody protocol to appropriately accredited laboratories.

Field QA/QC samples will include the following:

- A minimum of one blind coded intra-laboratory duplicates and one blind coded inter-laboratory duplicate (i.e. 1:20 intra-laboratory and 1:20 inter-laboratory duplicates).
- Laboratory supplied trip blanks will accompany both the primary and secondary samples for testing of volatile analysis (TRH Fraction C6-C10). The purpose of a trip blank is to confirm that no contamination is being introduced during shipping and field handling procedures and are typically only analysed for volatile compounds.
- Noting that samples are to be collected directly from the excavator bucket utilising a fresh pair of disposable gloves per sample, it is considered that the potential of cross-contamination between sample locations will be mitigated and, as such, no rinsate samples are required to be collected/ analysed.

LWC will submit validation samples to a National Association of Testing Authorities (NATA) accredited laboratory for the above analysis.

Sampling of the walls of the excavations (not just base) will be completed to demonstrate that the full lateral extent of contaminated soils has been removed.

Testing for VOCs will be included for validation of shallow fill zones (and elsewhere) where there is evidence of organic contamination (staining, odours, elevated PID readings), in addition to validation samples specified in Table 6-3.

6.8.2 Soil Vapour Contamination Validation

Following the removal of the inferred primary / secondary TCE (and other VOCs) source beneath Building C (and/ or extending northwards to the north boundary), a round of soil vapour sampling and analysis is required to assess:

1. The efficacy of the remediation works.
2. Residual flux of TCE from groundwater.

6.8.2.1 Rationale

Four nested soil vapour locations (8 probes) will be installed by SGS as follows:

- Two in the footprint of the source removal excavation after back fill works has occurred (Section 6.9).
- Two either side of the source removal excavation (total of eight – depending on excavation size / area) to assess completion of works and background soil flux external to the footprint.

The probes will be installed at the following depth intervals to assist in soil source versus groundwater source delineation:

- 1.1 m (results from this depth interval can be screened against ASC NEPM interim HIL for volatile organic chlorinated compounds); and
- 2.5 – 3.0 m – assess residual flux from groundwater

6.8.2.2 Soil Vapour Bore / Probe Installation

Soil vapour bores will be drilled with push tube. The soil profile and texture at each soil vapour probe will be logged in detail and soil samples collected for PID screening (and possible analysis). If there is evidence of residual NAPL, other testing will be considered.

If notable soil moisture is observed in the soil at the base of the soil bores, powdered bentonite will be placed in the base of each soil bore to ~100 mm above where the moisture was observed.

A stainless steel vapour probe with quarter inch Teflon tube connected to it will be lowered into the borehole so that the tip of the probe is just above the base of the powdered bentonite. The bore annulus will be backfilled with a clean washed sand pack to create a total sand pack interval of approximately 350 mm. The length of the soil vapour probe is 270 mm, with 50 mm of sand present beneath the base of the probe and 30 mm above the top of the probe. Approximately 50 mm of powdered bentonite will be placed above the sand pack.

A slurry of cement powder, bentonite powder and water at an approximate ratio of 10:7:1 will be used to backfill the borehole to a depth of approximately 0.15 m below the existing ground surface. The soil vapour probe will be completed with a flush mounted trafficable gatic cover and rapid set concrete to the surface.