Urban Growth NSW

Remedial Action Plan

Sewage Treatment Plant
Former Defence Ingleburn Site
Campbelltown Rd, Edmondson Park,
NSW

20 April 2015
43008-57149 (Rev 1)

www.jbsg.com.au

UrbanGrowth NSW

Remedial Action Plan

Sewage Treatment Plant
Former Defence Ingleburn Site
Campbelltown Rd, Edmondson Park, NSW

20 April 2015
43008–57149 (Rev 1)
JBS&G

Table of Contents

Figures

Appendices

List of Abbreviations

ACM	Asbestos Containing Material
AHD	Australian Height Datum
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, xylenes
COC	Chain of Custody
COPC	Contaminant of potential concern
CSM	Conceptual site model
BTEX	Benzene, toluene, ethylbenzene and xylenes
B(a)P	Benzo(a)pyrene
DEC	NSW Department of Environment and Conservation
DECCW	NSW Department of Environment, Climate Change and Water
DO	Dissolved oxygen
DQI	Data quality indicator
DQOs	Data Quality Objectives
DWE	NSW Department of Water and Energy
Eh	Redox Potential
EPA	NSW Environment Protection Authority
ESA	Environmental Site Assessment
ha	Hectare
HIL	Health based investigation level
IDS	Ingleburn Defence Site
JBS&G	JBS&G Australia Pty Ltd
LOR	Limit of Reporting
NEPM	National Environment Protection Measure
OEH	Office of Environment and Heritage
OCP	Organochlorine Pesticides
PAH	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyls
PID	Photo-ionisation Detector
PQL	Practical Quantitation Limit
QA/QC	Quality Assurance/Quality Control
RAP	Remedial Action Plan
RPD	Relative Percentage Difference
SAQP	Sampling, Analysis and Quality Plan

SAR	Site Audit Report
SAS	Site Audit Statement
SMF	Synthetic Mineral Fibres
STP	Sewage Treatment Plant
TPH	Total Petroleum Hydrocarbons
UGNSW	UrbanGrowth NSW
VOC	Volatile Organic Compound

Executive Summary

JBS&G Australia Pty Ltd (JBS&G) was engaged by UrbanGrowth NSW (UGNSW, the client) to develop a Remedial Action Plan (RAP) for remediation of the Sewage Treatment Plant (STP) and two associated oxidation pond areas, accessed from Campbelltown Road at Edmondson Park, NSW. The site location is shown on **Figure 1**.

The site comprises the STP Compound and two oxidation ponds, which cover an area of approximately 1.5 to 2 hectares (ha). Within the STP Compound are several buildings, primary treatment ponds, pipes, tanks, two large trickle filters and associated infrastructure. The site layout is shown on **Figure 2**.

The site is a redundant STP for the former Ingleburn Army Camp.

Previous investigations have been completed within the site and adjacent to the site. The investigation identified elevate nutrients within soils and groundwater at the site, biological constituents in soils down gradient of the STP area and asbestos containing materials (ACM) along the STP boundary. Additionally, TPH and biologicals were reported in sewer sludge. The TPH concentrations were attributed to organic matter in the sediment.

A subsequent detailed site assessment was completed by JBS&G (JBS&G 2013[1]) which included investigation of the soil within the STP compound and in and around the oxidation ponds. One location within the western oxidation pond contained elevated lead, one location within the eastern oxidation pond contained asbestos fragments, and three locations which contained biological impacts (E.Coli).

Consequently, this RAP has been developed to address the identified impacts at the site.

The objectives of the RAP are to:

- Summarise the Site characteristics;
- Define the extent of remediation required;
- Assess appropriate remediation options and select a preferred option;
- Document the remediation methodology, including the associated safety and environmental management controls;
- Establish pre-determined validation criteria relevant to the likely future land use and detail the validation program (including reporting);
- Identify the regulatory requirements relevant to the proposed remedial works; and
- Outline any potential ongoing monitoring or management requirements to ensure the continued protection of human health and the environment.

The preferred remedial option is to excavate impacted fill materials for potential onsite containment with management under an Environmental Management Plan (EMP) with onsite treatment and retention of biologically impacted materials.

Subject to the successful implementation of the measures detailed in this RAP and subject to the limitations in **Section 13**, it is considered that the identified impacted soils can be remediated and validated without the need for further management.

