REPORT TO

FRESH HOPE CARE

ON

DETAILED SITE INVESTIGATION (DSI / STAGE 2)

FOR

PROPOSED RESIDENTIAL AGED CARE FACILITY

AT

7 MARTIN CLOSE, EAST MAITLAND, NSW

Date: 30 March 2020

Ref: E32932PTrpt2

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Executive Summary

Fresh Hope Care ('the client') commissioned JK Environments (JKE) to undertake a detailed site investigation (DSI / Stage 2) for the proposed residential aged care facility development at 7 Martin Close, East Maitland, NSW ('the site'). The site location is shown on Figure 1 and the investigation was confined to the site boundaries as shown on Figure 2.

JKE have previously undertaken a Preliminary Site Investigation (PSI) and Preliminary Acid Sulfate Soil Assessment at the site. A summary of this information has been included in Section 2.

A preliminary groundwater quality screening for temporary construction dewatering was undertaken in conjunction with this investigation. The results of the screening are presented in a separate report (Ref: E32932PTrpt3, dated 30 March 2020) attached as Appendix C.

It is understood the proposed development includes demolition of the existing aged care facility and construction of a new facility. The development is still in the concept stage, however it is assumed that at least one level of basement will be included in the design.

The investigation objectives were to:

- Assess the soil and groundwater contamination conditions via implementation of a sampling and analysis program;
- Prepare a conceptual site model (CSM);
- Assess the potential risks posed by contamination to the receptors identified in the CSM (Tier 1 assessment);
- Provide a preliminary waste classification for off-site disposal of soil;
- Assess whether the site is suitable or can be made suitable for the proposed development (from a contamination viewpoint); and
- Assess whether further intrusive investigation and/or remediation is required.

The scope of work included the following:

- Review of existing JKE project information;
- Design and implementation of a sampling, analysis and quality plan (SAQP);
- Interpretation of the analytical results against the adopted Site Assessment Criteria (SAC);
- Data Quality Assessment; and
- Preparation of a report including a Tier 1 risk assessment.

Soil samples were obtained from 24 locations and groundwater samples were obtained from two monitoring wells.

Elevated concentrations of the contaminant of potential concern were not encountered above the adopted SAC in any of the soil samples analysed. No asbestos containing materials were encountered in the fill material at the site during the field work. Elevated cadmium, nickel and zinc was encountered in groundwater above the ecological-based SAC, however this was considered to be a regional issue and was assessed not to pose a risk to the ecological/environmental receptors.

Based on the findings of the assessment, JKE are of the opinion that the site is suitable for the proposed development described in Section 1.1. Further investigation and/or remediation is not considered to be required. An unexpected finds protocol is included in Section 9.3 of this report to manage any unexpected finds during the development.

JKE recommend a hazardous building materials survey is undertaken of the existing site structure prior to demolition.

The conclusions and recommendations should be read in conjunction with the limitations presented in the body of this report.

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Attachments

Abbreviations

Asbestos Fines/Fibrous Asbestos	**AF/FA**
Ambient Background Concentrations	**ABC**
Added Contaminant Limits	**ACL**
Asbestos Containing Material	**ACM**
Australian Drinking Water Guidelines	**ADWG**
Area of Environmental Concern	**AEC**
Australian Height Datum	**AHD**
Acid Sulfate Soil	**ASS**
Above-Ground Storage Tank	**AST**
Below Ground Level	**BGL**
Benzo(a)pyrene Toxicity Equivalent Factor	**BaP TEQ**
Bureau of Meteorology	**BOM**
Benzene, Toluene, Ethylbenzene, Xylene	**BTEX**
Cation Exchange Capacity	**CEC**
Contaminated Land Management	**CLM**
Contaminant(s) of Potential Concern	**CoPC**
Chain of Custody	**COC**
Conceptual Site Model	**CSM**
Development Application	**DA**
Dial Before You Dig	**DBYD**
Data Quality Indicator	**DQI**
Data Quality Objective	**DQO**
Detailed Site Investigation	**DSI**
Ecological Investigation Level	**EIL**
Ecological Screening Level	**ESL**
Environmental Management Plan	**EMP**
Excavated Natural Material	**ENM**
Environment Protection Authority	**EPA**
Environmental Site Assessment	**ESA**
Ecological Screening Level	**ESL**
Fibre Cement Fragment(s)	**FCF**
General Approval of Immobilisation	**GAI**
Health Investigation Level	**HILs**
Hardness Modified Trigger Values	**HMTV**
Health Screening Level	**HSL**
Health Screening Level-Site Specific Assessment	**HSL-SSA**
International Organisation of Standardisation	**ISO**
JK Environments	**JKE**
Lab Control Spike	**LCS**
Light Non-Aqueous Phase Liquid	**LNAPL**
Map Grid of Australia	**MGA**
National Association of Testing Authorities	**NATA**
National Environmental Protection Measure	**NEPM**
Organochlorine Pesticides	**OCP**
Organophosphate Pesticides	**OPP**
Polycyclic Aromatic Hydrocarbons	**PAH**
Potential ASS	**PASS**
Polychlorinated Biphenyls	**PCBs**
Per-and Polyfluoroalkyl Substances	**PFAS**
Photo-ionisation Detector	**PID**
Protection of the Environment Operations	**POEO**
Practical Quantitation Limit	**PQL**
Quality Assurance	**QA**

Quality Control	**QC**
Remediation Action Plan	**RAP**
Relative Percentage Difference	**RPD**
Site Assessment Criteria	**SAC**
Sampling, Analysis and Quality Plan	**SAQP**
Site Audit Statement	**SAS**
Site Audit Report	**SAR**
Site Specific Assessment	**SSA**
Source, Pathway, Receptor	**SPR**
Specific Contamination Concentration	**SCC**
Standard Penetration Test	**SPT**
Standard Sampling Procedure	**SSP**
Standing Water Level	**SWL**
Trip Blank	**TB**
Toxicity Characteristic Leaching Procedure	**TCLP**
Total Recoverable Hydrocarbons	**TRH**
Trip Spike	**TS**
Upper Confidence Limit	**UCL**
United States Environmental Protection Agency	**USEPA**
Underground Storage Tank	**UST**
Virgin Excavated Natural Material	**VENM**
Volatile Organic Compounds	**VOC**
World Health Organisation	**WHO**
Work Health and Safety	**WHS**

Units

Litres	**L**
Metres BGL	**mBGL**
Metres	**m**
Millivolts	**mV**
Millilitres	**ml or mL**
Milliequivalents	**meq**
micro Siemens per Centimetre	**µS/cm**
Micrograms per Litre	**µg/L**
Milligrams per Kilogram	**mg/kg**
Milligrams per Litre	**mg/L**
Parts Per Million	**ppm**
Percentage	**%**

1 INTRODUCTION

Fresh Hope Care ('the client') commissioned JK Environments (JKE) to undertake a detailed site investigation (DSI / Stage 2) for the proposed residential aged care facility development at 7 Martin Close, East Maitland, NSW ('the site'). The site location is shown on Figure 1 and the investigation was confined to the site boundaries as shown on Figure 2.

JKE have previously undertaken a Preliminary Site Investigation (PSI) and Preliminary Acid Sulfate Soil Assessment at the site. A summary of this information has been included in Section 2.

A preliminary groundwater quality screening for temporary construction dewatering was undertaken in conjunction with this investigation. The results of the screening are presented in a separate report (Ref: E32932PTrpt3, dated 30 March 2020)[1] attached as Appendix C.

1.1 Proposed Development Details

It is understood the proposed development includes demolition of the existing aged care facility and construction of a new facility. The development is still in the concept stage, however it is assumed that at least one level of basement will be included in the design.

1.2 Aims and Objectives

The primary aim of the investigation was make an assessment of the risks posed by soil and groundwater contamination. The investigation objectives were to:

- Assess the soil and groundwater contamination conditions via implementation of a sampling and analysis program;
- Prepare a conceptual site model (CSM);
- Assess the potential risks posed by contamination to the receptors identified in the CSM (Tier 1 assessment);
- Provide a preliminary waste classification for off-site disposal of soil;
- Assess whether the site is suitable or can be made suitable for the proposed development (from a contamination viewpoint); and
- Assess whether further intrusive investigation and/or remediation is required.

1.3 Scope of Work

The assessment was undertaken generally in accordance with a JKE proposal (Ref: EP50804P-DSI) of 3 December 2019 and written acceptance from the client of 4 February 2020. The scope of work included the following:

- Review of existing JKE project information;
- Design and implementation of a sampling, analysis and quality plan (SAQP);
- Interpretation of the analytical results against the adopted Site Assessment Criteria (SAC);
- Data Quality Assessment; and

[1] JK Environments (2020). Report to Fresh Hope Care on Preliminary Groundwater Quality Screening for Proposed Residential Aged Care Facility Development at 7 Martins Close, East Maitland, NSW. (Report ref: E32932PTrpt3, dated 24 March 2020)

- Preparation of a report including a Tier 1 risk assessment.

The scope of work was undertaken with reference to the National Environmental Protection (Assessment of Site Contamination) Measure 1999 as amended (2013)[2], other guidelines made under or with regards to the Contaminated Land Management Act (1997)[3] and State Environmental Planning Policy No.55 – Remediation of Land (1998)[4]. A list of reference documents/guidelines is included in the appendices.

[2] National Environment Protection Council (NEPC), (2013). *National Environmental Protection (Assessment of Site Contamination) Measure 1999 (as amended 2013).* (referred to as NEPM 2013)

[3] Contaminated Land Management Act 1997 (NSW) (referred to as CLM Act 1997)

[4] *State Environmental Planning Policy No. 55 – Remediation of Land 1998* (NSW) (referred to as SEPP55)

2 SITE INFORMATION

2.1 Background

2.1.1 Preliminary Site Investigation & Preliminary Acid Sulfate Soil Assessment (JKE, 2020)

In January 2020, JKE were engaged to undertake a PSI & Preliminary Acid Sulfate Soil Assessment at the site. The PSI included a desktop review of site information, including: background and historical information; review of an existing report by STS GeoEnvironmental; a walkover site inspection; and preparation of a report presenting the results of the assessment, including a CSM.

The site history review indicated that the site had been utilised for potential farming/agricultural purposes between 1921 and 1976, with development of the site occurring sometime between 1982 and 1993 for residential aged care purposes. Observations made during the investigation identified fill material (i.e. imported/disturbed soils) at the site surface in several areas and the potential for the existing structures to contain hazardous building materials.

Based on the scope of work undertaken for the assessment, the CSM identified the following potential contamination sources/areas of environmental concern (AEC):

- Fill material – The site appears to have been historically filled to achieve the existing levels. The fill may have been imported from various sources and could be contaminated. Topsoil and fill were encountered to depths of approximately 0.3m-0.7m across parts of the site during the STS GeoEnvironmental investigation in 2019.
- Historical agricultural use - The historical land title records indicate that the site may have been used for grazing/farming purposes;
- Use of pesticides – Pesticides may have been used beneath the building and/or around the site;
- Hazardous Building Material – Hazardous building materials may be present in the existing site structures.

The PSI recommended a Stage 2 DSI be undertaken to characterise the site contamination conditions. In addition, a hazardous building materials survey was recommended (if not already completed) prior to demolition of existing site structures. The PSI assessment of ASS occurrence at the site indicated there to be a very low risk of ASS materials being disturbed during the proposed development. An ASS management plan was not recommended.

