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Stage 2 Detailed Site Investigation
Portion of Lot 1 in DP837179 (Lot 10 in DP1232584)
Meadowbank Education and Employment Precinct Schools Project

2 Rhodes Street, Meadowbank, NSW

Prepared for Woods Bagot

Report Number: 6179-ER-1-2 REV6
Report date: 11 October 2019

We give you the right information to make the right decisions

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LIST OF ABBREVIATIONS

A list of the common abbreviations used throughout this report is provided below:

ACM	Asbestos Containing Material
AEC	Area of Environmental Concern
AG	Alliance Geotechnical Pty Ltd
AHD	Australian Height Datum
BTEX	Benzene, toluene, ethyl benzene and xylenes
COPC	Contaminant of Potential Concern
CSM	Conceptual Site Model
DSI	Detailed Site Investigation
DP	Deposited Plan
EPA	Environment Protection Authority
m	metres
m^2	square metres
m bgs	metres below ground surface
mg/kg	milligrams per kilogram
OCP	Organochlorine pesticides
PAH	Polycyclic aromatic hydrocarbons
PCB	Polychlorinated biphenyls
PSI	Preliminary Site Investigation
TRH	Total recoverable hydrocarbons

EXECUTIVE SUMMARY

Alliance Geotechnical Pty Ltd (AG) was engaged by Woods Bagot (the client), to conduct a Stage 2 Detailed Site Investigation (DSI) for a portion of the Meadowbank Education and Employment Precinct Schools Project at 2 Rhodes Street, Meadowbank, NSW (the site).

AG has the following project appreciation:

- TAFE and NSW Department of Education are in negotiations for the sale/purchase of the site;
- The site is being considered for redevelopment, comprising a primary school and secondary school; and
- contamination assessment works are required to inform the property transaction process and master planning process.

The objectives of this investigation were to:

- Assess the nature and likely extent of identified contaminants of potential concern (COPC) in the identified areas of environmental concern;
- Provide advice on whether the identified COPC present an unacceptable human health exposure risk (in the context of land contamination) for the proposed land use setting; and
- Provide recommendations for further investigation, management and/or remediation (if warranted).

The scope of works undertaken to address the investigation objectives, included:

- A desktop review;
- Intrusive drilling and soil sampling fieldwork;
- Laboratory analysis; and
- Data assessment and reporting.
    - The site history data collected and site walkover observations made were assessed within the objectives of this investigation and in the context of the proposed development works. That assessment identified areas of environmental concern (AEC) and contaminants of potential concern (COPC) which have the potential to be present on site. The AEC identified are presented in attached **Figure 5** and associated COPC are presented in **Table 4.1**.

    - **Table 4.1: AEC and COPC**

ID	AEC	Land Use Activity	Contaminants of Potential Concern
AEC01	Embankment	Uncontrolled filling	Hydrocarbons, pesticides, polychlorinated biphenyl, metals, asbestos
AEC02	Block Y1	Boat building and chemical storage / handling	Hydrocarbons and metals
AEC03	Block Y6	Boat building and chemical storage / handling	Hydrocarbons and metals
AEC04	Former dwelling	Uncontrolled demolition	Metals and asbestos
AEC05	Former dwelling	Uncontrolled demolition	Metals and asbestos
AEC06	Open space	Uncontrolled filling	Hydrocarbons, pesticides, polychlorinated biphenyl, metals, asbestos
AEC07	Embankment	Uncontrolled filling	Hydrocarbons, pesticides, polychlorinated biphenyl, metals, asbestos

ID	AEC	Land Use Activity	Contaminants of Potential Concern
AEC08	Former building	Uncontrolled filling	Hydrocarbons, pesticides, polychlorinated biphenyl, metals, asbestos
AEC09	Former dwelling	Uncontrolled demolition	Metals and asbestos
AEC10	Former greenhouse	Pesticide storage / handling	Pesticides and metals
AEC11	Multipurpose courts	Uncontrolled filling	Hydrocarbons, pesticides, polychlorinated biphenyl, metals, asbestos
AEC12	Embankment	Uncontrolled filling	Hydrocarbons, pesticides, polychlorinated biphenyl, metals, asbestos
AEC13	Embankment	Uncontrolled filling	Hydrocarbons, pesticides, polychlorinated biphenyl, metals, asbestos
AEC14	Former industrial building	Manufacturing and demolition	Hydrocarbons, pesticides, polychlorinated biphenyl, metals, asbestos.
AEC15	Former industrial building	Manufacturing and demolition	Hydrocarbons, pesticides, polychlorinated biphenyl, metals, asbestos
AEC16	Former industrial building	Manufacturing and demolition	Hydrocarbons, pesticides, polychlorinated biphenyl, metals, asbestos
AEC17	Carpark and grassed area	Uncontrolled filling	Hydrocarbons, pesticides, polychlorinated biphenyl, metals, asbestos
AEC18	Small embankment	Uncontrolled filling	Hydrocarbons, pesticides, polychlorinated biphenyl, metals, asbestos
AEC19	Embankment next to path	Uncontrolled filling	Hydrocarbons, pesticides, polychlorinated biphenyl, metals, asbestos
-	General site footprint	Potential uncontrolled filling	Hydrocarbons, pesticides, polychlorinated biphenyl, metals, asbestos

Soil sampling was undertaken by AG on 13 and 14 January 2018. A total of 44 sampling points (BH01 to BH41 and SS01 to SS03) were established on site. Sampling points BH01 to BH41 were excavated using a track mounted drilling rig fitted with push tube and solid flight augers, or a hand auger where access was limited. Soil samples at SS01 to SS03 were collected as grab samples from the surface.

Based on AG's assessment of the desktop review information, fieldwork data and laboratory analytical data, in the context of the proposed redevelopment scenario, AG makes the following conclusions:

- The concentrations of identified contaminants of potential concern in the soils assessed are considered unlikely to present an unacceptable direct contact human health exposure risk, with the exception of:
    - lead in soil at BH02 (560mg/kg), lead in soil at BH22 (490mg/kg) and lead in soil at BH24 (610mg/kg);

  - benzo(a)pyrene (TEQ) in soil at BH04 (8.5mg/kg), BH16 (18mg/kg), and BH23 (8.4mg/kg); and
  - asbestos in soils in the vicinity of sampling points BH07, SS02, SS03, BH30, BH40 and BH41;

- The concentrations of identified contaminants of potential concern in the soils assessed are considered unlikely to present an unacceptable inhalation / vapour intrusion human health exposure risk;

- The concentrations of identified contaminants of potential concern in the soils assessed are considered unlikely to present a petroleum hydrocarbon management limit risk;

- The asbestos detected in the soils assessed, may present an unacceptable human health exposure risk and unacceptable aesthetics risk;

- The site could be made suitable for the proposed land use setting, subject to the further assessment, management and/or remediation of potential unacceptable contamination risks and those areas unable to be assessed.

Based on these conclusions, AG makes the following recommendations:

- A supplementary contamination assessment should be undertaken by a suitably experienced environmental consultant to:
  - further characterise the nature and extent of the elevated concentrations of lead in soil risks and benzo(a)pyrene (TEQ) in soil risks;
  - further characterise the nature and extent of asbestos in soil risks, and provide a quantitative assessment of those risks;
  - address data gaps associated with AEC13, the southern portion of AEC10, and the central portions of AEC02, AEC03, AEC09, AEC12, AEC14, AEC15, AEC16 (constrained due to the presence of existing structures and/or accessibility constraints);

- Consideration should be given to removal of existing structure and accessibility constraints, prior to undertaking the supplementary contamination assessment. Removal of access constraints would likely also require provision for significant surface and pavement disturbance across the site to facilitate quantitative asbestos in soil risk assessment;

- Pending the findings of the supplementary contamination assessment, a remedial action plan should be prepared to address unacceptable soil contamination related human health exposure risks. The RAP should be prepared by a suitably experience consultant with reference to NSW OEH (2011) and include (but not be limited to) the following:
  - A remedial goal for the site;
  - An assessment of remedial options available to address the identified asbestos risks. These options may include removal offsite, in-situ containment, ex-situ containment, or a combination of these:
    - Offsite removal would likely involve excavation and disposal of impacted materials. Subject to successful removal of all impacted material, it is unlikely that a long term operational environmental management plan (EMP) would be required for the proposed development site;

    - In-situ containment could include application of a capping layer across the site. Typically, concrete and/or asphalt pavements are adequate for non-exposed soils, while a minimum 0.5m thickness of clean fill (excluding planting media) would be required in unsealed areas (e.g. playgrounds, soft landscaping etc). Depending on design levels for the development, a portion of the impacted soils may require removal offsite to allow for capping layer thicknesses. This remedial strategy would likely require a long term environmental management plan (EMP) for the proposed development site, and notification on the Section 149 planning certificate and/or title for the site;

- Ex-situ containment could include excavation and relocation of a portion of the impacted material elsewhere on the site, and application of a capping layer (similar to that discussed for in-situ containment). This remedial strategy would likely require a long term operational environmental management plan (EMP) for the proposed development site, and notification on the Section 149 planning certificate and/or title for the site;

- The proposed testing to validate the site after remediation;
- The proposed testing to validate the site after remediation;
- A contingency plan to address unexpected finds or if the selected remedial strategy fails; and
- A site management plan (for the remediation works).