[1] Environmental and Geotechnical Site Investigation, Sewage Treatment Plant, Former Defence Ingleburn Site, Campbelltown Road, Edmondson Park, NSW, JBS&G 2013 (JBS&G 2013)

1 Introduction

1.1 Background

JBS&G Australia Pty Ltd (JBS&G) was engaged by UrbanGrowth NSW (UGNSW, the client) to develop a Remedial Action Plan (RAP) for remediation of the Sewage Treatment Plant (STP) and two associated oxidation pond areas, accessed from Campbelltown Road at Edmondson Park, NSW. The site location is shown on **Figure 1.**

The site comprises the STP Compound and two oxidation ponds, which cover an area of approximately 1.5 to 2 hectares (ha). Within the STP Compound are several buildings, primary treatment ponds, pipes, tanks, two large trickle filters and associated infrastructure. The site layout is shown on **Figure 2**.

The site is a redundant STP for the former Ingleburn Army Camp. When acquired by UrbanGrowth NSW in 2011, the STP was servicing the Ingleburn North Primary School, the Bardia Barracks heritage precinct and a number of residential tenancies. The STP was shut down in late 2011. The Department of Defence (Defence) had undertaken a number of investigations of the site, but had not initiated any remedial plans. Other areas of the former Ingleburn Defence Site (IDS) have undergone investigation and remediation, and are subject to a Site Audit Statement (SAS) regarding their suitability for mixed land uses. The STP and oxidation ponds were excluded from the remediation program and the SAS. The site boundaries on **Figures 1** and **2** are based on figures provided in the Site Audit Report (SAR)[2] indicating the area as being excluded.

The majority of the site is zoned E1 under the Liverpool City Council's Local Environment Plan (LEP 2008[3]) for the future Edmondson Regional Park, and once remediated, is to be transferred to the Office of Environment and Heritage (National Parks) (OEH). A section of the site (understood to comprise the western-most oxidation pond and clearing) is zoned RE1 (LEP 2008) and is to become local open space area managed by Liverpool City Council.

Previous investigations have been completed within the site and adjacent to the site. The investigation identified elevate nutrients within soils and groundwater at the site, biological constituents in soils down gradient of the STP area and asbestos containing materials (ACM) along the STP boundary. Additionally, TPH and biologicals were reported in sewer sludge. The TPH concentrations were attributed to organic matter in the sediment. The elevated nutrients may have been attributed to natural features of the soils present at the site. The biologicals were not compared with guidelines during the previous assessments.

A subsequent detailed site assessment was completed by JBS&G (JBS&G 2013[4]) which included investigation of the soil within the STP compound and in and around the oxidation ponds. The investigation included the advancement of test pits and installation of four groundwater monitoring wells.

With the exception of one location within the western oxidation pond that contained elevated lead, one location within the eastern oxidation pond which contained asbestos fragments, and three locations which contained biological impacts (E.Coli), all concentrations of contaminants of potential concern (COPCs) were below the relevant assessment criteria.

Based on the previous assessment (JBS&G 2013) it was considered the site could be made suitable for the proposed open space land use subject to remediation, including onsite

[2] *Site Audit Report – Defence Ingleburn Site*, prepared for Department of Defence by AECOM Australia Pty Ltd, 25 July 2011 (AECOM 2011).

[3] Liverpool City Council Local Environment Plan, 2008, (LEP 2008)

[4] Environmental and Geotechnical Site Investigation, Sewage Treatment Plant, Former Defence Ingleburn Site, Campbelltown Road, Edmondson Park, NSW, JBS&G 2013 (JBS&G 2013)

containment of materials where appropriate. Six areas were identified for potential containment cell locations.

This RAP has been prepared with reference to relevant Australian Standards and guidelines made or approved by the NSW Environmental Protection Authority (EPA).

1.2 Objectives

The objective of this RAP is to document the procedures and standards to be followed in order to remove potentially unacceptable risks posed by contaminated soils (asbestos, heavy metals and biologicals impacted soils), while ensuring the protection of human health and the surrounding environment for the proposed open space landuse. Further, the RAP was to provide advice regarding options and concept designs for onsite containment, should this be considered an appropriate remediation approach during the RAP development.