2.2 Site Identification

Table 2-1: Site Identification

Current Site Owner:	The Churches of Christ Property Trust
Site Address:	7 Martin Close, East Maitland, NSW
Lot & Deposited Plan:	Lot 57 in DP260833
Current Land Use:	Residential (aged care facility)

Proposed Land Use:	Continued residential use (aged care facility)
Local Government Authority:	Maitland City Council
Current Zoning:	R1 - General Residential
Site Area (m^2) (approx.):	13,340
RL (AHD in m) (approx.):	19-24
Geographical Location (decimal degrees) (approx.):	Latitude: -32.765986 Longitude: 151.590015
Site Location Plan:	Figure 1
Sample Location Plan:	Figure 2

2.3 Site Location and Regional Setting

The site is located in an urban area of East Maitland and is bound by Martin Close to the south-east and Brooklyn Park to the north (narrow verge along creek line) and west. The site is located approximately 25m to 35m to the east and south-east of Two Mile Creek.

2.4 Topography

The regional topography is characterised by a north-west facing hillside that falls towards Two Mile Creek. The site is located towards the toe of the hillside and slopes towards the north-west at approximately 3° to 10°. Parts of the site appear to have been levelled to account for the slope and accommodate the existing development.

2.5 Site Description/Inspection

A walkover inspection of the site was undertaken by JKE on 25 February 2020. The site was generally similar to the inspection undertaken as part of the PSI with observations summarised below:

- At the time of the inspection, the site was occupied by the Green Hills Residential Aged Care facility, with the building positioned in the southern half of the site. The section of the site to the north of the building was generally a paved car park and driveway, and the north and east section of the site was generally grass covered gardens / landscaped areas;
- The site building appeared to be of mid-to-late 1980's construction, with the potential for hazardous building materials (i.e. asbestos containing material / fibre cement - ACM);
- A surface drain in the paved driveway/car park to the west of the maintenance workshop was observed to show evidence of paint or other chemical washdown via residual fragments and slight dis-colouration of the grate and surrounding concrete. Adjacent to this against the building was a painting roller and tray, and two large tubs of cleaning fluid ('One Shot'). A limited review of readily available information for this cleaning product suggested that it is non-hazardous, sulfamic acid that is not classified as dangerous goods. There were no leaks evident near the storage area, therefore the minor storage of this cleaning fluid was not considered to pose a contamination risk;

- Fill material was identified in numerous areas around the site where exposed soil was present at the site surface. This included mainly garden beds and landscaped areas around the building and near the chicken coop in the north-east of the site. Fill containing concrete, terracotta pipe fragments and brick (demolition waste), was observed in the fill batter along the south-east boundary of the site with the neighbouring residential properties;
- A chemical store was located in a locked room on the south-east side of the building and adjacent to the laundry. This store was not accessible. Green waste was stored in two side by side concrete lined bunds in the south-west corner of the site; and
- Two Mile Creek and the surrounding riparian zone extend along the north-west boundary of the site, and Brooklyn Park is situated to the north-west and west of the site. Brooklyn Park is identified as an endangered ecological community supporting Spotted Gum Ironbark Forest. Both these features are situated in or beyond the down-gradient section of the site and therefore considered to be sensitive environments.

2.6 Surrounding Land Use

During the site inspection, JKE observed the following land uses in the immediate surrounds:
- North – riparian zone, Two Mile creek and low density residential (Green Hills Retirement Village);
- South – Low density residential properties within Martin Close, Erin Close and Kilkenny Circuit;
- East – Low density residential properties within Martin Close and Stronach Avenue; and
- West – Brooklyn Park, endangered ecological community also containing Two Mile Creek.

JKE did not observe any land uses in the immediate surrounds that were identified as potential contamination sources for the site.

2.7 Summary of Site History Information

The PSI report included a review of various site history documentation sources. Based on a review of this information and additional observations/findings made by JKE during the current assessment, a time line summary of the historical land uses and activities is presented in the table below. The information presented in the table is based on a weight of evidence assessment of the site history documentation and observations made by JKE.

Table 2-2: Summary of Historical Land Uses / Activities

Year(s)	Potential Land Use / Activities
Between 1921 - 1976	• Potential farming/agricultural land use; and • Disused, vacant scrubland.
Sometime between 1982 and 1993	• Land use changed to residential (aged care) land use; • Construction of existing buildings and pavements; • Potential filling of the site during construction of the buildings and pavements; and • Potential hazardous building materials (ACM, lead paint) within building materials due to age of structures.
1993 to present	• Continuous residential aged care land use.

3 SUMMARY OF GEOLOGY AND HYDROGEOLOGY

3.1 Regional Geology

Regional geological information reviewed as part of the PSI indicated that the site is underlain by Palaeozoic aged Tomago Coal Measures of siltstone, sandstone, coal, tuff, claystone, conglomerate, and minor clay lenses.

The Maitland City Council Local Environment Plan (LEP) 2011 identified the site to be located in a Class 5 risk area. Information reviewed as part of the PSI indicated ASS conditions are not likely to be present at the site. The proposed development does not meet any of the Class 5 triggers that would impact ASS on adjacent land.

3.2 Hydrogeology

Hydrogeological information reviewed as part of the PSI indicated that the regional aquifer on-site, and in the area immediately surrounding the site includes porous, extensive highly productive aquifers. There were a total of 12 registered bores within the report buffer of 2,000m. In summary:

- The nearest registered bore was located approximately 1,470m from the site. This was utilised for monitoring/test purposes;
- The majority of the bores were registered for monitoring/test purposes;
- There were no nearby bores (i.e. within 2km) registered for domestic or irrigation uses; and
- The drillers log information from the closest registered bores typically identified fill and/or clay soil to depths of 1.0-7.5m, underlain by sandstone or shale/siltstone bedrock and/or coal. Standing water levels (SWLs) in the bores ranged from 4.82m below ground level (BGL) to 85.0mBGL.

Based on the above the subsurface conditions at the site were considered likely to consist of relatively low permeability (residual) soils overlying shallow bedrock. The potential for viable groundwater abstraction and use of groundwater under these conditions is considered to be low. There is a reticulated water supply in the area and consumption of groundwater is not expected to occur. Use of groundwater is not proposed as part of the development.

Considering the local topography and surrounding land features, JKE would generally expect groundwater to flow towards the north-west.

3.3 Receiving Water Bodies

The closest surface water body, Two Mile Creek, was identified approximately 25m to 35m to the north-west of the site, extending parallel to this boundary. This is down-gradient from the site and is considered to be a potential receptor. Discharge points from the site surface water drains were also observed to feed into the creek.

4 CONCEPTUAL SITE MODEL

4.1 Potential Contamination Sources/AEC and CoPC

The conceptual site model has been reviewed after consideration of the data collected for the previous investigation.

Table 4-1: Potential (and/or known) Contamination Sources/AEC and Contaminants of Potential Concern

Source / AEC	CoPC
Fill material – The site appears to have been historically filled to achieve the existing levels. The fill may have been imported from various sources and could be contaminated. Fill was encountered to depths of between 0.1m and 1.7m during the fieldwork.	Heavy metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc), petroleum hydrocarbons (referred to as total recoverable hydrocarbons – TRHs), benzene, toluene, ethylbenzene and xylene (BTEX), polycyclic aromatic hydrocarbons (PAHs), organochlorine pesticides (OCPs), organophosphate pesticides (OPPs), polychlorinated biphenyls (PCBs) and asbestos.
Historical agricultural use – The historical land title records indicate that the site may have been used for grazing/farming purposes.	Heavy metals, TRH, PAHs, OCPs, PCBs and asbestos
Use of pesticides – Pesticides may have been used beneath the buildings and/or around the site, consistent with residential-type applications.	Heavy metals and OCPs
Hazardous Building Material – Hazardous building materials may be present in the existing buildings/structures on site.	Asbestos, lead and PCBs It is noted that lead in paint was generally phased out from 1970 and Australia banned the importation of PCBs in 1975.

4.2 Mechanism for Contamination, Affected Media, Receptors and Exposure Pathways

The mechanisms for contamination, affected media, receptors and exposure pathways relevant to the potential contamination sources/AEC are outlined in the following CSM table:

Table 4-2: CSM

Potential mechanism for contamination	Potential mechanisms for contamination include: • Fill material – importation of impacted material, 'top-down' impacts (e.g. placement of fill, leaching from surficial material etc), or sub-surface release (e.g. impacts from buried material); • Historical agricultural use – 'top-down' and spills (e.g. application of pesticides, and other activities at the ground surface level); • Use of pesticides – 'top-down' and spills (e.g. during normal use, application and/or improper storage); and • Hazardous building materials – 'top-down' (e.g. demolition resulting in surficial impacts in unpaved areas).
Affected media	Soil and groundwater have been identified as potentially affected media.

Receptor identification	Human receptors include site occupants/users (including primarily adults), construction workers and intrusive maintenance workers. Off-site human receptors include adjacent land users. Ecological receptors include terrestrial organisms and plants within unpaved areas (including any proposed landscaped areas), and freshwater ecology in Two Mile Creek.
Potential exposure pathways	Potential exposure pathways relevant to the human receptors include ingestion, dermal absorption and inhalation of dust (all contaminants) and vapours (volatile TRH, naphthalene and BTEX). The potential for exposure would typically be associated with the construction and excavation works, and future use of the site. Potential exposure pathways for ecological receptors include primary/direct contact and ingestion. Exposure during future site use could occur via direct contact with soil in unpaved areas such as gardens, inhalation of airborne asbestos fibres during soil disturbance, or inhalation of vapours within enclosed spaces such as buildings and basements. Exposure to groundwater could occur in Two Mile Creek through direct migration. Two Mile Creek could also be impacted via runoff (overland flows) or via discharge through the stormwater system.
Potential exposure mechanisms	The following have been identified as potential exposure mechanisms for site contamination: • Vapour intrusion into the proposed basement and/or building (either from soil contamination or volatilisation of contaminants from groundwater); • Contact (dermal, ingestion or inhalation) with exposed soils in landscaped areas and/or unpaved areas; and • Migration of groundwater off-site and into nearby water bodies, including aquatic ecosystems.
Presence of preferential pathways for contaminant movement	Local services such as stormwater pipe trenches could act as preferential pathways for contaminant migration. This could occur through fill soil. Any or via groundwater/seepage. This would be dependent on the contaminant type and transport mechanisms.

5 SAMPLING, ANALYSIS AND QUALITY PLAN

5.1 Data Quality Objectives (DQO)

Data Quality Objectives (DQOs) were developed to define the type and quality of data required to achieve the project objectives outlined in Section 1.2. The DQOs were prepared with reference to the process outlined in Schedule B2 of NEPM (2013) and the Guidelines for the NSW Site Auditor Scheme, 3rd Edition (2017)[5]. The seven-step DQO approach for this project is outlined in the following sub-sections.

The DQO process is validated in part by the Data Quality Assurance/Quality Control (QA/QC) Evaluation. The Data (QA/QC) Evaluation is summarised in Section 7.1 and the detailed evaluation is provided in the appendices.

5.1.1 Step 1 - State the Problem

The CSM identified potential sources of contamination/AEC at the site that may pose a risk to human health and the environment. Investigation data is required to assess the contamination status of the site, assess the risks posed by the contaminants in the context of the proposed development/intended land use, and assess whether remediation is required.

A waste classification is required prior to off-site disposal of excavated soil/bedrock.

The investigation was constrained in-part, by access limitations associated with the existing structures on site.

5.1.2 Step 2 - Identify the Decisions of the Study

The objectives of the assessment are outlined in Section 1.2. The decisions to be made reflect these objectives and are as follows:

- Are any results above the SAC?
- Do potential risks associated with contamination exist, and if so, what are they?
- Is remediation required?
- Is the site characterisation sufficient to provide adequate confidence in the above decisions?
- Is the site suitable for the proposed development, or can the site be made suitable subject to further characterisation and/or remediation?