This report, including its conclusions and recommendations, must be read in conjunction with the limitations presented in **Section 11**.

1. INTRODUCTION

Alliance Geotechnical Pty Ltd (AG) was engaged by Woods Bagot (the client), to conduct a Stage 2 Detailed Site Investigation (DSI) for a portion of the Meadowbank Education and Employment Precinct Schools Project at 2 Rhodes Street, Meadowbank, NSW (the site).

This report has been prepared by AG on behalf of the NSW Department of Education (the Applicant). It accompanies an Environmental Impact Statement (EIS) in support of State Significant Development Application (SSD 18_9343) for the new Meadowbank Education and Employment Precinct Schools Project (hereafter referred to as MEEPSP) at 2 Rhodes Street, Meadowbank (the site).

MEEPSP will cater for 1,000 primary school students and 1,620 high school students. The proposal seeks consent for:

- A multi-level, multi-purpose, integrated school building with a primary school wing and high school wing. The school building is connected by a centralised library that is embedded into the landscape. The school building contains:
    - Collaborative general and specialist learning hubs, with a combination of enclosed and open spaces;
    - Adaptable classroom home bases;
    - Four level central library, with primary school library located on ground floor and high school library on levels 1 to 3.
    - Laboratories and workshops;
    - Staff workplaces;
    - Canteens;
    - Indoor gymnasium;
    - Multipurpose communal hall;
    - Outdoor learning, play and recreational areas (both covered and uncovered).
- Associated site landscaping and public domain improvements;
- An on-site car park for 60 parking spaces; and
- Construction of ancillary infrastructure and utilities as required.

The purpose of this Stage 2 Detailed Site Investigation is to:

- Assess the nature and likely extent of identified contaminants of potential concern (COPC) in the identified areas of environmental concern;
- Provide advice on whether the identified COPC present an unacceptable human health exposure risk (in the context of land contamination) for the proposed land use setting; and
- Provide recommendations for further investigation, management and/or remediation (if warranted).

The **Stage 2 Detailed Site Investigation** is required by the Secretary's Environmental Assessment Requirements (SEARs) for SSD 18_9343. This table identifies the SEARs and relevant reference within this report.

Table 1.1 – SEARs and Relevant Reference

SEARs Item	Report Reference
13 Contamination	

SEARs Item	Report Reference
Assess and quantify any soil and groundwater contamination and demonstrate that the site is suitable for the proposed use in accordance with SEPP 55.	Whole Report

SITE IDENTIFICATION

The site is registered with NSW Land and Property Information as a portion of Portion of Lot 1 in DP837179 (Lot 10 in DP1232584).

A registered Lot survey plan of acquisition drawing provided by the client indicates the site is Lot 10 in DP1232584 being part of Lot 1 in DP837179.

The Section 149 planning certificate for the site (refer Alliance Geotechnical (2017a)) refers to the site as being Lot 10 in DP1232584, with a street address of 2 Rhodes Street, Meadowbank, NSW.

For the purpose of this investigation, the site will be defined as Lot 10 in DP1232584 being part of Lot 1 in DP837179.

The approximate geographic coordinates of the middle of the site, inferred from Google Earth were 33°48'46" S and 151°05'27" E.

The locality of the site is set out in **Figure 1**.

The general layout of the site is set out in **Figure 2**, while the general layout of current site facilities is set out in **Figure 3**.

The site covers an area of 3.329 hectares (by Lot survey plan).

A copy of a detail and level survey and the Lot plan survey is presented in **Appendix A**.

2. GEOLOGY, ACID SULFATE SOILS, TOPOGRAPHY AND HYDROGEOLOGY

2.1 Geology

A review of the Sydney 1;100,000 Geological Series Sheet 9130 (Edition 1) 1983, indicated that the site is underlain by Middle Triassic Hawkesbury Sandstone, which is comprised of medium to coarse grained quartz sandstone, very minor shale and laminite lenses. A portion of the eastern boundary of the site is in close proximity to Ashfield Shale, which is comprised of black to dark grey shale and laminite.

2.2 Acid Sulfate Soils

A review of the Prospect Parramatta Acid Sulfate Soil Risk Map (1:25,000 scale) indicates that the site is in a map class description of "No Known Occurrence". Land management activities are not likely to be affected by acid sulfate soil materials.

Further assessment of acid sulfate soils in the context of this investigation is considered by AG as not warranted.

2.3 Topography

The site topography was generally undulating, with overall slopes generally towards the south and south west, and some localised slopes in the northern portion, towards the east.

The detail and level survey presented in **Appendix A** provides further information on surface contours and elevations.

2.4 Hydrogeology

Surface water courses proximal to the site included:

- Parramatta River located approximately 400m to the south of the site.

Based on distances to the nearest surface water course and the site topography, groundwater flow in the vicinity of the site is considered likely to be towards the south.

A review of the NSW Office of Water groundwater database (www. http://allwaterdata.water.nsw.gov.au/water) indicated there are three (3) registered groundwater features located within a 500m radius of the site (GW1048997, GW1048998, GW1048999):

- GW1048997 with an authorised purpose for "monitoring bore". The water bearing zone for the feature was at 2.4m and the standing water level in that bore was measured at 2.32m.
- GW1048998 with an authorised purpose for "monitoring bore". The water bearing zone for the feature was at 2.1m and the standing water level in that bore was measured at 2.5m.
- GW1048999 with an authorised purpose for "monitoring bore". The water bearing zone for the feature was at 2.4m and the standing water level in that bore was measured at 2.32m.

Each of the three features were located to the west of the site, considered to be in an inferred down or cross gradient location, relative to the site.

3. PREVIOUS CONTAMINATION ASSESSMENTS

The following reports were considered during the undertaking of this project:

- Alliance Geotechnical 2017a, *'Stage 1 Preliminary Site Investigation, Portion of Lot 1 in DP837179 (Lot 10 in DP1232584), Meadowbank Education and Employment Precinct Schools Project 2 Rhodes Street, Meadowbank, NSW'*, dated 22 December 2017, ref: 6179-ER-1-1 REV5.

A summary of this report is presented in Section 3.1.

3.1 Alliance Geotechnical (2017)

Alliance Geotechnical Pty Ltd (AG) was engaged by Woods Bagot (the client), to conduct a Stage 1 Preliminary Site Investigation (PSI) for a portion of the Meadowbank Education and Employment Precinct Schools Project at 2 Rhodes Street, Meadowbank, NSW (the site).

AG has the following project appreciation:

- TAFE and NSW Department of Education are in negotiations for the sale/purchase of the site;
- The site is being considered for redevelopment, comprising a pre-school, primary school and secondary school; and
- Contamination assessment works are required to inform the property transaction process and master planning process.

The objectives of this investigation were to:

- Assess the potential for contamination to be present on the site as a result of past and current land use activities;
- Provide advice on whether the site would be suitable (in the context of land contamination) for a pre-school / primary school and secondary school land use setting; and
- Provide recommendations for further investigation, management and/or remediation (if warranted).

The scope of works undertaken to address the investigation objectives, included:

- A desktop review;
- A site walkover;
- Data assessment and reporting.

Alliance Geotechnical (2017a) reported that the predominant historical land title holdings for the site included the Metropolitan Water Sewerage and Drainage Board, and the Meadowbank Manufacturing Company. The inferred onsite boundaries of these title holdings, are presented in **Figure 4**.

The site history data collected and site walkover observations made were assessed within the objectives of the investigation and in the context of the proposed development works. That assessment identified areas of environmental concern (AEC) and contaminants of potential concern (COPC) which have the potential to be present on site (refer **Table 4.1** and **Figure 5**).

Based on AG's assessment of the desktop review and site walkover data, in the context of the proposed development scenario, AG concluded that:

- There is a moderate potential for land contamination to be present on the site, as a result of past and current land use activities; and
- Further investigation would be required to make an assessment of the suitability of the site, for a pre-school, primary school and secondary school land use setting.

Based on these conclusions, AG made the following recommendations:

- A Stage 2 Detailed Site Investigation (DSI) should be undertaken for the site. AG notes that, if a Stage 2 DSI is undertaken while the site remains operational and/or while existing buildings and infrastructure remain on the site, there will likely be constraints limiting further assessment of some areas of the site, which may increase uncertainty around the contamination status of the site; and
- The Stage 2 DSI should be undertaken by a suitably experienced environmental consultant.

4. CONCEPTUAL SITE MODEL

4.1 Areas of Environmental Concern and Contaminants of Potential Concern

The site history data collected and site walkover observations made were assessed within the objectives of this investigation and in the context of the proposed development works. That assessment identified areas of environmental concern (AEC) and contaminants of potential concern (COPC) which have the potential to be present on site. The AEC identified are presented in attached **Figure 5** and associated COPC are presented in **Table 4.1**.