2 Site Conditions and Surrounding Environment

2.1 Site Identification

Detailed information about the site condition, physical characteristics, history and surrounding land uses is provided in ERM (2010). The following is a summary of relevant information.

The site layout is shown on **Figure 2**. The site details are summarised in **Table 2.1**.

Table 2.1 Summary of Site Details

Lot/DP	Part of Lot 3 in Deposited Plan (DP) 831152
Address	Off Campbelltown Road, Edmondson Park, NSW
Local Government Authority	Liverpool Council
Site Zoning	E1 for the future Edmondson Regional Park, except western oxidation pond zoned RE1 Public Open Space
Current Use	Former STP and associated oxidation ponds
Proposed Use	Edmondson Regional Park under OEH management, except western oxidation pond to be Public Open Space under Liverpool Council management.
Site Area	Approximately 1.5 to 2 ha
MGA Coordinates (Zone 56) of approximate centre of STP Compound	E: 302796 N: 6239208

2.2 Site Condition

The site comprised the STP Compound and the eastern and western oxidation ponds to the northeast and north of the STP Compound respectively. The clearings immediately east of the STP Compound and south of the western oxidation pond do not form part of the site, as these areas were included in the AECOM (2011) Site Audit. However, these areas are discussed herein for the purpose of identifying potential future on-site containment areas..

STP Compound

The STP Compound (STP) comprises a square area, approximately 1.2 ha, within a wire-mesh security fence. An unsealed access road is located outside the eastern STP boundary, between the STP and the clearing east of the STP. According to ERM (2010[5]), this cleared area east of the STP is a former sewage sludge disposal (SSD) area that has since been remediated and included in the AECOM (2011) SAS.

The STP area slopes to the north and northeast, other than flat areas presumably excavated level for placement of STP infrastructure, which includes several buildings, primary treatment ponds, pipes, tanks, two large circular trickle filters and associated infrastructure. ERM 2010 provides a description of the STP infrastructure and process, while ERM (2011[6]) provides further detail on the infrastructure. The following is noted:

- Grit chambers are comprised primarily of concrete, with a depth of approximately 0.6 m to 1 m;
- Two primary settling tanks are concrete funnel-shaped structures with a depth of approximately 8 to 10 m;
- Sludge digesters are circular with approximate depths of 6 to 8 m, and an interim chamber with a depth greater than 6 m;
- The pump house within the valve house has an estimated depth of between 6 and 8 m;
- Drying beds comprised 0.5 m thick coarse filter sand with some perforated terracotta underlying for drainage, surrounded by concrete walls;

[5] *Phase II Environmental Site Assessment, Sewage Treatment Plant, Campbelltown Road, Ingleburn, Final*, prepared for Department of Defence by Environmental Resources Management Australia, 13 October 2010 (ERM 2010).

[6] *Ingleburn Sewage Treatment Plant, Preliminary Remedial Strategy*, prepared for Department of Defence by Environmental Resource Management Australia Pty Ltd, 4 March 2011 (ERM 2011).

- Trickle filters are two large circular concrete structure approximately 2 to 3 m high, filled with cobble-sized stone grading to coarse sand substrate. Two metal irrigation booms are understood to have possibly contained mercury bearings, however these are also reported to have possibly been removed; and
- Tertiary treatment tanks store effluent after the trickle filters, prior to discharge to the oxidation ponds, however ERM (2011) reports the tanks have not been used for any specific treatment since operated by Sydney Water. The tanks comprise concrete and are approximately 4 m deep.

Surfaces were largely unsealed and vegetated (grass and minor trees) other than where there are concrete paths between structures and immediately surrounding the base of most structures.

Structures at the site are understood to comprise hazardous building materials including asbestos containing material (ACM).

Oxidation Ponds

The oxidation ponds are located approximately 150 m north and northeast of the STP, and were used to store treated water. The majority of the water is reported to have been used by a nearby golf course for irrigation, with any overflow discharging to a small creek to the northeast (ERM 2010).

The western (primary) and eastern (secondary) oxidation ponds are separated by a narrow cleared area. At the eastern end of the western oxidation pond is a small pumping station, with an underground concrete pipe connecting the two ponds.