5.1.3 Step 3 - Identify Information Inputs

The primary information inputs required to address the decisions outlined in Step 2 include the following:

- Existing relevant environmental data from previous reports;
- Site information, including site observations and site history documentation;
- Sampling of potentially affected media, including soil and groundwater;
- Observations of sub-surface variables such as soil type, photo-ionisation detector (PID) concentrations, odours and staining, and groundwater physiochemical parameters;

[5] NSW EPA (2017). *Guidelines for the NSW Site Auditor Scheme, 3rd ed.* (referred to as Site Auditor Guidelines 2017)

- Laboratory analysis of soils and groundwater for the CoPC identified in the CSM; and
- Field and laboratory QA/QC data.

5.1.4 Step 4 - Define the Study Boundary

The sampling will be confined to the site boundaries as shown in Figure 2 and will be limited vertically to a depth of 4.1m (spatial boundary). The sampling was completed between 24 February and 2 March 2020 (temporal boundary). The assessment of potential risk to adjacent land users has been made based on data collected within the site boundary.

Sampling was not undertaken within the existing building footprint due to access constraints.

5.1.5 Step 5 - Develop an Analytical Approach (or Decision Rule)

5.1.5.1 Tier 1 Screening Criteria

The laboratory data will be assessed against relevant Tier 1 screening criteria (referred to as SAC), as outlined in Section 6. Exceedances of the SAC do not necessarily indicate a requirement for remediation or a risk to human health and/or the environment. Exceedances are considered in the context of the CSM and valid SPR-linkages.

For this assessment, the individual results have been assessed as either above or below the SAC. Statistical evaluation of the dataset via calculation of mean values and/or 95% upper confidence limit (UCL) values has not been undertaken due to the spatial distribution of the data(i.e. sample design was not probabilistic).

5.1.5.2 Field and Laboratory QA/QC

Field QA/QC included analysis of inter-laboratory duplicates, intra-laboratory duplicates, trip spike, trip blank and rinsate samples. Further details regarding the sampling and analysis undertaken, and the acceptable limits adopted, is provided in the Data Quality (QA/QC) Evaluation in the appendices.

The suitability of the laboratory data is assessed against the laboratory QA/QC criteria which is outlined in the attached laboratory reports. These criteria were developed and implemented in accordance with the laboratory's National Association of Testing Authorities, Australia (NATA) accreditation and align with the acceptable limits for QA/QC samples as outlined in NEPM (2013) and other relevant guidelines.

In the event that acceptable limits are not met by the laboratory analysis, other lines of evidence are reviewed (e.g. field observations of samples, preservation, handling etc) and, where required, consultation with the laboratory is undertaken in an effort to establish the cause of the non-conformance. Where uncertainty exists, JKE typically adopt the most conservative concentration reported (or in some cases, consider the data from the affected sample as an estimate).

5.1.5.3 Appropriateness of Practical Quantitation Limits (PQLs)

The PQLs of the analytical methods are considered in relation to the SAC to confirm that the PQLs are less than the SAC. In cases where the PQLs are greater than the SAC, a discussion of this is provided.

5.1.6 Step 6 – Specify Limits on Decision Errors

To limit the potential for decision errors, a range of quality assurance processes are adopted. A quantitative assessment of the potential for false positives and false negatives in the analytical results is undertaken with reference to Schedule B(3) of NEPM (2013) using the data quality assurance information collected.

Decision errors can be controlled through the use of hypothesis testing. The test can be used to show either that the baseline condition is false or that there is insufficient evidence to indicate that the baseline condition is false. The null hypothesis is an assumption that is assumed to be true in the absence of contrary evidence. For this assessment, the null hypothesis has been adopted which is that, there is considered to be a complete SPR linkage for the CoPC identified in the CSM unless this linkage can be proven not to (or unlikely to) exist. The null hypothesis has been adopted for this assessment.

5.1.7 Step 7 - Optimise the Design for Obtaining Data

The most resource-effective design will be used in an optimum manner to achieve the assessment objectives. Adjustment of the assessment design can occur following consultation or feedback from project stakeholders. For this investigation, the design was optimised via consideration of the various lines of evidence used to select the sample locations, the media being sampled, and also by the way in which the data were collected.

The sampling plan and methodology are outlined in the following sub-sections.

5.2 Soil Sampling Plan and Methodology

The soil sampling plan and methodology adopted for this assessment is outlined in the table below:

Table 5-1: Soil Sampling Plan and Methodology

Aspect	Input
Sampling Density	The sampling density for asbestos in soil included sampling at the minimum sampling density (24 locations) for sites where asbestos was suspected, as recommended in the Guidelines for the Assessment, Remediation and Management of Asbestos-Contaminated Sites in Western Australia (2009)[6] (endorsed in NEPM 2013). This density met the investigation regime outlined in Table 1 of the WA DoH (2009) guidelines. Samples for other contaminants were collected from 24 locations as shown on the attached Figure 2. Based on the site area (13,340m^2), this number of locations corresponded to a sampling density of approximately one sample per 556m^2. The sampling plan was not designed to meet the minimum sampling density for hotspot identification, as outlined in the NSW EPA Contaminated Sites Sampling Design Guidelines (1995)[7] as a probabilistic sample design was not achievable due to access limitations.

[6] Western Australian (WA) Department of Health (DoH), (2009). Guidelines for the Assessment, Remediation and Management of Asbestos-Contaminated Sites in Western Australia. (referred to as WA DoH 2009)

[7] NSW EPA, (1995), *Contaminated Sites Sampling Design Guidelines.* (referred to as EPA Sampling Design Guidelines 1995)

Aspect	Input
Sampling Plan	The sampling locations were placed on a judgemental sampling plan and were broadly positioned for site coverage, taking into consideration areas that were not easily accessible. This sampling plan was considered suitable to make an assessment of potential risks associated with the AEC and CoPC identified in the CSM, and assess whether further investigation is warranted. A number of locations were drilled immediately adjacent to the buildings to provide an indication of potential application of pesticides in these areas (i.e. potentially used beneath the slabs or around the edges of the buildings).
Set-out and Sampling Equipment	Sampling locations were set out using a hand held GPS unit (with an accuracy of ±5m). In-situ sampling locations were checked for underground services by an external contractor prior to sampling. Samples were collected: • Using a hand auger from BH2, BH10, BH11, BH13, BH14, BH18, and BH20; • Using a drill rig equipped with spiral flight augers (150mm diameter) from BH6, BH6a, BH12 and BH21. Soil samples were generally obtained from a Standard Penetration Test (SPT) split-spoon sampler for general contamination analysis, and/or directly from the auger for field asbestos quantification; and • Using disposable polyethylene push tube samplers from BH1, BH3, BH4, BH5, BH7, BH8, BH9, BH15, BH16, BH17, BH19, BH22, BH23 and BH24. Each borehole was initially advanced using push tubes for standard contamination sampling, then subsequently using a 150mm diameter auger to facilitate the asbestos quantification sampling.
Sample Collection and Field QA/QC	Soil samples were obtained between 24 and 26 February 2020 in accordance with the standard sampling procedure (SSP) attached in the appendices. Soil samples were collected from the fill and natural profiles based on field observations. The sample depths are shown on the logs attached in the appendices. Samples were placed in glass jars with plastic caps and teflon seals with minimal headspace. Samples for asbestos analysis were placed in zip-lock plastic bags. During sampling, soil at selected depths was split into primary and duplicate samples for field QA/QC analysis.
Field Screening	A portable Photoionisation Detector (PID) fitted with a 10.6mV lamp was used to screen the samples for the presence of volatile organic compounds (VOCs). PID screening for VOCs was undertaken on soil samples using the soil sample headspace method. VOC data was obtained from partly filled zip-lock plastic bags following equilibration of the headspace gases. PID calibration records are maintained on file by JKE. The field screening for asbestos quantification included the following: • A representative 10L sample (or bulk sample based on whatever was achieved using the auger) was collected from fill at 1m intervals, or from each distinct fill profile from BH1 to BH3, BH6 to BH14, BH16, BH18 to BH24. The bulk sample intervals are shown on the attached borehole logs; • Each bulk sample was weighed using an electronic scale; • Each bulk sample was passed through a sieve with a 7.1mm aperture and inspected for the presence of fibre cement; • The condition of fibre cement or any other suspected asbestos materials was noted on the field records; and

Aspect	Input
	• If observed, any fragments of fibre cement in the bulk sample were collected, placed in a zip-lock bag and assigned a unique identifier. Calculations for asbestos content were undertaken based on the requirements outlined in Schedule B1 of NEPM (2013), as summarised in Section 6.1. The field assessment was used as the primary screening method for asbestos. A limited number of soil samples were also submitted to the laboratory for asbestos identification in soils. A calibration/check of the accuracy of the scale used for weighing the fibre cement fragments was undertaken using a set of calibration weights. Calibration/check records are maintained on file by JKE. The scale used to weigh the bulk samples was not calibrated, however this is not considered significant as this method of providing a weight for the bulk sample is considered to be considerably more accurate than applying a nominal soil density conversion.
Decontamination and Sample Preservation	Sampling personnel used disposable nitrile gloves during sampling activities. Re-usable sampling equipment was decontaminated as outlined in the SSP. Soil samples were preserved by immediate storage in an insulated sample container with ice. On completion of the fieldwork, the samples were stored temporarily in fridges in the JKE warehouse before being delivered in the insulated sample container to a NATA registered laboratory for analysis under standard chain of custody (COC) procedures.

5.3 Groundwater Sampling Plan and Methodology

The groundwater sampling plan and methodology is outlined in the table below:

Table 5-2: Groundwater Sampling Plan and Methodology

Aspect	Input
Sampling Plan	Four groundwater wells were installed for the investigation: MW6 (in BH6); MW6a (in BH6a); MW12 (in BH12); and MW21 (in BH21). Assuming that groundwater flow is likely to be towards the north-west (based on the topography and the nearest surface water body), MW6 and MW6a are considered to be capturing the groundwater conditions in the 'up-gradient' area of the site, and MW12 and MW21 are considered to be capturing the groundwater conditions in the 'down-gradient' areas of the site.
Monitoring Well Installation Procedure	The monitoring well construction details are documented on the borehole logs attached in the appendices. The monitoring wells were installed to a depth of approximately 2.8m to 4.1mBGL. The wells were generally constructed as follows: • A 50mm diameter Class 18 PVC casing and machine slotted screen (wells were screened between 2.8m and 3.5m in MW6, 1.5 and 2.8m in MW6A, 2.5m and 4.1m in MW12 and 2.8m and 3.5m in MW21); • A 2mm sand filter pack was installed around the slotted screen to approximately 0.5m above the screen interval; • A bentonite seal/plug was installed above the filter pack to seal the wells at a depth of approximately 0.5m to 1m below ground level; • The void around the casing was backfilled with spoil as required; and

Aspect	Input
	• A gatic cover was installed at the surface with a concrete plug to limit the inflow of surface water, and the wells were sealed with an envirocap.
Monitoring Well Development	MW6 and MW6 a were dry after installation and on the date of development. Monitoring wells MW12 and MW21 were developed on 25 February 2020 using a submersible electrical pump. A minimum of three well volumes was removed and the following parameters were monitored using calibrated field instruments: • SWL using an electronic dip meter; and • pH, temperature, electrical conductivity (EC), dissolved oxygen (DO) and redox potential (Eh) using a YSI Multi-probe water quality meter. The field monitoring records are attached in the appendices. Calibration data is retained on file by JKE.
Groundwater Sampling	Groundwater samples were obtained from MW12 and MW21 on date 2 March 2020. Prior to sampling, the monitoring wells were checked for the presence of Light Non-Aqueous Phase Liquids (LNAPLs) using an inter-phase probe electronic dip meter. The samples were obtained using a peristaltic pump. During sampling, parameters were recorded as outlined in the development step in order to assess steady state conditions. Groundwater samples were obtained directly from the single use tubing and placed in the sample containers. Duplicate samples were obtained by alternate filling of sample containers. This technique was adopted to minimise disturbance of the samples and loss of volatile contaminants associated with mixing of liquids in secondary containers, etc. Groundwater removed from the wells during development and sampling was transported to JKE in jerry cans and stored in holding drums prior to collection by a licensed waste water contractor for off-site disposal. The field monitoring records are attached in the appendices. Calibration data is retained on file by JKE.
Decontaminant and Sample Preservation	The samples were placed in appropriate plastic and glass containers (preserved as required). Samples for heavy metals analysis were field filtered. On completion of the fieldwork, the samples were delivered in the insulated sample container to a NATA registered laboratory for analysis under standard COC procedures.