Table 4.1: AEC and COPC

ID	AEC	Land Use Activity	Contaminants of Potential Concern
AEC01	Embankment	Uncontrolled filling	Hydrocarbons, pesticides, polychlorinated biphenyl, metals, asbestos
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AEC03	Block Y6	Boat building and chemical storage / handling	Hydrocarbons and metals
AEC04	Former dwelling	Uncontrolled demolition	Metals and asbestos
AEC05	Former dwelling	Uncontrolled demolition	Metals and asbestos
AEC06	Open space	Uncontrolled filling	Hydrocarbons, pesticides, polychlorinated biphenyl, metals, asbestos
AEC07	Embankment	Uncontrolled filling	Hydrocarbons, pesticides, polychlorinated biphenyl, metals, asbestos
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AEC12	Embankment	Uncontrolled filling	Hydrocarbons, pesticides, polychlorinated biphenyl, metals, asbestos
AEC13	Embankment	Uncontrolled filling	Hydrocarbons, pesticides, polychlorinated biphenyl, metals, asbestos
AEC14	Former industrial building	Manufacturing and demolition	Hydrocarbons, pesticides, polychlorinated biphenyl, metals, asbestos.

ID	AEC	Land Use Activity	Contaminants of Potential Concern
AEC15	Former industrial building	Manufacturing and demolition	Hydrocarbons, pesticides, polychlorinated biphenyl, metals, asbestos
AEC16	Former industrial building	Manufacturing and demolition	Hydrocarbons, pesticides, polychlorinated biphenyl, metals, asbestos
AEC17	Carpark and grassed area	Uncontrolled filling	Hydrocarbons, pesticides, polychlorinated biphenyl, metals, asbestos
AEC18	Small embankment	Uncontrolled filling	Hydrocarbons, pesticides, polychlorinated biphenyl, metals, asbestos
AEC19	Embankment next to path	Uncontrolled filling	Hydrocarbons, pesticides, polychlorinated biphenyl, metals, asbestos
-	General site footprint	Potential uncontrolled filling	Hydrocarbons, pesticides, polychlorinated biphenyl, metals, asbestos

4.2 Land Use Setting

AG understands that the proposed development works includes redevelopment of the site with pre-school, primary school and secondary school facilities.

Based on the proposed development works and guidance provided in Section 2.2 of NEPC (1999a), AG considers it reasonable to adopt the 'HIL A – residential with garden/accessible soil, including children's day care centres, preschools and primary schools' land use setting, for the purpose of assessing land contamination exposure risks.

4.3 Direct Contact – Human Health

The proposed land use setting is likely to include unsealed playground, garden/softscape and open space areas. In these areas, it is considered that a direct contact exposure pathway may be complete.

4.4 Inhalation / Vapour Intrusion – Human Health

In order for a potentially unacceptable inhalation / vapour intrusion human health exposure risk to exist, a primary vapour source (e.g. underground storage tank) or secondary vapour source (e.g. significantly contaminated soil or groundwater) would typically need to be present.

The historical evidence reviewed indicated a low likelihood for a potential primary source to be present on the site[1]. The same historical evidence indicated a potential land use activity to be uncontrolled filling.

The excavation, transport, placement and spreading of imported (uncontrolled) fill material involves significant disturbance of soils which typically results in volatilisation of vapour producing contaminants. On that basis, the

[1] An application for renewal of a licence to keep dangerous goods, dated 24 November 1999 was reported in Alliance Geotechnical (2018). The application suggests the presence of a roofed store in the vicinity of Building Y1, containing minor quantities of various flammable liquids including fuels, turpentine, kerosene, solvents and alcohols.

potential for vapours to be present in soils on site at concentrations which might present an unacceptable exposure risk, is considered to be low to negligible.

Potential sources of groundwater contamination in the immediate vicinity of the site (e.g. service stations) were not observed. A groundwater source of vapours was considered unlikely at the site.

As a conservative measure, AG will consider data obtained during field investigations in the context of inhalation / vapour intrusion risk.

4.5 Management Limits for Petroleum Hydrocarbon Compounds

NEPC (1999a) notes that there are a number of policy considerations which reflect the nature and properties of petroleum hydrocarbons:

- formation of observable light non-aqueous phase liquids (LNAPL);
- fire and explosive hazards; and
- effects on buried infrastructure (e.g. penetration of or damage to, in-ground services by hydrocarbons).

NEPC (1999a) includes 'management limits' to avoid or minimise these potential effects. Application of the management limits requires consideration of site-specific factors such as the depth of building basements and services and depth to groundwater, to determine the maximum depth to which the limits should apply. NEPC (1999a) also notes that management limits may have less relevance at operating industrial sites which have no or limited sensitive receptors in the area of potential impact, and when management limits are exceeded, further site-specific assessment and management may enable any identified risk to be addressed.

4.6 Aesthetics – Human Health

Section 3.6.3 of NEPC (1999a) advises that there are no specific numeric aesthetic guidelines, however site assessment requires a balanced consideration of the quantity, type and distribution of foreign material or odours in relation to the specific land use and its sensitivity.

The proposed land use setting is likely to include unsealed playground, garden/softscape and open space areas. In these areas, it is considered that an aesthetics exposure pathway may exist.

4.7 Ecological – Terrestrial Ecosystems

NEPC (1999) requires a pragmatic risk-based approach should be taken in applying ecological investigation and screening levels in residential and commercial / industrial land use settings.

It is noted that Alliance Geotechnical (2017a) reported that there was no visual evidence observed to suggest significant or widespread phytotoxic impact (in the form of dieback or plant stress) in onsite vegetation. Similar observations were made of visible vegetation on land adjacent to the site.

On this basis, AG considers further assessment of terrestrial ecosystems exposure risks, not warranted.

4.8 Drinking Water

Alliance Geotechnical (2017a) did not report the presence of registered drinking water extraction bores onsite or within a 500m radius of the site.

There is a reticulated drinking water available both onsite and within a 500m radius of the site.

Further assessment of this groundwater value at the site is considered not warranted.

4.9 Recreational Water Use

The nearest hydraulically down gradient major surface water body to the site is considered to be Parramatta River.

Parramatta River is located a significant distance (400m) from the site and therefore unlikely to be a material receptor of potential contamination from this site.

Further assessment of this groundwater value is considered not warranted.

4.10 Agricultural Water Use (Irrigation and Stock Watering)

There are no groundwater bores onsite or down gradient of the site, registered for agricultural use. Urban development, both on site and on surrounding land, is considered likely to prevent agricultural activities being undertaken both on site and on surrounding land.

Further assessment of this groundwater value is considered not warranted.

4.11 Aquatic Ecosystems

The nearest hydraulically down gradient major surface water body to the site is considered to be Parramatta River.

Parramatta River is located a significant distance (400m) from the site and therefore unlikely to be a material receptor of potential contamination from this site.

Further assessment of this groundwater value is considered not warranted.

5. DATA QUALITY OBJECTIVES

Appendix B of NEPC (1999b) provides guidance on the development of data quality objectives (DQO) using a seven-step process.

The DQO for this project are set out in Sections 5.1 to 5.7 of this report.

5.1 Step 1: State the problem

The first step involves summarising the contamination problem that requires new environmental data and identifying resources available to solve the problem.

The objectives of this investigation are to:

- assess the nature and likely extent of identified contaminants of potential concern (COPC) in the identified areas of environmental concern;
- provide advice on whether the identified COPC present an unacceptable human health exposure risk (in the context of land contamination) for the proposed land use setting; and
- provide recommendations for further investigation, management and/or remediation (if warranted).

The investigation is being undertaken because:

- the site is the subject of a pre-school, primary school and secondary school redevelopment; and
- a stage 2 detailed site investigation (DSI), is required to make an assessment of potential unacceptable human health exposure risks, in the context of land contamination, in the identified areas of environmental concern.

The project team identified for this investigation is comprised primarily of suitably experienced environmental consultants from Alliance Geotechnical Pty Ltd.

The regulatory authorities identified for this investigation include NSW EPA and the local Council.

5.2 Step 2: Identify the decision/goal of the study

The second step involves identifying decisions that need to be made about the contamination problem and the new environmental data required to make them.

The decisions that need to be made during this investigation include:

- Is the environmental data collected for the investigation, suitable for assessing relevant land contamination exposure risks?
- Do the concentrations of identified contaminants of potential concern (COPC) present an unacceptable exposure risk to identified receptors, for the proposed land use setting?
- Is the site suitable for the proposed land use setting, in the context of land contamination?

5.3 Step 3: Identify the information inputs

The third step involves identifying the information needed to support decisions and whether new environmental data will be needed.

The inputs required to make the decisions set out in Section 5.2 for this investigation, will include:

- data obtained during searches of the site's history;
- the nature and extent of sampling at the site, including both density and distribution;
- samples of relevant site media;
- the measured physical and/or chemical parameters of the site media samples (including field screening and laboratory analysis, where relevant); and

- assessment criteria adopted for each of the media sampled.