2.3 Surrounding Landuse

Current landuse of adjacent properties or properties across adjacent roads is summarised as follows:

- North – a mixture of bushland north of the STP and eastern oxidation pond, and semi-rural residential land north of the western oxidation pond. A small creek is located north of the STP, which flows in an easterly direction towards the eastern oxidation ponds;
- East – bushland, with the exception of a clearing to the east of the STP Compound;
- South – bushland between the site and Campbelltown Road; and
- West – bushland.

2.4 Topography and Drainage

The STP generally follows regional topography, sloping generally towards the north and northeast. ERM (2010) report the elevation at the southwest corner of the STP is 47.5 m AHD. The area immediately surround the oxidation ponds is relatively level. Land north of the oxidation ponds slopes gently to the southeast towards the ponds.

A small creek is located north of the STP, and appears to flow easterly towards the oxidation ponds, and from there to the east into bushland. ERM report the creek flows intermittently after periods of heavy rain. The creek is referred to as Maxwells Creek by ERM (2011). ERM (2010) also report the oxidation ponds can dry out in dry conditions.

Rainfall will generally follow the local topography towards the creek and oxidation ponds, where rainfall is too great for infiltration into unsealed ground surfaces.

2.5 Geology and Hydrogeology

ERM (2010) report the site is located over Bringelly Shale, part of the Wianamatta Group being the uppermost unit of the Sydney Basin. The Bringelly Shale is reported to comprise

shale, carbonaceous claystone, laminate, fine to medium grained lithic sandstone, rare coal and tuff.

The site-specific geology is summarised below and is based on both the ERM (2010) and JBS&G (2013) assessments:

- A layer of fill or topsoil covers the STP area, overlying natural clay and weathered shale and shale bedrock, with bedrock at depths between 1.3 and 4 m below ground surface (bgs);
- Within a former sludge drying bed in the east of the STP, a thin layer of silty sewage sludge (0.05 m bgs) underlain by coarse grained sand to 0.3 m bgs and very coarse gravel to 0.5 m bgs was encountered over natural clays at 0.5 m bgs;
- Within the oxidation ponds there was an upper layer of dark brown silty 'sludge' over silty clay, clayey silt or clayey sand, with stiff natural clay between 0.4 m and 0.8 m bgs.

Strong organic/sulphurous odours (not hydrocarbon) were observed in shale or weathered shale at depths from 5 m to 8 m bgs in three locations in the north and northwest of the STP. ERM did not consider these associated with hydrocarbons, but rather hydrogen sulphide production.

ERM report regional groundwater occurs within the shales with principle flow through fissures and joints within the bedrock, although with low potential for movement. Groundwater is reported to be somewhat saline and typically hard.

During drilling, ERM reported water encountered at two of five borehole locations in the STP area between 4 m bgs at the northern STP boundary and 5.3 m bgs near the northwest STP boundary, in shale or weathered shale. The boreholes were drilled to between 8 m and 12 m bgs. Final water levels following installation of monitoring wells at the five locations ranged from 2.2 m to 5.8 m bgs, with predicted groundwater contours indicating groundwater flow to the east. The groundwater was under reducing and low dissolved oxygen (DO) conditions, except at the southeast corner, with organic/sulphurous odours noted in groundwater at two locations, consistent with similar odours in shales at depths where water ingress is expected.

During the JBS&G (2013) investigation, fill material within the STP area was encountered from the ground surface at all sampling locations and generally comprised topsoil of silty clay and silty sand. The fill material extended to depths of between 0.3 m (TP12 and TP23) and 1.3 m bgs in the majority of locations.

Material in the trickle filter comprised angular gravels and building rubble. No fines were observed within or at the base of the gravels. The thickness of filter material in TP17 and TP18 was observed to be between 1.9 to 2.1 m.

Within the oxidation ponds fill material was encountered from the ground surface at all sampling locations and generally comprised topsoil of silty clay and silty sand. The fill material extended to depths of between 0.3 m (TP12 and TP13) and 1.0 m bgs in the majority of locations.

Residual clay soils were encountered from 0.4 to 4.2 m depth and weathered shale was encountered at depths of 1.7 m to 6.7 m bgs, with shale bedrock underlying.

The geology encountered was generally consistent with the previous investigation (ERM 2010).

During the previous investigation (JBS&G 2013), three monitoring wells (MW01-MW03) were installed in the STP area. Additionally, a monitoring well (MW04) was installed in the oxidation ponds area and a monitoring well was placed west of the settling tanks and sludge digesters in the south of the STP.