5.4 Analytical Schedule

The analytical schedule (for primary samples) is outlined in the following table:

Table 5-3: Analytical Schedule (Primary Samples)

Analyte/CoPC	Fill Samples	Natural Soil Samples	Groundwater Samples
Heavy Metals	24	6	2

Analyte/CoPC	Fill Samples	Natural Soil Samples	Groundwater Samples
TRH/BTEX	24	6	2
PAHs	24	6	2
OCPs/OPPs	24	6	0
PCBs	24	6	0
Asbestos	24	0	0
pH/EC	0	0	2

Groundwater was not assessed for OCPs/OPPs as the soil analysis did not encounter these CoPC and they were considered to pose a negligible risk in groundwater on this basis.

5.4.1 Laboratory Analysis

Samples were analysed by an appropriate, NATA Accredited laboratory using the analytical methods detailed in Schedule B(3) of NEPM 2013. Reference should be made to the laboratory reports attached in the appendices for further details.

Table 5-4: Laboratory Details

Samples	Laboratory	Report Reference
All primary samples and field QA/QC samples including (intra-laboratory duplicates, trip blanks, trip spikes and field rinsate samples)	Envirolab Services Pty Ltd NSW, NATA Accreditation Number – 2901 (ISO/IEC 17025 compliance)	237693, 237693-A, and 238010
Inter-laboratory duplicates	Envirolab Services Pty Ltd VIC, NATA Accreditation Number – 2901 (ISO/IEC 17025 compliance)	20252 and 20284

6 SITE ASSESSMENT CRITERIA (SAC)

The SAC were derived from the NEPM 2013 and other guidelines as discussed in the following sub-sections. The guideline values for individual contaminants are presented in the attached report tables and further explanation of the various criteria adopted is provided in the appendices.

6.1 Soil

Soil data were compared to relevant Tier 1 screening criteria in accordance with NEPM (2013) as outlined below.

6.1.1 Human Health

- Health Investigation Levels (HILs) for a 'residential with accessible soils' exposure scenario (HIL-A);
- Health Screening Levels (HSLs) for a 'low-high density residential' exposure scenario (HSL-A & HSL-B). HSLs were calculated based on conservative assumptions including a 'sand' type and a depth interval of 0m to 1m;
- HSLs for direct contact presented in the CRC Care Technical Report No. 10 – Health screening levels for hydrocarbons in soil and groundwater Part 1: Technical development document (2011)[8]; and
- Asbestos quantification data was assessed against the HSL-A criteria. A summary of this asbestos criteria is provided in the table below. Asbestos results for the 40-50g analysis was assessed as present/absent.

Table 6-1: Details for Asbestos SAC

Guideline	Applicability
Asbestos in Soil	The HSL-A criteria were adopted for the assessment of asbestos in soil. The SAC adopted for asbestos were derived from the NEPM 2013 and are based on WA DoH (2009) guidance. The SAC include the following: • <0.01% w/w bonded asbestos containing material (ACM) in soil; and • <0.001% w/w asbestos fines/fibrous asbestos (AF/FA) in soil. The NEPM (2013) and WA DoH (2009) also specify that the surface should be free of visible asbestos. Concentrations for bonded ACM concentrations in soil are based on the following equation which is presented in Schedule B1 of NEPM (2013): $\textbf{\% w/w asbestos in soil} = \dfrac{\textbf{\% asbestos content x bonded ACM (kg)}}{\text{Soil volume (L) x soil density (kg/L)}}$ However, we are of the opinion that the actual soil volume in a 10L bucket varies considerably due to the presence of voids, particularly when assessing cohesive soils. Therefore, each bucket sample was weighed using electronic scales and the above equation was adjusted as follows (we note that the units have also converted to grams): $\textbf{\% w/w asbestos in soil} = \dfrac{\textbf{\% asbestos content x bonded ACM (g)}}{\text{Soil weight (g)}}$

[8] Cooperative Research Centre for Contamination Assessment and Remediation of the Environment (CRC Care), (2011). Technical Report No. 10 - *Health screening levels for hydrocarbons in soil and groundwater Part 1: Technical development document*

6.1.2 Environment (Ecological – terrestrial ecosystems)

- Ecological Investigation Levels (EILs) and Ecological Screening Levels (ESLs) for an 'urban residential and public open space' (URPOS) exposure scenario. These have only been applied to the top 2m of soil as outlined in NEPM (2013). The criterion for benzo(a)pyrene has been increased from the value presented in NEPM (2013) based on the Canadian Soil Quality Guidelines[9];
- ESLs were adopted based on the soil type; and
- EILs for selected metals were calculated based on the most conservative added contaminant limit (ACL) values presented in Schedule B(1) of NEPM (2013) and published ambient background concentration (ABC) values presented in the document titled Trace Element Concentrations in Soils from Rural and Urban Areas of Australia (1995)[10]. These data were used to select the added contaminant limit (ACL) values presented in Schedule B(1) of NEPM (2013), and published ambient background concentration (ABC) presented in the document titled Trace Element Concentrations in Soils from Rural and Urban Areas of Australia (1995)[11]. This method is considered to be adequate for the Tier 1 screening.

6.1.3 Management Limits for Petroleum Hydrocarbons

Management limits for petroleum hydrocarbons (as presented in Schedule B1 of NEPM 2013) were considered (if required) following evaluation of human health and ecological risks, and risks to groundwater.

6.1.4 Waste Classification

Data for the waste classification assessment were assessed in accordance with the Waste Classification Guidelines, Part 1: Classifying Waste (2014)[12] as outlined in the following table:

Table 6-2: Waste Categories

Category	Description
General Solid Waste (non-putrescible)	• If Specific Contaminant Concentration (SCC) ≤ Contaminant Threshold (CT1) then Toxicity Characteristics Leaching Procedure (TCLP) not needed to classify the soil as general solid waste; and • If TCLP ≤ TCLP1 and SCC ≤ SCC1 then treat as general solid waste.
Restricted Solid Waste (non-putrescible)	• If SCC ≤ CT2 then TCLP not needed to classify the soil as restricted solid waste; and • If TCLP ≤ TCLP2 and SCC ≤ SCC2 then treat as restricted solid waste.
Hazardous Waste	• If SCC > CT2 then TCLP not needed to classify the soil as hazardous waste; and • If TCLP > TCLP2 and/or SCC > SCC2 then treat as hazardous waste.
Virgin Excavated Natural Material (VENM)	Natural material (such as clay, gravel, sand, soil or rock fines) that meet the following:

[9] Canadian Council of Ministers of the Environment, (1999). *Canadian soil quality guidelines for the protection of environmental and human health: Benzo(a)Pyrene (1997)* (referred to as the Canadian Soil Quality Guidelines)

[10] Olszowy, H., Torr, P., and Imray, P., (1995), *Trace Element Concentrations in Soils from Rural and Urban Areas of Australia. Contaminated Sites Monograph Series No. 4*. Department of Human Services and Health, Environment Protection Agency, and South Australian Health Commission

[11] Olszowy, H., Torr, P., and Imray, P., (1995), *Trace Element Concentrations in Soils from Rural and Urban Areas of Australia. Contaminated Sites Monograph Series No. 4*. Department of Human Services and Health, Environment Protection Agency, and South Australian Health Commission.

[12] NSW EPA, (2014). *Waste Classification Guidelines, Part 1: Classifying Waste.* (referred to as Waste Classification Guidelines 2014)

Category	Description
	• That has been excavated or quarried from areas that are not contaminated with manufactured chemicals, or with process residues, as a result of industrial, commercial mining or agricultural activities; • That does not contain sulfidic ores or other waste; and • Includes excavated natural material that meets such criteria for virgin excavated natural material as may be approved from time to time by a notice published in the NSW Government Gazette.

6.2 Groundwater

Groundwater data were compared to relevant Tier 1 screening criteria in accordance with NEPM (2013), following an assessment of environmental values in accordance with the Guidelines for the Assessment and Management of Groundwater Contamination (2007)[13]. Environmental values for this assessment include aquatic ecosystems, and human-health risks in non-use scenarios.

6.2.1 Human Health

- The NEPM (2013) HSLs were not applicable for this project as the proposed basement will intersect groundwater. On this basis, JKE have undertaken a site specific assessment (SSA) for the Tier 1 screening of human health risks posed by volatile contaminants in groundwater. The assessment included selection of alternative Tier 1 criteria that were considered suitably protective of human health. These criteria are based on drinking water guidelines and have been referred to as HSL-SSA. The criteria were based on the following (as shown in the attached report tables):
    - Australian Drinking Water Guidelines 2011 (updated 2018)[14] for BTEX compounds and selected VOCs;
    - World Health Organisation (WHO) document titled Petroleum Products in Drinking-water, Background document for the development of WHO Guidelines for Drinking Water Quality (2008)[15] for petroleum hydrocarbons;
    - USEPA Region 9 screening levels for naphthalene (threshold value for tap water); and
    - The use of the laboratory PQLs for other contaminants where there were no Australian guidelines; and
- The ADWG 2011 criteria were multiplied by a factor of 10 to assess potential risks associated with incidental/recreational-type exposure to groundwater (e.g. within down-gradient water bodies, or with seepage water in the basement). These have been deemed as 'recreational' SAC.

6.2.2 Environment (Ecological - aquatic ecosystems)

Groundwater Investigation Levels (GILs) for 95% protection of freshwater species were adopted based on the Default Guideline Values in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2018)[16].

[13] NSW Department of Environment and Conservation, (2007). *Guidelines for the Assessment and Management of Groundwater Contamination.*

[14] National Health and Medical Research Council (NHMRC), (2018). *National Water Quality Management Strategy, Australian Drinking Water Guidelines 2011* (referred to as ADWG 2011)

[15] World Health Organisation (WHO), (2008). *Petroleum Products in Drinking-water, Background document for the development of WHO Guidelines for Drinking Water Quality* (referred to as WHO 2008)

[16] Australian and New Zealand Governments (ANZG), (2018). *Australian and New Zealand Guidelines for Fresh and Marine Water Quality.* Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia (referred to as ANZG 2018)

7 RESULTS

7.1 Summary of Data (QA/QC) Evaluation

The data evaluation is presented in the appendices. In summary, JKE are of the opinion that the data are adequately precise, accurate, representative, comparable and complete to serve as a basis for interpretation to achieve the investigation objectives.

7.2 Subsurface Conditions

A summary of the subsurface conditions encountered during the investigation is presented in the following table. Reference should be made to the borehole logs attached in the appendices for further details.