Taking into consideration the objectives of this investigation, and the conceptual site model and land use setting presented in Section 3 of this investigation, the assessment criteria relevant to the proposed land use setting have been adopted for this investigation

- Human health direct contact – HILs in Table 1A (1) in NEPC (1999a) and HSLs in Table B4 of Friebel, E & Nadebaum, P (2011);
- Human health inhalation/vapour intrusion – HSLs in Table 1 (A) in NEPC (1999a);
- Human health (asbestos) – absence / presence for preliminary screening, and no visible ACM on surface;
- Petroleum hydrocarbon compounds (management limits) – Table 1 B(7) of NEPC (1999a); and
- Aesthetics – no highly malodorous site media (e.g. strong residual petroleum hydrocarbon odours, hydrogen sulphide in site media, organosulfur compounds), no hydrocarbon sheen on surface water, no discoloured chemical deposits or soil staining with chemical waste other than of a very minor nature, no large monolithic deposits of otherwise low risk material (e.g. gypsum as powder or plasterboard, cement kiln dust), no presence of putrescible refuse including material that may generate hazardous levels of methane such as a deep-fill profile of green waste or large quantities of timber waste, and no soils containing residue from animal burial (e.g. former abattoir sites).

5.4 Step 4: Define the boundaries of the study

The fourth step involves specifying the spatial and temporal aspects of the environmental media that the data must represent to support decisions.

The spatial extent of the investigation will be limited to the site as defined by its boundaries.

The temporal boundaries of the investigation include

- the project timeframe presented in the AG proposal for this project,
- unacceptable weather conditions at the time of undertaking fieldwork, including rainfall, cold and/or heat;
- access availability of the site (to be defined by the site owner/representative); and
- availability of AG field staff (typically normal daylight working hours, Monday to Friday).

The lateral extent that contamination is expected to be distributed across, based on the conceptual site model, is defined by the inferred boundaries of the areas of environmental concern (AEC).

The vertical extent that contamination is expected to be distributed across, based on the conceptual site model and the project scope, is limited to fill material.

The scale of the decisions required will be based on the entire site.

Constraints which may affect the carrying out of this investigation may include access limitations, presence of above and below ground infrastructure, and hazards creating health and safety risks.

5.5 Step 5: Develop the analytical approach (or decision rule)

The fifth step involves defining the parameter of interest, specifying the action level, and integrating information from Steps 1 to 4 into a single statement that gives a logical basis for choosing between alternative actions.

5.5.1. Rinsate Blanks

One rinsate blank will be collected and scheduled for analysis, for each day of sampling undertaken, if non-disposable sampling equipment was used on that day. The rinsate blank will be analysed for at least one of the analytes the sample/s collected that day are being scheduled for analysis for (with the exception of asbestos).

5.5.2. Trip Spikes and Trip Blank Samples

One trip spike and trip blank sample will be used and scheduled for analysis, for each day of sampling undertaken, if site samples being collected that day are being analysed for volatile contaminants of concern (typically BTEX and/or TRH C_6-C_{10}).

5.5.3. Field Duplicates and Field Triplicates

Field duplicate and field triplicates will be collected at a rate of one per twenty (5%) site samples collected. The duplicates and triplicates collected will be analysed for at least one of the analytes that the parent sample of the duplicate/triplicate is being scheduled for analysis for (with the exception of asbestos).

The relevant percent difference (RPD) of concentrations of relevant analytes, between the parent sample and the duplicate/triplicate will be calculated.

5.5.4. Laboratory Analysis Quality Assurance / Quality Control

The analytical laboratory QA/QC program will typically include laboratory method blank samples, matrix spike samples, surrogate spike samples, laboratory control samples, and laboratory duplicate samples.

5.5.5. If/Then Decision Rules

AG has adopted the following 'if/then' decision rules for this investigation:

- If the result of the assessment of field data and laboratory analytical data is considered acceptable, then that field data and laboratory analytical data is suitable for interpretation within the scope of this investigation; and
- If the field data and laboratory analytical data is within the constraints of the assessment criteria adopted for this investigation (refer **Section 5.3**), then the contamination exposure risks to identified receptors, are considered acceptable.

In the event the assessment of field data and/or laboratory analytical data results in the data being not suitable for interpretation, then AG will determine if additional data is required to allow interpretation to be undertaken.

In the event that field data and/or laboratory analytical data exceeds the assessment criteria adopted for this investigation (refer **Section 5.3**), AG will undertake an assessment of the exceedance in the context of the project objectives to determine if additional data is required and whether management and/or remediation is required.

5.6 Step 6: Specify the performance or acceptance criteria

The sixth step involves specifying the decision maker's acceptable limits on decision errors, which are used to establish performance goals for limiting uncertainties in the data. When assessing contaminated land, there are generally two types of errors in decision making:

- Contamination exposure risks for a specific land use setting are acceptable, when they are not; and
- Contamination exposure risks for a specific land use setting are not acceptable, when they are.

AG will mitigate the risk of decision error by:

- Calculation of the 95% upper confidence limit (UCL) statistic to assess the mean concentration of relevant contaminants of potential concern;
- Assignment of fieldwork tasks to suitably experienced AG consulting staff, and suitably experienced contractors;
- Assignment of laboratory analytical tasks to reputable NATA accredited laboratories;
- Assignment of data interpretation tasks to suitably experienced AG consulting staff, and outsourcing to technical experts where required.

AG will also adopt a range of data quality indicators (DQI) to facilitate assessment of the completeness, comparability, representativeness, precision and accuracy (bias).

Completeness			
Field Considerations	**Assessment Criterion**	**Laboratory Considerations**	**Assessment Criterion**
Critical locations sampled	Refer **Section 5.7.1**	Critical samples analysed according to SAQP	Refer **Section 5.7.7**
Critical samples collected	Refer **Section 5.7.1**	Analytes analysed according to SAQP	Refer **Section 5.7.7**
SOPs appropriate and complied with	100%	Appropriate laboratory analytical methods and LORs	Refer **Section 5.7.7**
Field documentation complete	All sampling point logs, calibration logs and chain of custody forms	Sample documentation complete	All sample receipt advices, all certificates of analysis
		Sample extraction and holding times complied with	Refer **Section 5.7.8**
Comparability			
Field Considerations	**Assessment Criterion**	**Laboratory Considerations**	**Assessment Criterion**
Same SOPs used on each occasion	100%	Same analytical methods used by primary laboratory	Refer **Section 5.7.8**
Climatic conditions	Samples stored in insulated containers with ice, immediately after collection	Same LORs at primary laboratory	Refer **Section 5.7.8**
Same types of samples collected, and handled/preserved in same manner	All soil samples same size, all stored in insulated containers with ice	Same laboratory for primary sample analysis	All primary samples to SGS Environmental
		Same analytical measurement units	Refer **Section 5.7.8**
Representativeness			
Field Considerations	**Assessment Criterion**	**Laboratory Considerations**	**Assessment Criterion**
Appropriate media sampled according to SAQP	Refer Section 5.4	Samples analysed according to SAQP	Refer **Section 5.7.7**
Media identified in SAQP sampled	Refer Section 5.4		
Precision			

Field Considerations	**Assessment Criterion**	**Laboratory Considerations**	**Assessment Criterion**
Field duplicate / triplicate RPD	Minimum 5% duplicates and triplicates No limit for analytical results <10 times LOR 50% for analytical results 10-20 times LOR 30% for analytical results >10 times LOR	Laboratory duplicates	No exceedances of laboratory acceptance criteria
SOPs appropriate and complied with	100%		
Accuracy (bias)			
Field Considerations	**Assessment Criterion**	**Laboratory Considerations**	**Assessment Criterion**
Rinsate blanks	Less than laboratory limit of reporting	Laboratory method blank	No exceedances of laboratory acceptance criteria
Field trip spikes	Recoveries between 60% and 140%	Matrix spike recovery	No exceedances of laboratory acceptance criteria
Field trip blanks	Analyte concentration <LOR	Surrogate spike recovery	No exceedances of laboratory acceptance criteria
		Laboratory control sample recovery	No exceedances of laboratory acceptance criteria

5.7 Step 7: Develop the plan for obtaining data

The seventh step involves identifying the most resource effective sampling and analysis design for generating the data that is required to satisfy the DQOs.

5.7.1. Sampling Point Density and Locations

Table A in NSW EPA (1995) provides guidance on minimum sampling point densities required for site characterisation, based on detecting circular hot spots by using a systematic sampling pattern. This guidance assumes the investigator has little knowledge about the probable locations of the contamination, the distribution of the contamination is expected to be random (e.g. land fill sites) or the distribution of the contamination is expected to be fairly homogenous (e.g. agricultural lands).

However, Section 3.1 of NSW EPA (1995) states that a judgemental sampling pattern can be used where there is enough information on the probable locations of contamination. Further to this, Section 6.2.1 of NEPC (1999b) states that the number and location or sampling points is based on knowledge of the site and professional judgement. Sampling should be localised to known or potentially contaminated areas identified from knowledge of the site either from site history or an earlier phase of site investigation. Judgemental sampling can be used to investigation sub-surface contamination issues in site assessment.

Table 1 in WA DOH (2009) indicates that where the 'likelihood of asbestos' is assessed as "possible" or "suspect", the investigation regimen should include a sampling density that is either judgemental or the same as that set out in Table A of NSW EPA (1995) for assessing asbestos.