Groundwater levels from the JBS&G investigation ranged between 3.218 and 8.521 m bgs with groundwater elevations ranging between 38.569 m AHD (MW03) and 43.026 m AHD (MW04). The groundwater flow direction is anticipated to the north east. The water quality parameters were comparable to the ERM investigation.

3 Site History

A detailed site history is provided in ERM (2010). Based on historical aerial photographs, the STP was present in 1947, with land surrounding the STP cleared and containing only scattered trees. No changes were reported in subsequent aerial photographs up to 1994.

An historical title search was completed for the site. The search indicated that the site has been owned by the Commonwealth of Australia since 1943.

Information from UGNSW, who acquired the site in 2011, indicates the STP was servicing the Ingleburn North Primary School, the Bardia Barracks heritage precinct and a number of residential tenancies, prior to it being shut down in late 2011. The STP was operated by Sydney Water on behalf of Defence (ERM 2011).

ERM reported the STP could have potentially been impacted by a wide range of liquid wastes and sewage sludge, including from possible sub-surface burial of general waste materials from the former Defence facility. It was reported by ERM (2011) the STP was likely to have had mercury seals on the main bearings of the trickle filter pivot mechanisms but that site staff suggested such seals may have been replaced and mercury removed. ERM did not obtain any documentation to verify bearing replacement or mercury removal.

As previously noted, treated dried sewage sludge from the STP had been disposed in the cleared area east of the STP, known as the SSD. This area has been remediated and validated and was the subject of a SAS (AECOM 2011).

4 Previous Investigations

A brief summary of the previous investigations is provided below. The previous locations completed by ERM (2010) and JBS&G (2013) are provided on **Figures 3a to 3b**. The previous investigation exceedances are shown on **Figure 4a** and **4b**.

4.1 ERM (ERM 2010) STP Assessment

The assessment of the STP area included the drilling of five boreholes to a maximum of 12 m bgs for installation of monitoring wells, and excavation of 19 test pits to a maximum of 1.5 m bgs for soil sampling. The locations were placed on a general grid pattern across the STP, noting that a number of test pit and two borehole locations appeared to be outside the fence surround the STP. The previous locations completed by ERM (2010) are provided in **Figure 3a** and **3b.**

The assessment of oxidation pond areas included installation of four test pits around the perimeter of each pond with the exception of one apparently placed towards the centre of the western pond. These were excavated to a maximum of 2.2 m bgs for sediment sampling.

A total of 54 primary soil and sediment samples from the STP area, and 16 primary samples from the two oxidation ponds, were analysed for a range of COPC including metals, total petroleum hydrocarbons (TPH), benzene, toluene, ethylbenzene and xylenes (BTEX), polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), organochlorine pesticides (OCPs) and asbestos, as well as nutrients including ammonia, nitrate and total phosphate. A number of samples were analysed for pathogens including E coli bacteria, faecal coliforms, salmonella bacteria, enteric viruses and helminths ova.

Relevant findings are summarised as follows:

- Minor ACM on the ground surface was observed on the boundary and outside the southeast STP boundary (at STPTP20). No asbestos fibres were reported in soil samples;
- Limited soil contamination was identified within the STP area, with only TPH (C_{10}-C_{36}) reported at 7400 mg/kg at STP TP14 (0.1 m) in the sludge drying beds exceeding adopted site assessment criterion of 1000 mg/kg (EPA 1994[7]). This sample was analysed without silica-gel clean-up to remove potential hydrocarbons associated with organic materials, as opposed to hydrocarbon-based sources. The maximum TPH (C_{10}-C_{36}) following repeat analysis with silica-gel clean-up was reported as 1470 mg/kg, in excess of the previously adopted criterion. Samples collected at depth reported TPH and PAH below the reporting limits or assessment criteria;
- Volatile TPH, BTEX, pesticides and PCBs were below laboratory limits of reporting (LOR) in all samples analysed, and metals were reported below LOR or adopted assessment criteria being NEPC (1999) health investigation levels for parks and recreational open space areas (HIL-E);
- Salmonella and faecal coliforms were detected in the sewage sludge drying beds at STP TP14, faecal coliforms were detected in surface soils (0.1 m) in STP BH03, TP16 and TP17, and helminths ova were detected in near-surface samples at STP TP12 (0.25 m) and TP17 (0.5 m). It is noted that STP TP16 and TP17 were respectively located at and towards the upslope STP boundary and may be considered as potential background locations with regards to STP operations. No assessment criteria were adopted for the assessment of these biological results;
- Elevated PID readings and organic/sulphurous odours in weathered and unweathered shale at depths below 5 m bgs in three borehole locations (STP BH01, BH02 and BH05) in the STP area were considered representative of hydrogen sulphide production and