Table 7-1: Summary of Subsurface Conditions

Profile	Description
Pavement	Asphaltic Concrete (AC) pavement was encountered at the surface in BH4, BH5, BH15 and BH17 and ranged in thickness between 30mm and 40mm.
Fill	Fill was encountered at the surface or beneath the pavement in all boreholes and extended to depths of approximately 0.1mBGL to 1.7mBGL. BH14 and BH20 were terminated in the fill at a maximum depth of approximately 1.5mBGL. The fill typically comprised silty clayey sand, silty clay, silty sandy clay, silty sand and sandy silt with inclusions of igneous, ironstone and sandstone gravel, concrete fragments, ash, brick fragments, root fibres, slag and sand. Neither staining nor odours were encountered in the fill material during the fieldwork. No ACM was encountered in the fill material during the fieldwork.
Natural Soil	With the exception of BH4, BH5, BH8, BH11, BH14, BH15, BH17, and BH20, natural silty clay, silty sandy clay, and sandy clay residual soil was encountered beneath the fill in all boreholes and extended to depths of between approximately 0.3mBGL and 2.8mBGL. Neither staining nor odours were encountered in the natural soils during the fieldwork.
Bedrock	Sandstone bedrock was encountered beneath the fill or natural soils in BH1, BH4 to BH6, BH7, BH8, BH11 to BH13, BH15, BH17, BH21 and BH22 at depths of between approximately 0.15mBGL to 2.9m BGL.
Groundwater	Groundwater seepage was encountered in boreholes BH18 and BH21 at depths of between 1.0mBGL and 3.3mBGL respectively at the completion of drilling. All other boreholes remained dry on completion of drilling and a short time after.

7.3 Field Screening

A summary of the field screening results is presented in the following table:

Table 7-2: Summary of Field Screening

Aspect	Details
PID Screening of Soil Samples for VOCs	PID soil sample headspace readings are presented in attached report tables and the COC documents attached in the appendices. The results ranged from 0ppm to 0.7ppm equivalent isobutylene. These results indicate slight PID detectable VOCs.

Aspect	Details
Bulk Screening for Asbestos	The bulk field screening results are summarised in the attached report tables. No visible ACM was encountered during the bulk sampling. All results were below the SAC.
Groundwater Depth & Flow	Groundwater seepage was encountered in boreholes BH18 and BH20 during drilling at depths of approximately 1.0mBGL and 3.3mBGL. The remaining boreholes were dry during and a short time after completion of drilling. SWLs measured in the monitoring wells installed at the site ranged from 1.64mBGL to 2.32mBGL. Groundwater RLs calculated on these measurements ranged from approximately RL 19.5m to RL 20m. The groundwater RLs indicate that excavation for the proposed basement may intercept groundwater.
Groundwater Field Parameters	Field measurements recorded during sampling were as follows: - pH ranged from 5.84 to 6.78; - EC ranged from 11,533µS/cm to 12,129µS/cm; - Eh ranged from 57.7mV to 142.3mV; and - DO was 1.1mg/L in both wells. PID readings in the monitoring wells were low ranging from 0.1ppm to 5.7ppm.
LNAPLs petroleum hydrocarbons	Phase separated product (i.e. LNAPL) were not detected using the interphase probe during groundwater sampling.

7.4 Soil Laboratory Results

The soil laboratory results are compared to the relevant SAC in the attached report tables. A summary of the results assessed against the SAC is presented below:

7.4.1 Human Health and Environmental (Ecological) Assessment

Table 7-3: Summary of Soil Laboratory Results – Human Health and Environmental (Ecological)

Analyte	Results Compared to SAC
Heavy Metals	All heavy metals results were below the SAC.
TRH	All TRH results were below the SAC.
BTEX	All BTEX results were below the SAC.
PAHs	All PAH results were below the SAC.
OCPs and OPPs	All OCP and OPP results were below the SAC. All pesticide concentrations were below the laboratory PQLs.
PCBs	All PCB results were below the SAC. All PCB concentrations were below the laboratory PQLs.
Asbestos	All asbestos results were below the SAC (i.e. asbestos was absent in the samples analysed for the investigation).

7.4.2 Waste Classification Assessment

The laboratory results were assessed against the criteria presented in Part 1 of the Waste Classification Guidelines, as summarised previously in this report. The results are presented in the report tables attached in the appendices. A summary of the results is presented in the following table:

Table 7-4: Summary of Soil Laboratory Results Compared to CT and SCC Criteria

Analyte	No. of Samples Analysed	No. of Results > CT Criteria	No. of Results > SCC Criteria	Comments
Heavy Metals	30	0	0	-
TRH	30	0	0	-
BTEX	30	0	0	-
Total PAHs	30	0	0	-
Benzo(a)pyrene	30	0	0	-
OCPs & OPPs	30	0	0	-
PCBs	30	0	0	-
Asbestos	24	-	-	Asbestos was not detected in the samples analysed.

7.5 Groundwater Laboratory Results

The groundwater laboratory results are compared to the relevant SAC in the attached report tables. A summary of the results assessed against the SAC is presented in the following table:

Table 7-5: Summary of Groundwater Laboratory Results – Human Health and Environmental (Ecological)

Analyte	Results Compared to SAC
Heavy Metals	The reported cadmium concentration of 0.3µg/L in MW21 was above the fresh water GIL SAC of 0.2µg/L. The duplicate sample WDUP1 also reported an elevated concentration of cadmium of 0.3µg/L. The reported nickel concentration of 19µg/L in MW21 was above the fresh water GIL SAC of of 11µg/L. The duplicate sample WDUP1 also reported an elevated concentration of nickel of 19µg/L. The reported zinc concentration of 17µg/L and 9µg/L in MW12 and MW21 respectively were above the fresh water GIL SAC of 8µg/L. The duplicate samples WDUP1 and WDUP2 also reported elevated concentrations of zinc of 9µg/L and 22µg/L respectively. All other heavy metals results were below the SAC.
TRH	All TRH results were below the PQLs and the SAC.
BTEX	All BTEX results were below the PQLs and the SAC.
PAHs	All PAH results were below the PQLs and the SAC.

Analyte	Results Compared to SAC
Other Parameters	The results for pH and EC are summarised below: • pH ranged from 6 to 7. The pH of 6 is outside the acceptable GIL range for fresh water; and • EC ranged from 11,000µS/cm to 12,000µS/cm.

8 WASTE CLASSIFICATION ASSESSMENT

8.1 Waste Classification of Fill

Based on the results of the assessment, and at the time of reporting, the fill material is classified as **General Solid Waste (non-putrescible)**. An inspection should occur following demolition to confirm that the demolition has not impacted this classification and to confirm that the soils in the building footprints are consistent with expectations.

Surplus fill should be disposed of to a facility that is appropriately licensed to receive this waste stream. The facility should be contacted to obtain the required approvals prior to commencement of excavation.

It should be noted that due to the limited anthropogenic inclusions encountered in the fill material, it could be beneficial to consider undertaking an excavated natural material (ENM) assessment of this material during or prior to development. This may result in significant cost savings if the fill material can be beneficially re-used.

8.2 Classification of Natural Soil and Bedrock

Based on the scope of work undertaken for this assessment, and at the time of reporting, JKE are of the opinion that the natural soil and bedrock at the site meets the definition of **VENM** for off-site disposal or re-use purposes. VENM is considered suitable for re-use on-site (from a contamination viewpoint), or alternatively, the information included in this report may be used to assess whether the material is suitable for beneficial reuse at another site as fill material.

In accordance with Part 1 of the Waste Classification Guidelines, the VENM is pre-classified as general solid waste and can also be disposed of accordingly to a facility that is licensed to accept it.

9 DISCUSSION

9.1 Tier 1 Risk Assessment and Review of CSM

For a contaminant to represent a risk to a receptor, the following three conditions must be present:

1. Source – The presence of a contaminant;
2. Pathway – A mechanism or action by which a receptor can become exposed to the contaminant; and
3. Receptor – The human or ecological entity which may be adversely impacted following exposure to contamination.

If one of the above components is missing, the potential for adverse risks is relatively low.

9.1.1 Soil

Elevated concentrations of the CoPC were not encountered above the adopted SAC in any of the soil samples analysed. On this basis there has been no confirmed source of contamination and no complete SPR linkage.

No asbestos containing materials were encountered in the fill material at the site during the field work. No asbestos was detected in any of the soil samples analysed. Sampling was completed from boreholes using auger drilling methods which limits the disturbance of the soil. Based on the findings of the assessment, JKE considers there to be a low risk from asbestos in the context of the current and proposed development.

9.1.2 Groundwater

Cadmium, nickel and zinc were encountered in groundwater above the ecological SAC. The source of these heavy metals is likely to be a regional issue for the following reasons:

- The ADWG-2018 show that passive leaching from copper or stainless steel (chromium-nickel) pipework can contribute to the regional aquifers, thus elevated heavy metals, especially nickel and zinc are common in groundwater; and
- Elevated heavy metals concentrations were not encountered in the fill soil at the site, therefore fill/soil on site is not considered to be a point source for heavy metal impacts.

The pH of the sample from MW12 was outside the range generally acceptable for discharge to stormwater (pH of 6.5 and 8.5). It should be noted that pH is a parameter that can fluctuate depending on site conditions and activities such as excavation.

JKE recommend that, as it is possible that groundwater may need to be extracted for construction dewatering, extracted groundwater should be held in a settlement tank prior to discharge so that the pH can be measured. If required, the pH can be adjusted by passing the extracted water through a dosing unit. The metals in the groundwater will also require treatment (e.g. possibly via addition of flocculant) prior to disposal. Additional sampling and analysis is likely to be required to support any future application for a temporary construction dewatering application (refer to JKE report E32932PTrpt3, dated 30 March 2020, attached in Appendix C).

9.1.3 General

Hazardous building materials in the existing structure at the site has not been assessed. The buildings and structures at the site are of an age indicative of containing hazardous building materials. An intrusive hazardous building materials assessment should be undertaken of all buildings and structures prior to demolition to reduce any associated risk of contaminating the site during demolition.

9.2 Decision Statements

The decision statements are addressed below:

Are any results above the SAC?

Yes, cadmium, nickel and zinc in groundwater were above the fresh water GILs, and pH in one sample was outside the fresh water GIL range.

Do potential risks associated with contamination exist, and if so, what are they?

JKE are of the opinion that potential risks associated with contamination at the site is low. Due to the presence of uncontrolled fill, the likelihood of asbestos being present is possible, however the data collected during the investigation suggests that significant and widespread issues are unlikely to be encountered. Any residual risk can be easily managed via the implementation of an unexpected finds protocol.

The metals in groundwater are likely associated with regional factors and are not considered to pose a risk. However, management of the groundwater will be required during construction/excavation in regards to dewatering.

Is remediation required?

Further investigation and/or remediation is not considered to be required. Potential risks associated with the unidentified occurrence of asbestos or other sources of contamination can be addressed via the implementation of an unexpected finds protocol and, if required, appropriate management during the development works.

Is the site characterisation sufficient to provide adequate confidence in the above decisions?

The site characterisation is considered to be sufficient to provide adequate confidence in the above decisions.

Is the site suitable for the proposed development, or can the site be made suitable subject to further characterisation and/or remediation?

JKE are of the opinion that the area of investigation is suitable for the proposed development outlined in Section 1.1. An unexpected finds protocol (outlined in Section 9.3) is to be implemented during the proposed development works.

9.3 Unexpected Finds Protocol

As part of the implementation of this protocol, a suitably qualified contaminated land consultant[17] should be engaged to inspect the site following the initial demolition works (i.e. after demolition of buildings and removal of pavements etc.). A letter should be prepared to document the findings of the inspection(s) and provide further commentary on contamination and any unexpected finds.