As this investigation has included gathering data which provides a reasonable understanding of site history (in the context of potential areas of environmental concern on the site), and taking into consideration Table 1 in WA DOH (2009), it is considered reasonable to adopt a judgemental sampling pattern, with up to 45 sampling points.

The locations of the sampling points are set out in **Figure 6**. The location of actual sampling points will be recorded by hand on a site plan.

AG notes that:

- the client is not able to provide access inside buildings on site, for the purpose of visual assessment and/or drilling works; and
- AEC13 appears to be located behind fencing and within an active rail corridor, which will constrain access for sampling.

5.7.2. Sampling Methodology

The sampling point methodology presented in Table 5.7.2 will be used for this investigation. The methodology is based on a range of factors considered relevant to this investigation, including:

- the identified contaminants of potential concern;
- the suspected laydown mechanisms for those contaminants of concern;
- the suspected likely depth of contamination; and
- site specific constraints which affect the type of sampling techniques suited to the site.

Table 5.7.2 Proposed Sampling Methodology

AEC	Sampling Point ID	Method	Target Depth of Sampling Point (m bgs)
AEC01	BH01 – BH02	Hand auger	1.0m, practical refusal or 0.3m into natural material, whichever occurs first
AEC02	BH03-BH04	Concrete core and push tube auger	1.0m, practical refusal or 0.3m into natural material, whichever occurs first
AEC03	BH05	Concrete core and push tube auger	1.0m, practical refusal or 0.3m into natural material, whichever occurs first
AEC04	BH06	Push tube auger	1.0m, practical refusal or 0.3m into natural material, whichever occurs first
AEC05	BH07	Push tube auger	1.0m, practical refusal or 0.3m into natural material, whichever occurs first
AEC06	BH08	Push tube auger / hand auger	1.0m, practical refusal or 0.3m into natural material, whichever occurs first
AEC07	BH09-BH10	Push tube auger	1.0m, practical refusal or 0.3m into natural material, whichever occurs first

AEC	Sampling Point ID	Method	Target Depth of Sampling Point (m bgs)
AEC08	BH11	Push tube auger	2.0m, practical refusal or 0.3m into natural material, whichever occurs first
AEC09	BH12	Push tube auger	1.0m, practical refusal or 0.3m into natural material, whichever occurs first
AEC10	BH13-BH14	Push tube auger	1.0m, practical refusal or 0.3m into natural material, whichever occurs first
AEC11	BH15-BH18	Push tube auger	2.0m, practical refusal or 0.3m into natural material, whichever occurs first
AEC12	BH19-BH20	Push tube auger	2.0m, practical refusal or 0.3m into natural material, whichever occurs first
AEC13	Not accessible		
AEC14	BH21-BH22	Concrete core and push tube auger	1.0m, practical refusal or 0.3m into natural material, whichever occurs first
AEC15	BH23-BH24	Concrete core and push tube auger	1.0m, practical refusal or 0.3m into natural material, whichever occurs first
AEC16	BH25-BH26	Concrete core and push tube auger	1.0m, practical refusal or 0.3m into natural material, whichever occurs first
AEC17	BH27-BH28	Concrete core (1) and push tube auger / hand auger	2.0m, practical refusal or 0.3m into natural material, whichever occurs first
AEC18	BH29	Push tube auger	1.0m, practical refusal or 0.3m into natural material, whichever occurs first
AEC19	BH30	Push tube auger	2.0m, practical refusal or 0.3m into natural material, whichever occurs first
General site footprint	BH31-BH41	Concrete core and push tube auger	1.0m, practical refusal or 0.3m into natural material, whichever occurs first
-	SS01-SS03	Surface fragments grab sample	Surface

Reference will also be made to Table 5 in WA DOH (2009) for the sampling and screening of fill soils for the presence of asbestos, where practical. It is noted however, that project constraints will likely limit intrusive investigation methodologies (including the use of excavation equipment for testpitting and/or minimum 150mm diameter soil coring equipment). Subsequently, application of asbestos screening criteria published in NEPC (1999a) may be limited.

5.7.3. Identification, Storage and Handling of Samples

Sample identifiers will be used for each sample collected, based on the sampling point number and the depth/interval the sample was collected from, e.g. a sample collected from BH03 at a depth of 0.2m to 0.4m below ground level, would be identified as BH03/0.2-0.4.

Project samples will be stored in laboratory prepared glass jars (and zip lock bags if collected for asbestos or acid sulfate soil assessment).

Soil samples in glass jars (and acid sulfate soil samples) will be placed in insulated container/s with ice.

Samples will be transported to the relevant analytical laboratory, with chain of custody (COC) documentation that includes the following information:

AG project identification number
- Each sample identifier
- Date each sample was collected
- Sample type (e.g. soil or water)
- Container type/s for each sample collected
- Preservation method used for each sample (e.g. ice)
- Analytical requirements for each sample and turnaround times
- Date and time of dispatch and receipt of samples (including signatures)

5.7.4. Headspace Screening

Where the contaminants of potential concern include volatiles (e.g. TRH, BTEX), project soil samples will be subjected to field screening for ionisable volatile organic compounds (VOC), using a photo-ionisation detector (PID). The results of field screening will be recorded on sampling point log.

5.7.5. Decontamination

In the event that non-disposable sampling equipment is used, that equipment will be decontaminated before and in between sampling events, to mitigate potential for cross contamination between samples collected. The decontamination methodology to be adopted for this project will include:
- Washing relevant sampling equipment using potable water with a phosphate free detergent (i.e. Decon 90 or similar) mixed into the water;
- Rinsing the washed non-disposable sampling equipment with distilled or de-ionised water; and
- Air drying as required.

5.7.6. Laboratory Selection

The analytical laboratories used for this project will be NATA accredited for the analysis undertaken.

5.7.7. Laboratory Analytical Schedule

Project samples will be scheduled for NATA accredited laboratory analysis, using a combination of:
- Observations made in the field of the media sampled;
- Headspace screening results (where available);
- The contaminants of potential concern (COPC) identified for the area of environmental concern that the sample was collected from.

Based on site history, AG has adopted the laboratory analytical schedule (and associated upper limiting quantities) presented in **Table 5.7.7** for this project.

Table 5.7.7 Laboratory Analytical Schedule

AEC	Sampling Point ID	TRH/BTEX	VOC	PAH	OCP	PCB	8 Metals	Asbestos (absence / presence)	Asbestos Material ID
AEC01	BH01 – BH02	2	-	4	1	1	4	2	1
AEC02	BH03-BH04	2	2	3	-	-	4	-	-
AEC03	BH05	1	1	2	-	-	2	-	-
AEC04	BH06	-	-	-	-	-	2	1	1
AEC05	BH07	-	-	-	-	-	2	1	-
AEC06	BH08	1	-	3	1	1	3	1	1
AEC07	BH09-BH10	2	-	5	1	1	5	2	1
AEC08	BH11	1	-	3	1	1	3	1	1
AEC09	BH12	-	-	-	-	-	2	1	1
AEC10	BH13-BH14	-	-	-	2	-	4	-	-
AEC11	BH15-BH18	4	-	8	3	3	8	8	2
AEC12	BH19-BH20	2	-	4	1	1	4	4	1
AEC13	Not accessible	-	-	-	-	-	-	-	-
AEC14	BH21-BH22	2	1	4	1	1	4	4	1
AEC15	BH23-BH24	2	1	4	1	1	4	4	1
AEC16	BH25-BH26	2	1	4	1	1	4	4	1
AEC17	BH27-BH28	2	-	4	1	1	4	4	1
AEC18	BH29	1	-	3	1	1	3	1	1
AEC19	BH30	1	-	4	1	1	4	4	1
General site footprint	BH30-BH41	12	-	24	6	6	24	12	6
-	SS01-SS03	-	-	-	-	-	-	-	3

5.7.8. Laboratory Holding Times, Analytical Methods and Limits of Reporting

The laboratory holding times, analytical methods and limits of reporting (LOR) being used for this project, are presented in **Table 5.7.8**.

Table 5.7.8 Laboratory Holding Times, Analytical Methods and Limits of Reporting

Analyte	Holding Time	Analytical Method	Limit of Reporting (mg/kg)
BTEX and TRH C_6-C_{10}	14 days	USEPA 5030, 8260B and 8020	0.2-0.5
TRH >C_{10}-C_{40}	14 days	USEPA 8015B & C	20-100
VOC	14 days	USEPA 8260	0.1-0.5
PAH	14 days	USEPA 8270	0.1-0.5
OCP	14 days	USEPA 8081	0.2
PCB	14 days	USEPA 8270	0.2
Metals	14 days	USEPA 8015B & C	0.05 – 2
Asbestos	No limit	AS4964:2004	Absence / presence
Asbestos	No limit	Inhouse Method	0.001% w/w

6. FIELDWORK

6.1 Soil Sampling

Soil sampling was undertaken by AG on 13 and 14 January 2018. An underground service locating contractor was engaged to survey each sampling point for the presence of underground services.

A total of 44 sampling points (BH01 to BH41 and SS01 to SS03) were established on site. Sampling points BH01 to BH41 were excavated using a track mounted drilling rig fitted with push tube and solid flight augers, or a hand auger where access was limited. Soil samples at SS01 to SS03 were collected as grab samples from the surface.