[7] *Contaminated Sites: Guidelines for Assessing Service Station Sites*, NSW Environment Protection Authority, 1994 (EPA 1994)

not hydrocarbons. Similarly, elevated PID readings at locations in the oxidation ponds were considered associated with organic odours in silt or silty clay sediments/soils;

- Slightly elevated nutrient (ammonia, phosphorous and nitrate) concentrations were reported in the oxidation pond sediments, and Salmonella was detected in sediments at PBBH09 in the western (primary) oxidation pond in the vicinity of the treated water discharge point from the STP area;
- Elevated inorganics including ammonia were detected in groundwater at STPBH03 east (downgradient) of the trickle filters was considered related to the STP operation. Dissolved TPH (C_{29}-C_{36}) up to 160 ug/L was reported in two monitoring wells STP BH02 and BH04, located upgradient of STP infrastructure. Elevated metals in up- and down-gradient groundwater were considered likely to be background concentrations within the shale aquifer; and
- Mounding of groundwater was observed at STP BH02 that may be indicative of potential leakage of STP infrastructure, otherwise groundwater flow was assessed to be easterly.

Reference is made to an *Assessment of Fill Material within the Oxidation Pond Wall* by ERM (9 September 2010), however JBS&G was not provided a copy. No summary of previous investigations was provided.

4.2 ERM (2011) STP Preliminary Remedial Strategy

ERM prepared a preliminary remedial strategy for the STP and oxidation ponds on the basis the site would be 'redeveloped' for National Park use.

Relevant information relating to ERM (2011) summary of previous investigations is as follows:

- The treated dried sludge disposed in the SSD east of the STP contained elevated metals, predominantly mercury, exceeding 'residential land use guidelines', noting this area was remediated and validated and included in the AECOM (2011) SAS. URS (2004) indicated the SSD area was validated to guidelines consistent with residential use with accessible soil, although there were reportedly exceedances of EILs in the northern and western boundaries of the SSD area, and further assessment of these areas was recommended during subsequent investigations. Review of URS (2004) results indicates exceedances of previously adopted EILs included one location for arsenic (27 mg/kg), one location for nickel (107 mg/kg), one location for copper (173 mg/kg), zinc (340 mg/kg) and mercury (8.7 mg/kg), and three other locations for mercury (1.1 to 2.1 mg/kg);
- URS (2004) reported no enteric viruses, faecal coliforms, E. coli or Salmonella reported, and two detections of Helminths ova (Taenia species) to 0.32 units, being less than the adopted EPA (1997[8]) criterion of <1 plaque forming unit (PFU) per 4 g, in validation soil results for the SSD area east of the STP;
- Investigation of sediment samples by SKM in 2008 indicated elevated mercury concentrations in the oxidation ponds, although no concentrations were reported in ERM 2011), while further data gap investigation indicated mercury in sediments was found to have low leachability and would be classified as General Solid Waste if sediments were removed;
- It was considered a risk assessment would be required to assess potential risks from bacteria in soil reported by ERM (2010), as no threshold criteria were available for these analytes, although no further justification for this was included;

[8] *Use and Disposal of Biosolids Products* "Stabilisation Grade A Product", NSW EPA (1997).

- Previous reported (ERM 2010) ACM fragments on the boundary and at TP20 outside the southeast boundary of the STP had been removed by a licensed contractor as part of the IDS site remediation;
- The mounding at BH02 previously reported as potentially associated with STP infrastructure leakage was expanded upon, with ERM noting that results of groundwater analysis indicated that "if this is indeed occurring, the water is unlikely to be significantly impacted with any of the contaminants of concern";
- Inspection in November 2010 and discussion with Sydney Water staff confirmed the western settlement tank had leaked and created a zone of saturated soil and ponding to the west of the western digestor, in the southwest of the STP. It is noted this would appear unrelated to the abovementioned groundwater mounding north of the western trickle filter at BH02 in the northwest of the STP. Saturated soils were reported from surface in test pit STPTP13 southwest of the western digestor, but not in STPTP17 immediately northwest of the western digestor; and
- A HMBS in 2009 identified asbestos, lead based paints, PCB capacitors in light fittings and or synthetic mineral fibres (SMF) within the site shed and valve house.