Unexpected finds would typically be able to be identified by visual or olfactory indicators and could include:

- Waste materials in fill, including building and demolition waste such as fibre cement or paint chips;
- Fibre cement fragments (e.g. ACM);
- Stained fill/soil;
- Odorous soils (e.g. hydrocarbon odours); and/or
- Distinct layers or areas of slag and/or coal wash.

The following should be implemented in the event of an unexpected find:

- All work in the immediate vicinity should cease, and the contaminated land consultant (who was engaged to complete the initial inspections) should be contacted immediately to inspect and document the find;
- Temporary barricades should be erected to isolate the area;
- The consultant should develop and implement a strategy to assess the issue and provide guidance on the appropriate course of action; and
- Any actions should be implemented and validated to demonstrate that there are no unacceptable risks to the receptors.

9.4 Data Gaps

An assessment of data gaps is provided in the following table:

Table 9-1: Data Gap Assessment

Data Gap	Assessment
Areas beneath the existing building footprint have not been assessed	Sampling beneath the existing building was not undertaken due to accessibility constraints. Based on the site history and the results reported, the potential for contamination to pose a risk to the receptors in this area of the site is considered to be low. Additional investigation work to address this data gap is not recommended. An inspection of the building footprints is recommended as part of the unexpected finds protocol (and waste classification).
Hazardous building materials in existing site structure	The existing site building is of an age indicative of housing hazardous building materials (i.e. asbestos fibre cement). Recommendations are included in Section 10 to address this data gap via completion of a hazardous building materials survey.

[17] JKE recommend that the consultancy engaged for the work be a member of the Australian Contaminated Land Consultants Associated (ACLCA), and/or the individual undertaking the works be certified under one of the NSW EPA endorsed certified practitioner schemes

10 CONCLUSIONS AND RECOMMENDATIONS

The DSI included a review of the PSI findings, soil sampling from 24 boreholes and groundwater sampling from two monitoring wells. Fill material was encountered to depths of between 0.1mBGL to 1.7mBGL and typically comprised silty clayey sand, silty clay, silty sandy clay, silty sand and sandy silt with inclusions of igneous, ironstone and sandstone gravel, concrete fragments, ash, brick fragments, root fibres, slag and sand. The fill was underlain by natural residual clay soils or sandstone bedrock. A selection of soil and groundwater samples were analysed for the CoPC identified in the CSM.

Elevated concentrations of contaminants above the SAC were not identified in the soil samples during the investigation. Elevated cadmium, nickel and zinc was encountered in groundwater, however is considered to be a regional issue and not pose a risk to receptors. Further investigation and/or remediation is not considered to be required.

Based on the findings of the assessment, JKE are of the opinion that the site is suitable for the proposed development described in Section 1.1.

An unexpected finds protocol is included in Section 9.3 of this report to manage any unexpected finds during the development.

JKE recommend a hazardous building materials survey is undertaken of the existing site structure prior to demolition.

JKE consider that the report objectives outlined in Section 1.2 have been addressed.

11 LIMITATIONS

The report limitations are outlined below:

- JKE accepts no responsibility for any unidentified contamination issues at the site. Any unexpected problems/subsurface features that may be encountered during development works should be inspected by an environmental consultant as soon as possible;
- Previous use of this site may have involved excavation for the foundations of buildings, services, and similar facilities. In addition, unrecorded excavation and burial of material may have occurred on the site. Backfilling of excavations could have been undertaken with potentially contaminated material that may be discovered in discrete, isolated locations across the site during construction work;
- This report has been prepared based on site conditions which existed at the time of the investigation; scope of work and limitation outlined in the JKE proposal; and terms of contract between JKE and the client (as applicable);
- The conclusions presented in this report are based on investigation of conditions at specific locations, chosen to be as representative as possible under the given circumstances, visual observations of the site and immediate surrounds and documents reviewed as described in the report;
- Subsurface soil and rock conditions encountered between investigation locations may be found to be different from those expected. Groundwater conditions may also vary, especially after climatic changes;
- The investigation and preparation of this report have been undertaken in accordance with accepted practice for environmental consultants, with reference to applicable environmental regulatory authority and industry standards, guidelines and the assessment criteria outlined in the report;
- Where information has been provided by third parties, JKE has not undertaken any verification process, except where specifically stated in the report;
- JKE has not undertaken any assessment of off-site areas that may be potential contamination sources or may have been impacted by site contamination, except where specifically stated in the report;
- JKE accept no responsibility for potentially asbestos containing materials that may exist at the site. These materials may be associated with demolition of pre-1990 constructed buildings or fill material at the site;
- JKE have not and will not make any determination regarding finances associated with the site;
- Additional investigation work may be required in the event of changes to the proposed development or landuse. JKE should be contacted immediately in such circumstances;
- Material considered to be suitable from a geotechnical point of view may be unsatisfactory from a soil contamination viewpoint, and vice versa; and
- This report has been prepared for the particular project described and no responsibility is accepted for the use of any part of this report in any other context or for any other purpose.

Important Information About This Report

These notes have been prepared by JKE to assist with the assessment and interpretation of this report.

The Report is based on a Unique Set of Project Specific Factors

This report has been prepared in response to specific project requirements as stated in the JKE proposal document which may have been limited by instructions from the client. This report should be reviewed, and if necessary, revised if any of the following occur:

- The proposed land use is altered;
- The defined subject site is increased or sub-divided;
- The proposed development details including size, configuration, location, orientation of the structures or landscaped areas are modified;
- The proposed development levels are altered, eg addition of basement levels; or
- Ownership of the site changes.

JKE will not accept any responsibility whatsoever for situations where one or more of the above factors have changed since completion of the assessment. If the subject site is sold, ownership of the assessment report should be transferred by JKE to the new site owners who will be informed of the conditions and limitations under which the assessment was undertaken. No person should apply an assessment for any purpose other than that originally intended without first conferring with the consultant.

Changes in Subsurface Conditions

Subsurface conditions are influenced by natural geological and hydrogeological process and human activities. Groundwater conditions are likely to vary over time with changes in climatic conditions and human activities within the catchment (e.g. water extraction for irrigation or industrial uses, subsurface waste water disposal, construction related dewatering). Soil and groundwater contaminant concentrations may also vary over time through contaminant migration, natural attenuation of organic contaminants, ongoing contaminating activities and placement or removal of fill material. The conclusions of an assessment report may have been affected by the above factors if a significant period of time has elapsed prior to commencement of the proposed development.

This Report is based on Professional Interpretations of Factual Data

Site assessments identify actual subsurface conditions at the actual sampling locations at the time of the investigation. Data obtained from the sampling and subsequent laboratory analyses, available site history information and published regional information is interpreted by geologists, engineers or environmental scientists and opinions are drawn about the overall subsurface conditions, the nature and extent of contamination, the likely impact on the proposed development and appropriate remediation measures.

Actual conditions may differ from those inferred, because no professional, no matter how qualified, and no subsurface exploration program, no matter how comprehensive, can reveal what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than an assessment indicates. Actual conditions in areas not sampled may differ from predictions. Nothing can be done to prevent the unanticipated, but steps can be taken to help minimise the impact. For this reason, site owners should retain the services of their consultants throughout the development stage of the project, to identify variances, conduct additional tests which may be needed, and to recommend solutions to problems encountered on site.

Assessment Limitations

Although information provided by a site assessment can reduce exposure to the risk of the presence of contamination, no environmental site assessment can eliminate the risk. Even a rigorous professional assessment may not detect all contamination on a site. Contaminants may be present in areas that were not surveyed or sampled, or may migrate to areas which showed no signs of contamination when sampled. Contaminant analysis cannot possibly cover every type of contaminant which may occur; only the most likely contaminants are screened.

Misinterpretation of Site Assessments by Design Professionals
Costly problems can occur when other design professionals develop plans based on misinterpretation of an assessment report. To minimise problems associated with misinterpretations, the environmental consultant should be retained to work with appropriate professionals to explain relevant findings and to review the adequacy of plans and specifications relevant to contamination issues.

Logs Should not be Separated from the Assessment Report
Borehole and test pit logs are prepared by environmental scientists, engineers or geologists based upon interpretation of field conditions and laboratory evaluation of field samples. Logs are normally provided in our reports and these should not be re-drawn for inclusion in site remediation or other design drawings, as subtle but significant drafting errors or omissions may occur in the transfer process. Photographic reproduction can eliminate this problem, however contractors can still misinterpret the logs during bid preparation if separated from the text of the assessment. If this occurs, delays, disputes and unanticipated costs may result. In all cases it is necessary to refer to the rest of the report to obtain a proper understanding of the assessment. Please note that logs with the 'Environmental Log' header are not suitable for geotechnical purposes as they have not been peer reviewed by a Senior Geotechnical Engineer.

To reduce the likelihood of borehole and test pit log misinterpretation, the complete assessment should be available to persons or organisations involved in the project, such as contractors, for their use. Denial of such access and disclaiming responsibility for the accuracy of subsurface information does not insulate an owner from the attendant liability. It is critical that the site owner provides all available site information to persons and organisations such as contractors.

Read Responsibility Clauses Closely
Because an environmental site assessment is based extensively on judgement and opinion, it is necessarily less exact than other disciplines. This situation has resulted in wholly unwarranted claims being lodged against consultants. To help prevent this problem, model clauses have been developed for use in written transmittals. These are definitive clauses designed to indicate consultant responsibility. Their use helps all parties involved recognise individual responsibilities and formulate appropriate action. Some of these definitive clauses are likely to appear in the environmental site assessment, and you are encouraged to read them closely. Your consultant will be pleased to give full and frank answers to any questions.

Appendix A: Report Figures

Appendix B: Laboratory Results Summary Tables

Appendix C: Preliminary Groundwater Quality Screening – Temporary Dewatering Report

Appendix D: Borehole Logs

Appendix E: Laboratory Reports & COC Documents

Appendix F: Report Explanatory Notes

Standard Sampling Procedure

These protocols specify the basic procedures to be used when sampling soils or groundwater for environmental site assessments undertaken by JKE. The purpose of these protocols is to provide standard methods for: sampling, decontamination procedures for sampling equipment, sample preservation, sample storage and sample handling. Deviations from these procedures must be recorded.

A. Soil Sampling

- Prepare a borehole/test pit log or made a note of the sample description for stockpiles.
- Layout sampling equipment on clean plastic sheeting to prevent direct contact with ground surface. The work area should be at a distance from the drill rig/excavator such that the machine can operate in a safe manner.
- Ensure all sampling equipment has been decontaminated prior to use.
- Remove any surface debris from the immediate area of the sampling location.
- Collect samples and place in glass jar with a Teflon seal. This should be undertaken as quickly as possible to prevent the loss of any volatiles. If possible, fill the glass jars completely.
- Collect samples for asbestos analysis and place in a zip-lock plastic bag.
- Label the sampling containers with the JKE job number, sample location (eg. BH1), sampling depth interval and date. If more than one sample container is used, this should also be indicated (eg. 2 = Sample jar 1 of 2 jars).
- Photoionisation detector (PID) screening of volatile organic compounds (VOCs) should be undertaken on samples using the soil sample headspace method. Headspace measurements are taken following equilibration of the headspace gasses in partly filled zip-lock plastic bags. PID headspace data is recorded on the borehole/test pit log and the chain of custody forms.
- Record the lithology of the sample and sample depth on the borehole/test pit log generally in accordance with AS1726-2017[18].
- Store the sample in a sample container cooled with ice or chill packs. On completion of the sampling the sample container should be delivered to the lab immediately or stored in the refrigerator prior to delivery to the lab. All samples are preserved in accordance with the standards outlined in the report.
- Check for the presence of groundwater after completion of each borehole using an electronic dip metre or water whistle. Boreholes should be left open until the end of fieldwork where it is safe to do so. All groundwater levels in the boreholes should be rechecked on the completion of the fieldwork.
- Backfill the boreholes/test pits with the excavation cuttings or clean sand prior to leaving the site.