The locations of the sampling points established on site, are presented in **Figure 6**.

Image 6.1.1 View of borehole drilling at BH3

Image 6.1.2 View of borehole drilling at BH15

Image 6.1.3 View of surface sampling at SS02

The jars and bags were labelled with the project number, sample identifier and date the samples were collected on. Sample were then placed in laboratory supplied acid-rinsed glass jars (with Teflon lined lids) and zip lock bags.

Each borehole was backfilled at the completion of the sampling task, and reinstated with hardstand materials, where appropriate.

Each sampling point established was marked on a site plan. The locations of these sampling points are presented in **Figure 6**.

6.2 Site Geology

Observations were made of soils encountered during sampling work. These observations were recorded on borehole logs. A copy of these logs is presented in **Appendix B**.

Fill was encountered at all sampling points and was comprised of silty SAND, silty gravelly SAND, clayey SAND, gravelly silty SAND, gravelly clayey SAND, shaley CLAY, gravelly silty CLAY and SAND.

Anthropogenic materials observed in some of the fill material encountered, included charcoal, concrete, brick, rail ballast, bitumen,

Inferred natural material was encountered at some sampling points. Inferred natural material was observed to be comprised of clayey SAND, weathered SANDSTONE, SAND and sandy CLAY.

Image 6.2.1 Example of fill profile at sampling point BH32

6.3 Headspace Screening

Samples collected were subjected to headspace screening. A sub sample from each sampling point was placed in a zip lock bag, sealed and shaken. Each bag was then pierced with the probe tip of a calibrated photoionisation detector (PID) and the screening results recorded. These results are recorded on the test pity logs presented in **Appendix B**.

The results of the headspace screening indicated the potential for ionisable volatile organic compounds (VOC) to be present in the samples, was low to negligible.

A copy of the calibration record for the PID is presented in **Appendix C**.

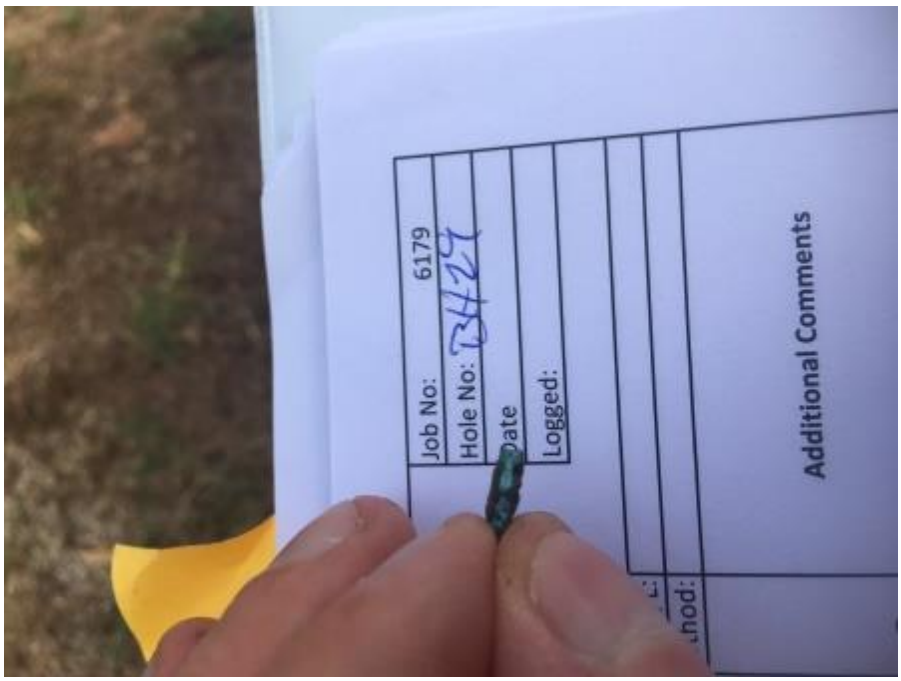
6.4 Odours

Olfactory evidence of odours in the soil samples collected, was not detected.

6.5 Staining

Visual evidence of staining in the soil samples collected, was not detected, with the exception of some very minor green/blue discolouration on a fragment of some fill material at sampling point BH29.

Image 6.5.1 Example of fill profile at sampling point BH32



6.6 Potential Asbestos Containing Materials

Visual evidence of potential asbestos containing materials (ACM) was not detected in the fill material encountered. However, it is noted that fragments of fibrous cement sheeting (conservatively assumed to contain asbestos, based on AG's experience and visual observations in the field), were observed in the vicinity of sampling points BH07 (AEC05), SS02 (east of AEC12), and SS03 (AEC18).

Image 6.6.1 Image of fibrous cement sheeting fragment in the vicinity of BH07

Image 6.6.2 Image of fibrous cement sheeting fragment in the vicinity of SS02

Image 6.6.3 Image of fibrous cement sheeting fragment in the vicinity of SS03

7. LABORATORY

The samples collected were transported to the analytical laboratory, using chain of custody (COC) protocols. A selection of these samples was scheduled for analysis, with reference to the relevant COPC identified for the AEC that the samples were collected from.

A copy of the analytical laboratory certificates of analysis, is presented in **Appendix D**.

The sample analytical results were tabulated and presented in the attached Table LAR1.

The results of the relative percentage difference (RPD) calculations are presented in Table LAR2.

The results of the rinsate blank, trip spike and trip blank analysis are presented in Table LAR3.

8. DATA QUALITY INDICATOR ASSESSMENT

8.1 Completeness

An assessment of the completeness of data collected was undertaken, and the results presented in **Table 8.1**.

Table 8.1 Completeness DQI

Field Considerations	**Target**	**Actual**	**Comment**
Critical locations sampled	44	43	One sampling point (BH14) was initially planned to be established in AEC10. However, site constraints prevented access to the planned BH14 location. Sampling point BH14 was subsequently relocated towards the south eastern corner of AEC02. Performance against indicator considered acceptable.
Critical samples collected	86	136	Acceptable
SOPs appropriate and complied with	100%	100%	Acceptable
Field documentation complete	All sampling point logs, calibration logs and chain of custody forms	All sampling point logs, calibration logs and chain of custody forms	Acceptable
Laboratory Considerations	**Target**	**Actual**	**Comment**
Critical samples analysed according to SAQP	Refer **Section 5.7.7**	Refer comments	Minor deviations from **Section 5.7.7**, to suit observations made in the field during sampling, and subsequent headspace screening. Performance against indicator considered acceptable.
Analytes analysed according to SAQP	Refer **Section 5.7.7**	100%	Acceptable
Appropriate laboratory analytical methods and LORs	Refer **Section 5.7.8**	100%	Acceptable
Sample documentation complete	All sample receipt advices, all certificates of analysis	100%	Acceptable

Sample extraction and holding times complied with	Refer **Section 5.7.8**	Refer comments	Volatiles and semi volatiles in batch SE174689 exceeded extraction time by 1-2 days, as analytical request was part of a second round of analysis. The exceedance is only marginal, and given that field observations did not indicate the presence of volatiles in the samples (i.e. PID headspace screening, and no odours or staining observed), the extraction exceedences are considered unlikely to affect the completeness of the laboratory data. Performance against indicator considered acceptable.

The data collected is considered to be adequately complete within the objectives and constraints of the project. AG notes that AEC13, the southern portion of AEC10, and central portions of AEC02, AEC03, AEC09, AEC12, AEC14, AEC15, AEC16 were constrained due to the presence of existing structures and/or accessibility limitations.

8.2 Comparability

An assessment of the comparability of data collected was undertaken, and the results presented in **Table 8.2**.

Table 8.2 Comparability DQI

Field Considerations	**Target**	**Actual**	**Comment**
Same SOPs used on each occasion	100%	100%	Acceptable
Climatic conditions	Samples stored in insulated containers with ice, immediately after collection	100%	Acceptable
Same types of samples collected, and handled/preserved in same manner	All soil samples same size, all stored in insulated containers with ice	100%	Acceptable
Laboratory Considerations	**Target**	**Actual**	**Comment**
Same analytical methods used by primary laboratory	Refer **Section 5.7.8**	100%	Acceptable
Same LORs at primary laboratory	Refer **Section 5.7.8**	100%	Acceptable

Same laboratory for primary sample analysis	All primary samples to SGS Environmental	100%	Acceptable
Same analytical measurement units	Refer **Section 5.7.8**	100%	Acceptable

The data collected is considered to be adequately comparable.

8.3 Representativeness

An assessment of the representativeness of data collected was undertaken, and the results presented in **Table 8.3**.

Table 8.3 Representativeness DQI

Field Considerations	**Target**	**Actual**	**Comment**
Appropriate media sampled according to SAQP	Refer **Section 5.7.2**	100%	Acceptable
Media identified in SAQP sampled	Refer **Section 5.7.2**	100%	Acceptable
Laboratory Considerations	**Target**	**Actual**	**Comment**
Samples analysed according to SAQP	Refer **Section 5.7.7**	Refer comments	Minor deviations from **Section 5.7.7**, to suit observations made in the field during sampling, and subsequent headspace screening. Performance against indicator considered acceptable.