4.3 JBS&G (2013) Environmental and Geotechnical Site Investigation

JBS&G was engaged by UGNSW to undertake a detailed environmental site contamination assessment of the site required prior to remediation of the Sewage Treatment Plant (STP) and two associated oxidation pond areas.

Soil sampling was completed for 37 locations across the site, including the STP and oxidation ponds. Additionally, four groundwater monitoring wells were installed and two surface water samples collected from the oxidation ponds.

The investigation reported the following:

- Fill material comprising a mix of silty clay /silty sand, gravels was identified at the site to depths of between 0.2 m bgs to 1.9 m bgs. Where encountered, natural soils underlying the fill material comprised either residual clay soil and/or weathered shale and shale bedrock;
- One sediment sample in the west oxidation pond was identified as having a concentration of lead (2100 mg/kg) that exceeded the NEPC (2013) health based investigation levels (HIL) and adopted ecological investigation levels (EIL) for urban residential and public open space landuse(s);
- A total of 4 samples from within the oxidation ponds, were analysed for E.Coli, faecal coliforms, salmonella, helminths ova and enteric viruses, with 1 having E.Coli samples (580 MPN in OPWS_01) above the NSW EPA (1997[9]) guidelines of <100 MPN per g (dry weight);
- Concentrations of COPCs were below the relevant criteria in all other samples collected from the STP, eastern oxidation pond and western oxidation pond;
- Suspected ACM were visually identified within soil at one location within the fill material, within the bank of the eastern oxidation pond during the investigation works. Subsequent selected laboratory analysis did identify a matted material containing asbestos fibres in fill material in the surface soil sample within the east oxidation pond;
- Concentrations of COPCs were below the relevant criteria in samples collected from the trickle filters;
- Groundwater and surface water heavy metal and organic contaminant concentrations were considered not to represent an unacceptable risk to sensitive receptors at, or down-gradient of the site as the metal concentrations are likely to be the result of background concentrations associated with the shale bedrock rather than

[9] *Use and Disposal of Biosolids Products* "Stabilisation Grade A Product", NSW EPA (1997).

contamination at the site which is consistent with the previous investigation (ERM 2010);

- Elevated concentrations of ammonia above the ANZECC (2004[10]) guidelines in groundwater were identified at one of the four groundwater sampling locations and surface water from the west oxidation pond. The ammonia concentration in groundwater is present in the sample collected at the up-gradient extent of the site in the STP area and the concentration at the down-gradient extent of the site is less than the adopted assessment criterion. The source of the ammonia in groundwater and surface water is considered to comprise the decomposition of organic material and is potentially a regional issues. The concentrations of ammonia in the current assessment is lower than the concentrations in the previous assessment (ERM 2010); and
- Biological concentrations within the oxidation sediments are lower in the JBS&G (2013) investigation across the site than the previous investigations (ERM 2010), as discussed in **Section 4**.

Based on the findings, the report considered that the site could be made suitable for the proposed use subject to implementation of an appropriate site management strategy to address site contamination issues in the soils/sediments, including the heavy metal, asbestos and E.coli impacts.

[10] *Australian Drinking Water Guidelines*, NHMRC 2004 (ANZECC 2004).

5 Remedial Action Plan

5.1 Remediation Objective

The primary remediation goal is to reduce the risks to future site users and the environment posed by the identified soil contamination at the site to acceptable levels to enable the proposed redevelopment of the site for open space use to proceed.