B. Decontamination Procedures for Soil Sampling Equipment

- All sampling equipment should be decontaminated between every sampling location. This excludes single use PVC tubing used for push tubes etc. Equipment and materials required for the decontamination include:
  - Phosphate free detergent (Decon 90);
  - Potable water;
  - Stiff brushes; and
  - Plastic sheets.
- Ensure the decontamination materials are clean prior to proceeding with the decontamination.
- Fill both buckets with clean potable water and add phosphate free detergent to one bucket.
- In the bucket containing the detergent, scrub the sampling equipment until all the material attached to the equipment has been removed.
- Rinse sampling equipment in the bucket containing potable water.
- Place cleaned equipment on clean plastic sheets.

[18] Standards Australia, (2017), *Geotechnical Site Investigations.* (AS1726-2017)

If all materials are not removed by this procedure, high-pressure water cleaning is recommended. If any equipment is not completely decontaminated by both these processes, then the equipment should not be used until it has been thoroughly cleaned.

C. **Groundwater Sampling**

Groundwater samples are more sensitive to contamination than soil samples and therefore adhesion to this protocol is particularly important to obtain reliable, reproducible results. The recommendations detailed in AS/NZS 5667.1:1998 are considered to form a minimum standard.

The basis of this protocol is to maintain the security of the borehole and obtain accurate and representative groundwater samples. The following procedure should be used for collection of groundwater samples from previously installed groundwater monitoring wells.

- After monitoring well installation, at least three bore volumes should be pumped from the monitoring wells (well development) to remove any water introduced during the drilling process and/or the water that is disturbed during installation of the monitoring well. This should be completed prior to purging and sampling.
- Groundwater monitoring wells should then be left to recharge for at least three days before purging and sampling. Prior to purging or sampling, the condition of each well should observed and any anomalies recorded on the field data sheets. The following information should be noted: the condition of the well, noting any signs of damage, tampering or complete destruction; the condition and operation of the well lock; the condition of the protective casing and the cement footing (raised or cracked); and, the presence of water between protective casing and well.
- Measure the groundwater level from the collar of the piezometer/monitoring well using an electronic dip meter. The collar level should be taken (if required) during the site visit using a dumpy level and staff.
- Purging and sampling of piezometers/monitoring wells is done on the same site visit when using micro-purge (or other low flow) techniques.
- Layout and organize all equipment associated with groundwater sampling in a location where they will not interfere with the sampling procedure and will not pose a risk of contaminating samples. Equipment generally required includes:
  - Stericup single-use filters (for heavy metals samples);
  - Bucket with volume increments;
  - Sample containers: teflon bottles with 1 ml nitric acid, 75mL glass vials with 1 mL hydrochloric acid, 1 L amber glass bottles;
  - Bucket with volume increments;
  - Flow cell;
  - pH/EC/Eh/Temperature meters;
  - Plastic drums used for transportation of purged water;
  - Esky and ice;
  - Nitrile gloves;
  - Distilled water (for cleaning);
  - Electronic dip meter;
  - Low flow peristaltic pump and associated tubing; and
  - Groundwater sampling forms.
- Ensure all non-disposable sampling equipment is decontaminated or that new disposable equipment is available prior to any work commencing at a new location. The procedure for decontamination of groundwater equipment is outlined at the end of this section.
- Disposable gloves should be used whenever samples are taken to protect the sampler and to assist in avoidance of contamination.
- Groundwater samples are obtained from the monitoring wells using low flow sampling equipment to reduce the disturbance of the water column and loss of volatiles.

- During pumping to purge the well, the pH, temperature, conductivity, dissolved oxygen, redox potential and groundwater levels are monitored (where possible) using calibrated field instruments to assess the development of steady state conditions. Steady state conditions are generally considered to have been achieved when the difference in the pH measurements is less than 0.2 units, the difference in conductivity is less than 10% and whilst the well is no longer in draw-down.
- All measurements are recorded on specific data sheets.
- Once steady state conditions are considered to have been achieved, groundwater samples are obtained directly from the pump tubing and placed in appropriate glass bottles, BTEX vials or plastic bottles.
- All samples are preserved in accordance with water sampling requirements specified by the laboratory and placed in an insulated container with ice. Groundwater samples are preserved by immediate storage in an insulated sample container with ice.
- At the end of each water sampling complete a chain of custody form for samples being sent to the laboratory.

D. <u>Decontamination Procedures for Groundwater Sampling Equipment</u>

- All equipment associated with the groundwater sampling procedure (other than single-use items) are decontaminated between every sampling location.
- The following equipment and materials are required for the decontamination procedure:
  - Phosphate free detergent;
  - Potable water;
  - Distilled water; and
  - Plastic Sheets or bulk bags (plastic bags).
- Fill one bucket with clean potable water and phosphate free detergent, and one bucket with distilled water.
- Flush potable water and detergent through pump head. Wash sampling equipment and pump head using brushes in the bucket containing detergent until all materials attached to the equipment are removed.
- Flush pump head with distilled water.
- Change water and detergent solution after each sampling location.
- Rinse sampling equipment in the bucket containing distilled water.
- Place cleaned equipment on clean plastic sheets.
- If all materials are not removed by this procedure that equipment should not be used until it has been thoroughly cleaned

QA/QC Definitions

The QA/QC terms used in this report are defined below. The definitions are in accordance with US EPA publication SW-846, entitled *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* (1994)[19] methods and those described in *Environmental Sampling and Analysis, A Practical Guide,* (1991)[20]. The NEPM (2013) is consistent with these documents.

A. Practical Quantitation Limit (PQL), Limit of Reporting (LOR) & Estimated Quantitation Limit (EQL)

These terms all refer to the concentration above which results can be expressed with a minimum 95% confidence level. The laboratory reporting limits are generally set at ten times the standard deviation for the Method Detection Limit for each specific analyte. For the purposes of this report the LOR, PQL, and EQL are considered to be equivalent.

When assessing laboratory data it should be borne in mind that values at or near the PQL have two important limitations: *"The uncertainty of the measurement value can approach, and even equal, the reported value. Secondly, confirmation of the analytes reported is virtually impossible unless identification uses highly selective methods. These issues diminish when reliably measurable amounts of analytes are present. Accordingly, legal and regulatory actions should be limited to data at or above the reliable detection limit*" (Keith, 1991).

B. Precision

The degree to which data generated from repeated measurements differ from one another due to random errors. Precision is measured using the standard deviation or Relative Percent Difference (RPD).

C. Accuracy

Accuracy is a measure of the agreement between an experimental result and the true value of the parameter being measured (i.e. the proximity of an averaged result to the true value, where all random errors have been statistically removed). The assessment of accuracy for an analysis can be achieved through the analysis of known reference materials or assessed by the analysis of surrogates, field blanks, trip spikes and matrix spikes. Accuracy is typically reported as percent recovery.

D. Representativeness

Representativeness expresses the degree to which sample data accurately and precisely represents a characteristic of a population, parameter variations at a sampling point, or an environmental condition. Representativeness is primarily dependent upon the design and implementation of the sampling program. Representativeness of the data is partially ensured by the avoidance of contamination, adherence to sample handing and analysis protocols and use of proper chain-of-custody and documentation procedures.

E. Completeness

Completeness is a measure of the number of valid measurements in a data set compared to the total number of measurements made and overall performance against DQIs. The following information is assessed for completeness:

- Chain-of-custody forms;
- Sample receipt form;
- All sample results reported;
- All blank data reported;

[19] US EPA, (1994). *SW-846: Test Methods for Evaluating Solid Waste, Physical/Chemical Methods.* (US EPA SW-846)

[20] Keith., H, (1991). *Environmental Sampling and Analysis, A Practical Guide*

- All laboratory duplicate and RPDs calculated;
- All surrogate spike data reported;
- All matrix spike and lab control spike (LCS) data reported and RPDs calculated;
- Spike recovery acceptable limits reported; and
- NATA stamp on reports.

F. <u>Comparability</u>

Comparability is the evaluation of the similarity of conditions (e.g. sample depth, sample homogeneity) under which separate sets of data are produced. Data comparability checks include a bias assessment that may arise from the following sources:

- Collection and analysis of samples by different personnel; Use of different techniques;
- Collection and analysis by the same personnel using the same methods but at different times; and
- Spatial and temporal changes (due to environmental dynamics).

G. <u>Blanks</u>

The purpose of laboratory and field blanks is to check for artefacts and interferences that may arise during sampling, transport and analysis.

H. <u>Matrix Spikes</u>

Samples are spiked with laboratory grade standards to detect interactive effects between the sample matrix and the analytes being measured. Matrix Spikes are reported as a percent recovery and are prepared for 1 in every 20 samples. Sample batches that contain less than 20 samples may be reported with a Matrix Spike from another batch. The percent recovery is calculated using the formula below. Acceptable recovery limits are 70% to 130%.

$$\frac{(\text{Spike Sample Result} - \text{Sample Result}) \times 100}{\text{Concentration of Spike Added}}$$

I. <u>Surrogate Spikes</u>

Samples are spiked with a known concentration of compounds that are chemically related to the analyte being investigated but unlikely to be detected in the environment. The purpose of the Surrogate Spikes is to check the accuracy of the analytical technique. Surrogate Spikes are reported as percent recovery.

J. <u>Duplicates</u>

Laboratory duplicates measure precision, expressed as Relative Percent Difference. Duplicates are prepared from a single field sample and analysed as two separate extraction procedures in the laboratory. The RPD is calculated using the formula where D1 is the sample concentration and D2 is the duplicate sample concentration:

$$\frac{(D1 - D2) \times 100}{\{(D1 + D2)/2\}}$$

Appendix G: Data (QA/QC) Evaluation

Data (QA/QC) Evaluation

A. INTRODUCTION

This Data (QA/QC) Evaluation forms part of the validation process for the DQOs documented in Section 5.1 of this report. Checks were made to assess the data in terms of precision, accuracy, representativeness, comparability and completeness. These 'PARCC' parameters are referred to collectively as DQIs and are defined in the Report Explanatory Notes attached in the report appendices.

1. Field and Laboratory Considerations

The quality of the analytical data produced for this project has been considered in relation to the following:

- Sample collection, storage, transport and analysis;
- Laboratory PQLs;
- Field QA/QC results; and
- Laboratory QA/QC results.