The data collected is considered to be adequately representative within the objectives and constraints of the project.

8.4 Precision

An assessment of the precision of data collected was undertaken, and the results presented in **Table 8.4**.

Table 8.4 Precision DQI

Field Considerations	**Target**	**Actual**	**Comment**

Field duplicate / triplicate RPD	Minimum 5% duplicates and triplicates No limit for analytical results <10 times LOR 50% for analytical results 10-20 times LOR 30% for analytical results >20 times LOR	5.7% duplicates and 5.7% triplicates Nil 1 4	Parent duplicate/triplicate relationships are as follows: DUP01/01A – BH8/0.0-0.2 DUP02/02A - BH4-0.0-0.2 DUP03/03A – BH7-0.0-0.2 DUP04/04A – BH16-0.0-0.2 DUP05/05A – BH18-0.0-0.2 DUP06/06A – BH30-0.0-0.2 DUP07/07A – BH28-0.0-0.2 DUP08/08A – BH20-0.0-0.2 Exceedences included: • Mercury RPD for DUP02; • Chromium RPD for DUP02A; and • Copper, lead and zinc RPD for DUP04A. AG considers these exceedences are likely to be attributable to heterogeneity in each of the discrete soils samples, as the parent sample could not be homogenised prior to splitting, due to the potential for volatile and semi volatile contaminants to be present. As a conservative measure, the sample reporting the higher concentration of the relevant analyte should be used when making decisions regarding contamination risks on the site. Performance against indicator considered acceptable.
SOPs appropriate and complied with	100%	100%	Acceptable
Laboratory Considerations	**Target**	**Actual**	**Comment**

Laboratory duplicates	No exceedances of laboratory acceptance criteria	Nine exceedences	Four exceedences in batch SE17488 were reported to have results less than 5 times the limit of reporting, which preclude acceptance criteria for relative percentage differences. Five exceedences in batch SE174689 were reported to have failed acceptance criteria due to sample heterogeneity. Performance against indicator considered acceptable.

The data collected is considered to be adequately precise.

8.5 Accuracy

An assessment of the precision of data collected was undertaken, and the results presented in **Table 8.5**.

Table 8.5 Accuracy DQI

Field Considerations	Target	Actual	Comment
Rinsate blanks	Less than laboratory limit of reporting	100%	Two rinsate blanks (RB01 and RB02) were collected in 13 January 2018, and two rinsate blanks (RB03 and RB04) were collected on 14 January 2018. Performance against indicator considered acceptable.
Field trip spikes	Recoveries between 60% and 140%	100%	Two trip spikes were used on 13 January 2018. One trip spike was used on 14 January 2018 (but dated 13 January 2018 in lab results) samples from both days were shipped to the laboratory as one batch. Performance against indicator considered acceptable.

Field trip blanks	Analyte concentration <LOR	100%	Two trip blanks were used on 13 January 2018. One trip blank was used on 14 January 2018 (but dated 13 January 2018 in lab results), as samples from both days were shipped to the laboratory as one batch. Performance against indicator considered acceptable.
Laboratory Considerations	**Target**	**Actual**	**Comment**
Laboratory method blank	No exceedances of laboratory acceptance criteria	Nil	Acceptable
Matrix spike recovery	No exceedances of laboratory acceptance criteria	Four exceedences	Two exceedences in batch SE174488 were reported to have failed recovery acceptance criteria due to sample heterogeneity, and matrix interference. Two exceedences in batch SE174689 were reported to have failed recovery acceptance criteria due to the presence of significant concentration of analyte (i.e. the concentration of analyte exceeds the spike level), and matrix interference. Performance against indicator considered acceptable.
Surrogate spike recovery	No exceedances of laboratory acceptance criteria	Nil	Acceptable
Laboratory control sample recovery	No exceedances of laboratory acceptance criteria	Nil	Acceptable

The data collected is considered to be adequately accurate.

9. DISCUSSION

A discussion on comparison of laboratory analytical results and field observations, in the context of the assessment criteria adopted for this investigation, is presented in **Sections 9.1** to **9.4**. Exceedences of those adopted criteria, are presented graphically in **Figure 7** and **Figure 8**.

9.1 Human Health - Direct Contact

9.1.1. TRH

The concentrations of TRH C_6-C_{10}, >C_{10}-C_{16}, >C_{16}-C_{34} and >C_{34}-C_{40} detected in the soil samples analysed, were less than the applicable adopted direct contact human health exposure criteria.

9.1.2. BTEX

The concentrations of benzene, toluene, ethyl benzene and xylenes detected in the soil samples analysed, were less than the applicable adopted direct contact human health exposure criteria.

9.1.3. PAH

The concentrations of naphthalene detected in the soil samples analysed, were less than the applicable adopted direct contact human health exposure criteria.

The concentrations of benzo(a)pyrene TEQ detected in the soil samples analysed, were less than the applicable adopted direct contact human health exposure criteria (3mg/kg), with the following exceptions:

- BH04-0.0-0.2 (8.5mg/kg) – concrete, brick and ballast were observed in the sample collected. This sample was collected at the southern end of AEC02 (Building Y1) to target the boat building and chemical storage land use activity. However, based on field observations and the detected concentrations of other analytes in this sample, the elevated benzo(a)pyrene (TEQ) concentration may be associated with uncontrolled filling, rather than boat building / chemical storage activities. Similar visual observations were made in a sample collected at 0.6-0.7, but not 1.0-1.2;

- BH16-1.5-1.7 (18mg/kg) – charcoal was observed in the sample collected. This sample was collected in AEC11 to target suspected uncontrolled filling around the tennis courts. Charcoal was also observed in the samples at depths of 0.5-0.6 and 0.9-1.1 at BH04, however, the detected concentration of benzo(a)pyrene (TEQ) in these samples (<0.3mg/kg and 0.4mg/kg) was well below the adopted criteria. Based on field observations and the detected concentrations of other analytes in this sample, the elevated benzo(a)pyrene (TEQ) concentration may be associated with uncontrolled filling; and

- BH23/0.05-0.15 (8.4mg/kg) – bitumen and roadbase pavement sampled. This sample was collected in AEC15 (south of Building T, to target the footprint of a former building. The detected concentration of benzo(a)pyrene (TEQ) in a sample collected from 0.3-0.5 at BH23 was <0.3mg/kg. Based on field observations and the detected concentrations of other analytes at this sampling point, the elevated concentration benzo(a)pyrene (TEQ) is considered likely to be associated with the bitumen pavement materials, as opposed to the former building land use. A footnote in Table 1A(1) of NEPC (1999a) notes that where benzo(a)pyrene occurs in bitumen fragments, it is relatively immobile and does not represent a significant health risk;

The concentrations of total PAH (16) detected in the soil samples analysed, were less than the applicable adopted direct contact human health exposure criteria.

9.1.4. OCP

The concentration of relevant OCP compounds detected in the soil samples analysed, were less than the applicable adopted direct contact human health exposure criteria.

9.1.5. PCB

The concentration of relevant PCB compounds detected in the soil samples analysed, were less than the applicable adopted direct contact human health exposure criteria.

9.1.6. Metals

The concentrations of arsenic, cadmium, chromium, copper, lead, nickel, zinc and mercury detected in the soil samples analysed, were less than the applicable adopted direct contact human health exposure criteria, with the following exceptions:

- Lead in sample BH02-0.0-0.2 (560mg/kg, criteria of 300mg/kg) – this sample was collected in AEC01 to target suspected uncontrolled filling. The sample was collected from fill material. The detected concentration of lead in the sample collected from 0.5-0.6 (inferred natural material) was 4mg/kg. Based on field observations and the elevated concentration of lead at BH02 is considered likely to be limited to the filling material;

- Lead in sample BH22-0.8-1.0 (490mg/kg, criteria of 300mg/kg) – this sample was collected at the south eastern end of AEC14 (south of Building R), to target a former building land use activity. The sample was collected from fill material. The detected concentration of lead in the sample collected at 0.5-0.6 (also fill material) was 150mg/kg. Based on field observations and the detected concentrations of other analytes at BH22, the elevated concentration of lead could be associated with uncontrolled fill, or land use activities associated with the former building at this location; and

- Lead in sample BH24-0.0-0.2 (610mg/kg, criteria of 300mg/kg) – this sample was collected at the north eastern end of AEC14 (east of Building T), to target a former building land use activity. The sample was collected from fill material. The detected concentration of lead in the sample collected at 0.2-0.4 (inferred natural material) was 4mg/kg. Based on field observations and the detected concentrations of other analytes at BH24, the elevated concentration of lead could be associated with uncontrolled fill, or land use activities associated with the former building at this location.

9.1.7. Asbestos Containing Materials

There were observations made of fragments of fibrous cement sheeting (conservatively assumed to contain asbestos), in the vicinity of sampling points:

- BH07 (AEC05 – former building and vicinity of uncontrolled filling);

- SS02 (east of AEC12 – curtilage of former building and in vicinity of uncontrolled filling); and

- SS03 (AEC18 – uncontrolled filling).