2. Field QA/QC Samples and Analysis

A summary of the field QA/QC samples collected and analysed for this assessment is provided in the following table:

Sample Type	Sample Identification	Frequency (of Sample Type)	Analysis Performed
Intra-laboratory duplicate (soil)	SDUP1 (primary sample BH12 0-0.3m)	Approximately 6.6% of primary samples	Heavy metals, TRH/BTEX, and PAHs
Intra-laboratory duplicate (soil)	SDUP2 (primary sample BH6 0-0.3m)		
Inter-laboratory duplicate (soil)	SDUP3 (primary sample BH8 0-0.2m)	Approximately 3.3% of primary samples	Heavy metals, TRH/BTEX, PAHs
Intra-laboratory duplicate (water)	WDUP1 (primary sample MW21)	Approximately 50% of primary samples	Heavy metals, TRH/BTEX, PAHs
Inter-laboratory duplicate (water)	WDUP2 (primary sample MW12)	Approximately 50% of primary samples	Heavy metals, TRH/BTEX, PAHs
Trip spike (soil)	TS-S1 (25 February 2020)	One for the investigation to demonstrate adequacy of preservation, storage and transport methods	BTEX
Trip blank (soil)	TB-S1 (25 February 2020)	One for the investigation to demonstrate adequacy of storage and transport methods	BTEX

Sample Type	Sample Identification	Frequency (of Sample Type)	Analysis Performed
Trip spike (water)	TS-W1 (2 March 2020)	One for the investigation to demonstrate adequacy of preservation, storage and transport methods	BTEX
Trip blank (water)	TB-W1 (2 March 2020)	One for the investigation to demonstrate adequacy of storage and transport methods	BTEX
Rinsate (soil hand auger)	FR-S1HA (25 February 2020)	One for the investigation to demonstrate adequacy of decontamination methods	Heavy metals, TRH/BTEX, PAHs

The results for the field QA/QC samples are detailed in the laboratory summary tables (Table Q1 and Table Q2 inclusive) attached to the investigation report and are discussed in the subsequent sections of this Data (QA/QC) Evaluation report.

3. <u>Data Assessment Criteria</u>

JKE adopted the following criteria for assessing the field and laboratory QA/QC analytical results:

Field Duplicates

Acceptable targets for precision of field duplicates in this report will be 30% or less, consistent with NEPM (2013). RPD failures will be considered qualitatively on a case-by-case basis taking into account factors such as the concentrations used to calculate the RPD (i.e. RPD exceedance where concentrations are close to the PQL are typically not as significant as those where concentrations are reported at least five or 10 times the PQL), sample type, collection methods and the specific analyte where the RPD exceedance was reported.

Field/Trip Blanks and Rinsates

Acceptable targets for field blank and rinsate samples in this report will be less than the PQL for organic analytes. Metals will be considered on a case-by-case basis with regards to typical background concentrations in soils and published drinking water guidelines for waters.

Trip Spikes

Acceptable targets for trip spike samples in this report will be 70% to 130%.

Laboratory QA/QC

The suitability of the laboratory data is assessed against the laboratory QA/QC criteria which is outlined in the laboratory reports. These criteria were developed and implemented in accordance with the laboratory's NATA accreditation and align with the acceptable limits for QA/QC samples as outlined in NEPM (2013) and other relevant guidelines.

A summary of the acceptable limits adopted by the primary laboratory (Envirolab) is provided below:

RPDs

- Results that are <5 times the PQL, any RPD is acceptable; and

- Results >5 times the PQL, RPDs between 0-50% are acceptable.

Laboratory Control Samples (LCS) and Matrix Spikes

- 70-130% recovery acceptable for metals and inorganics;
- 60-140% recovery acceptable for organics; and
- 10-140% recovery acceptable for VOCs.

Surrogate Spikes

- 60-140% recovery acceptable for general organics; and
- 10-140% recovery acceptable for VOCs.

Method Blanks

- All results less than PQL.

B. DATA EVALUATION

1. Sample Collection, Storage, Transport and Analysis

Samples were collected by trained field staff in accordance with the JKE SSP. The SSP was developed to be consistent with relevant guidelines, including NEPM (2013) and other guidelines made under the CLM Act 1997.

Appropriate sample preservation, handling and storage procedures were adopted. Laboratory analysis was undertaken within specified holding times generally in accordance with Schedule B(3) of NEPM (2013) and the laboratory NATA accredited methodologies. Envirolab noted that the asbestos results were reported to be consistent with the recommendations in NEPM (2013), however this level of reporting is outside the scope of their NATA accreditation. In the absence of other available analytical methods for asbestos, this was found to be acceptable for the purpose of this assessment.

JKE note that the temperature on receipt of soil samples was reported to be up to 16.2°C. JKE understand that the temperature is measured at the laboratory using an infrared temperature probe by scanning the outside of the sample container (i.e. one sample jar/container at the time of registering the samples). This procedure is not considered to be robust as there is a potential for the outside of the jar to warm to ambient temperature, or at least to increase from that of the internal contents, relatively quickly. On this basis, JKE are of the opinion that the temperatures reported on the Sample Receipts are unlikely to be reliable or representative of the overall batch. This is further supported by the trip spike recovery results (discussed further below) which reported adequate recovery in the range of 90% to 108%.

Whilst it could be argued that 10% loss of volatiles may have led to these contaminants being under-reported (i.e. the lower end of the trip spike recovery was 90%), it is noted that all BTEX results and volatile TRHs (F1 and F2) were below the PQLs and even a nominal 10% increase of TRH/BTEX concentrations in these samples would not result in exceedance of the SAC.

Review of the project data also indicated that:

- COC documentation was adequately maintained;
- Sample receipt advice documentation was provided for all sample batches;

- All analytical results were reported; and
- Consistent units were used to report the analysis results.

2. <u>Laboratory PQLs</u>

Appropriate PQLs were adopted for the analysis and all PQLs were below the SAC, with the exception of the anthracene PQL for groundwater analysis which was 10 times greater than the ecological SAC. In light of the PAH concentrations reported for soil and groundwater, JKE are of the opinion that this is not significant, and it does not affect the quality of the dataset as a whole or the outcome of the assessment.

3. <u>Field QA/QC Sample Results</u>

Field Duplicates

The results indicated that field precision was acceptable. RPD non-conformances were reported for some analytes as discussed below:

Soil Duplicates

- Elevated RPDs were reported for $TRH_{>C16-C34}$, chromium, copper, lead and zinc in SDUP1/BH12 (0-0.3m);
- Elevated RPDs were reported for chromium, copper, nickel and zinc in SDUP2/BH6 (0-0.3m); and
- Elevated RPDs were reported for arsenic, copper, and nickel in SDUP3/BH8 (0-0.2m).

As all primary and duplicate sample results were less than the SAC, the exceedances are not considered to have had an adverse impact on the data set as a whole.

Overall the soil duplicate frequency was marginally below 10% of primary samples, however it is not considered to have impacted on the precision of the data.

Water Duplicates

- Elevated RPDs were reported for copper in WDUP1/MW21; and
- Elevated RPDs were reported for arsenic in WDUP2/MW12.

These values outside the acceptable limits have been attributed to minimal differences in the reported concentration between the two samples and the fact that the results were close to the PQLs. As both the primary and duplicate sample results were less than the SAC, the exceedances are not considered to have had an adverse impact on the data set as a whole;

Field/Trip Blanks

During the investigation, one soil trip blank and one water trip blank were placed in the esky during sampling and transported back to the laboratory.

The soil trip blank analysis results were all less than the PQLs with the exception of chromium, lead and zinc with reported concentrations of 2mg/kg, 3mg/kg and 1mg/kg respectively. Low level metals concentrations are typical in washed sand which is utilised as blank material. In JKE's experience, the concentrations reported were consistent with background concentrations in a sand matrix and were not indicative of cross-contamination. On this basis, cross contamination between samples that may have significance for data validity did not occur.

The water trip blank analysis results were all less than the PQLs, therefore cross contamination between samples that may have significance for data validity did not occur.

Rinsates

With the exception of $TRH_{>C10-C16}$, all results were below the PQL. The detectable concentration of light fraction TRH is most likely attributed to the use of plastic containers and/or trihalomethanes. These compounds are breakdown products from the chlorination process and are common in potable water at the concentration reported (the Australian drinking water guideline for total trihalomethanes is 250µg/L).

Trip Spikes

The results ranged from 102% to 106% in the soil trip spike and 90% to 108% in the water trip spike. These results indicate that field preservation methods were appropriate.

4. Laboratory QA/QC

The analytical methods implemented by the laboratory were performed in accordance with their NATA accreditation and were consistent with Schedule B(3) of NEPM (2013). The frequency of data reported for the laboratory QA/QC (i.e. duplicates, spikes, blanks, LCS) was considered to be acceptable for the purpose of this assessment.

A review of the laboratory QA/QC data identified the following minor non-conformances:

Envirolab report 237693

- The positive result in the rinsate sample is due to a single peak with no hydrocarbon profile that is consistent with the use of plastic containers;
- The laboratory RPD acceptance criteria was exceeded for zinc in one sample. Therefore a triplicate result was issued;
- The laboratory RPD acceptance criteria was exceeded for copper, nickel and zinc in one sample. Therefore a triplicate result was issued; and
- The laboratory RPD acceptance criteria was exceeded for nickel in one sample. Therefore a triplicate result was issued.

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- Samples were out of the recommended holding time for pH analysis.

C. DATA QUALITY SUMMARY

JKE are of the opinion that the data are adequately precise, accurate, representative, comparable and complete to serve as a basis for interpretation to achieve the investigation objectives.

Non-conformances were reported for some field QA/QC samples and laboratory QA/QC analysis. These non-conformances were considered to be sporadic and minor, and were not considered to be indicative of systematic sampling or analytical errors. On this basis, these non-conformances are not considered to materially impact the report findings.

There was only one groundwater monitoring event undertaken for the assessment. On this basis there is some uncertainty around the representativeness of the groundwater data, particularly during different climatic conditions and after wet/dry periods. However, given the low contaminant concentrations reported, the site history and the surrounding land uses, this is not considered to alter the conclusions of the investigation.

Appendix H: Field Work Documents

Appendix I: Guidelines and Reference Documents

Australian and New Zealand Environment Conservation Council (ANZECC), (2000). Australian and New Zealand Guidelines for Fresh and Marine Water Quality

Canadian Council of Ministers of the Environment, (1999). Canadian soil quality guidelines for the protection of environmental and human health: Benzo(a)Pyrene (1997)

CRC Care, (2011). Technical Report No. 10 – Health screening levels for hydrocarbons in soil and groundwater Part 1: Technical development document

Contaminated Land Management Act 1997 (NSW)

Department of Land and Water Conservation, (1997). 1:25,000 Acid Sulfate Soil Risk Map Series

Managing Land Contamination, Planning Guidelines SEPP55 – Remediation of Land (1998)

National Health and Medical Research Council (NHMRC), (2018). National Water Quality Management Strategy, Australian Drinking Water Guidelines 2011

NSW Department of Environment and Conservation, (2007). Guidelines for the Assessment and Management of Groundwater Contamination

NSW EPA, (1995). Contaminated Sites Sampling Design Guidelines

NSW EPA, (2014). Waste Classification Guidelines - Part 1: Classifying Waste

NSW EPA, (2015). Guidelines on the Duty to Report Contamination under Section 60 of the CLM Act 1997

NSW EPA, (2017). Guidelines for the NSW Site Auditor Scheme, 3rd Edition

NSW Office of Environment and Heritage (OEH), (2011). Guidelines for Consultants Reporting on Contaminated Sites

National Environment Protection Council (NEPC), (2013). National Environmental Protection (Assessment of Site Contamination) Measure 1999 as amended (2013)

Olszowy, H., Torr, P., and Imray, P., (1995). Trace Element Concentrations in Soils from Rural and Urban Areas of Australia. Contaminated Sites Monograph Series No. 4. Department of Human Services and Health, Environment Protection Agency, and South Australian Health Commission

Protection of the Environment Operations Act 1997 (NSW)

State Environmental Planning Policy No.55 – Remediation of Land 1998 (NSW)

World Health Organisation (WHO), (2008). Petroleum Products in Drinking-water, Background document for the development of WHO Guidelines for Drinking Water Quality

Western Australia Department of Health, (2009). Guidelines for the Assessment, Remediation and Management of Asbestos-Contaminated Sites in Western Australia