Asbestos was detected by the analytical laboratory in samples:

- BH30-0.0-0.2 – asbestos was detected in a <7mm fragment which is considered to be asbestos fines (friable). The sample was collected from AEC19, to target potential uncontrolled filling material in the south western portion of the site;

- BH40-0.05-0.2 - asbestos was detected in a <7mm fragment which is considered to be asbestos fines (friable). The sample was collected from fill material in the south western carparking, as part of obtaining general site coverage data;

- BH41-0.05-0.2 – asbestos was detected in a number of fragments, at a concentration of >0.01% w/w. The sample was collected from fill material in the south western carparking area, as part of obtaining general site coverage data; and

- BH41-0.5-0.6 - asbestos was detected in a <7mm fragment which is considered to be asbestos fines (friable). The sample was collected from fill material in the south western carparking area, as part of obtaining general site coverage data.

The locations of these observations / detections are presented in **Figure 8**.

An assessment of the locations where asbestos has been identified, indicates that while the presence of asbestos could be attributed to historical uncontrolled demolition and/or uncontrolled filling, the available data does not indicate a discernible distribution pattern of asbestos in soil on the site.

9.2 Human Health – Inhalation / Vapour Intrusion (Residential)

9.2.1. TRH

The concentrations of TRH C_6-C_{10} (minus BTEX) and >C_{10}-C_{16} (minus naphthalene) detected in the soil samples analysed, were less than the applicable adopted inhalation / vapour intrusion human health exposure criteria.

9.2.2. BTEX

The concentrations of benzene, toluene, ethyl benzene and xylenes detected in the soil samples analysed, were less than the applicable adopted inhalation / vapour intrusion human health exposure criteria.

9.2.3. PAH

The concentrations of naphthalene detected in the soil samples analysed, were less than the applicable adopted inhalation / vapour intrusion human health exposure criteria.

9.3 TPH Management Limits (Residential)

The concentrations of TRH C_6-C_{10}, >C_{10}-C_{16}, >C_{16}-C_{34} and >C_{34}-C_{40} detected in the soil samples analysed, were less than the applicable adopted TRH management limits.

9.4 Aesthetics

There were no observations of odours, significant chemical deposits/wastes, large monolithic deposits of low risk material or putrescible waste in the soils sampled.

There were observations made of fragments of fibrous cement sheeting (conservatively assumed to contain asbestos), in the vicinity of sampling points BH07 (AEC05), SS02 (east of AEC12), and SS03 (AEC18).

10. CONCLUSIONS AND RECOMMENDATIONS

Based on AG's assessment of the desktop review information, fieldwork data and laboratory analytical data, in the context of the proposed redevelopment scenario, AG makes the following conclusions:

- the concentrations of identified contaminants of potential concern in the soils assessed are considered unlikely to present an unacceptable direct contact human health exposure risk, with the exception of:
    - lead in soil at BH02 (560mg/kg), lead in soil at BH22 (490mg/kg) and lead in soil at BH24 (610mg/kg);
    - benzo(a)pyrene (TEQ) in soil at BH04 (8.5mg/kg), BH16 (18mg/kg), and BH23 (8.4mg/kg); and
    - asbestos in soils in the vicinity of sampling points BH07, SS02, SS03, BH30, BH40 and BH41.
- the concentrations of identified contaminants of potential concern in the soils assessed are considered unlikely to present an unacceptable inhalation / vapour intrusion human health exposure risk;
- the concentrations of identified contaminants of potential concern in the soils assessed are considered unlikely to present a petroleum hydrocarbon management limit risk;
- the asbestos detected in the soils assessed, may present an unacceptable human health exposure risk and unacceptable aesthetics risk;
- the site could be made suitable for the proposed land use setting, subject to the further assessment, management and/or remediation of potential unacceptable contamination risks and those areas unable to be assessed.

Based on these conclusions, AG makes the following recommendations:

- A Supplementary Contamination Assessment should be undertaken by a suitably experienced environmental consultant to:
    - further characterise the nature and extent of the elevated concentrations of lead in soil risks and benzo(a)pyrene (TEQ) in soil risks;
    - further characterise the nature and extent of asbestos in soil risks, and provide a quantitative assessment of those risks;
    - address data gaps associated with AEC13, the southern portion of AEC10, and central portions of AEC02, AEC03, AEC09, AEC12, AEC14, AEC15, AEC16 (constrained due to the presence of existing structures and/or accessibility constraints);
- consideration should be given to removal of existing structure and accessibility constraints, prior to undertaking the supplementary contamination assessment. Removal of access constraints would likely also require provision for significant surface and pavement disturbance across the site to facilitate quantitative asbestos in soil risk assessment;
- pending the findings of the supplementary contamination assessment, a remedial action plan should be prepared to address unacceptable soil contamination related human health exposure risks. The RAP should be prepared by a suitably experience consultant with reference to NSW OEH (2011) and include (but not be limited to) the following:
    - a remedial goal for the site;
    - an assessment of remedial options available to address the identified asbestos risks. These options may include removal offsite, in-situ containment, ex-situ containment, or a combination of these:
        - Offsite removal would likely involve excavation and disposal of impacted materials. Subject to successful removal of all impacted material, it is unlikely that a long term operational

environmental management plan (EMP) would be required for the proposed development site;

- In-situ containment could include application of a capping layer across the site. Typically, concrete and/or asphalt pavements are adequate for non-exposed soils, while a minimum 0.5m thickness of clean fill (excluding planting media) would be required in unsealed areas (e.g. playgrounds, soft landscaping etc). Depending on design levels for the development, a portion of the impacted soils may require removal offsite to allow for capping layer thicknesses. This remedial strategy would likely require a long term environmental management plan (EMP) for the proposed development site, and notification on the Section 149 planning certificate and/or title for the site;

- Ex-situ containment could include excavation and relocation of a portion of the impacted material elsewhere on the site, and application of a capping layer (similar to that discussed for in-situ containment). This remedial strategy would likely require a long term operational environmental management plan (EMP) for the proposed development site, and notification on the Section 149 planning certificate and/or title for the site;

  - the proposed testing to validate the site after remediation;
  - the proposed testing to validate the site after remediation;
  - a contingency plan to address unexpected finds or if the selected remedial strategy fails; and
  - a site management plan (for the remediation works).

This report, including its conclusions and recommendations, must be read in conjunction with the limitations presented in Section 11.

11. STATEMENT OF LIMITATIONS

The findings presented in this report are based on specific searches of relevant, government historical databases and anecdotal information that were made available during the course of this investigation. To the best of our knowledge, these observations represent a reasonable interpretation of the general condition of the site at the time of report completion.

This report has been prepared solely for the use of the client to whom it is addressed and no other party is entitled to rely on its findings.

No warranties are made as to the information provided in this report. All conclusions and recommendations made in this report are of the professional opinions of personnel involved with the project and while normal checking of the accuracy of data has been conducted, any circumstances outside the scope of this report or which are not made known to personnel and which may impact on those opinions is not the responsibility of Alliance Geotechnical Pty Ltd. Should information become available regarding conditions at the site including previously unknown sources of contamination, AG reserves the right to review the report in the context of the additional information.

This report must be reviewed in its entirety and in conjunction with the objectives, scope and terms applicable to AG's engagement. The report must not be used for any purpose other than the purpose specified at the time AG was engaged to prepare the report.

Logs, figures, and drawings are generated for this report based on individual AG consultant interpretations of nominated data, as well as observations made at the time site walkover/s were completed.

Data and/or information presented in this report must not be redrawn for its inclusion in other reports, plans or documents, nor should that data and/or information be separated from this report in any way.

Should additional information that may impact on the findings of this report be encountered or site conditions change, AG reserves the right to review and amend this report.

12. REFERENCES

Alliance Geotechnical 2017a, '*Stage 1 Preliminary Site Investigation, Portion of Lot 1 in DP837179 (Lot 10 in DP1232584), Meadowbank Education and Employment Precinct Schools Project, 2 Rhodes Street, Meadowbank, NSW*', dated June 2019, ref: 6179-ER-1-1 REV5;

National Environment Protection Council (NEPC) 1999a, 'Schedule B(1) Guideline on Investigation Levels for Soil and Groundwater, National Environment Protection (Assessment of Site Contamination) Measure (NEPM) as amended in May 2013'.

National Environment Protection Council (NEPC) 1999b, 'Schedule B(2) Guideline on Site Characterisation, National Environment Protection (Assessment of Site Contamination) Measure (NEPM) as amended in May 2013'.

NSW DEC 2006, 'Contaminated Sites: Guidelines for the NSW Site Auditor Scheme (2nd edition)'.

NSW EPA 1995, 'Contaminated Sites: Sampling Design Guidelines'.

NSW OEH 2011, 'Contaminated Sites: Guidelines for Consultants Reporting on Contaminated Sites'.

WA DOH 2009, 'Guidelines for the Assessment, Remediation and Management of Asbestos-Contaminated Sites in Western Australia' dated May 2009.

FIGURES

TABLES

APPENDIX A

SURVEY (Lot Plan and Detail Level)

APPENDIX B

LOGS

APPENDIX C

CALIBRATION

APPENDIX D

LABORATORY