5.2 Extent of Remediation

Based on the findings of previous investigations (**Section 4**), the following areas (**Figure 5**) have been identified as requiring remediation:

- ACM fragments on the ground surface within the STP and within the soil in the eastern oxidation pond wall, as well as confirmation there is no remaining ACM in the vicinity observed during the previous investigations (at STPTP20, ERM 2010). It should be noted that the ERM 2011[11] Validation report indicated that all the ACM had been removed;
- The TPH impacted soil within the STP compound identified as part of the previous assessment (ERM 2010), which contained concentrations of C_{10}-C_{36} (after silica gel clean up) of 1470 mg/kg within the sample STTP14 (0.1 m);
- The lead impacted soil within the western oxidation pond; and
- The E.Coli impacted sediments within the oxidation ponds (JBS&G 2013) and from within the STP compound (ERM 2010).

It is understood that UGNSW may wish to use areas of the site and previously validated areas for containment of asbestos and other impacted soils.

The extent of impacted areas shown on **Figure 5** with the areas of the oxidation pond sediments and eastern oxidation pond embankment being subject to further characterisation.

5.2.1 Hierarchy of Remedial Options

The *Contaminated Sites Guidelines for the NSW Auditor Scheme* (DEC 2006) lists the following order of preference for soil remediation and management:

1. On-site treatment of the soil so that the contaminant is either destroyed or the associated hazard is reduced to an acceptable level;
2. Off-site treatment of excavated soil so that the contaminant is either destroyed or the associated hazard is reduced to an acceptable level, after which the soil is returned to the site;
3. Removal of contaminated soil to an approved site or facility, followed where necessary by replacement with clean fill; and
4. Consolidation and isolation of the soil on-site by containment within a properly designed barrier.

In addition, it is also a requirement that remediation should not proceed in the event that it is likely to cause a greater adverse effect than leaving the site undisturbed. And, where there are large quantities of soil with low levels of contamination, alternative strategies are required to be considered or developed (DEC 2006).

5.2.2 Options Assessment

Each of the potential remedial options have been assessed in **Table 5.1** following.

[11] *Validation Report*, Ingleburn Defence Site, Stage 3 Remediation Works, ERM 2011 (ERM 2011).

Table 5.1: Remediation Options Assessment Matrix

Remedial Option	Discussion	Conclusion
1. On-site treatment so that the contaminants are either destroyed or the associated hazards are reduced to an acceptable level.	Asbestos in fill material On-site treatment of ACM is not practicable as asbestos is a natural mineral fibre and cannot be readily destroyed, however, removal of the ACM, which removes the hazard from the ground surface, requires off-site disposal of the ACM to remove the hazard from the site.	Not a suitable option.
	Heavy metal impacts in fill Due to the relatively intractable nature of the contaminants within the fill material (i.e., heavy metals), there are no proven, cost effective or reliable treatment processes which are able to destroy the contaminant. However, there are a number of microencapsulation treatment technologies which can reduce the mobility of the identified contaminants of concern (e.g., cement stabilisation) and render the materials suitable for retention on site with ongoing management measures.	Not a suitable option.
	Biologicals/TPH On-site treatment of biological impacted soils is a suitable option. The sediment impacted would require excavation and spreading out to be dried. The removal of water and air drying/aeration would assist in the destruction of the biological impacts	Preferred option along with Option 4.
2. Off-site treatment so that the contaminants are either destroyed or the associated hazards are reduced to an acceptable level, after which the soil is returned to the site.	Asbestos in fill material There are no available off-site treatment facilities to treat asbestos impacted soils.	Not a suitable option.
	Heavy metal impacts in fill As above (Option 1), however, additional time, energy and costs are incurred to take materials off site and return them to the site.	Not a suitable option.
	Biologicals/TPH As above (Option 1), however, additional time, energy and costs are incurred to take materials off site and return them to the site and JBS&G is not aware of any licensed offsite facilities accepting material for offsite treatment.	Not a suitable option
3. Excavation and off-site removal of the impacted material.	Asbestos in fill material There are currently suitably licensed waste facilities in the Sydney Metropolitan region capable of accepting the identified contaminants within both the fill material. Hence, excavation and off-site removal is considered to be a feasible option. However, this option generates additional truck movements and associated fuel/emissions since materials are not returned to site. This option generates the highest quantity of waste, since the materials are disposed to landfill rather than treated and/or retained on site (option 4). This option is the most costly and generates additional environmental impacts, and it is understood that there is sufficient space available on site to safely contain the asbestos contamination as part of the proposed commercial/industrial development.	A potentially applicable option but inferior to on-site containment (option 4) due to additional costs and environmental impacts. More appropriate for large volumes of impacted material. Potentially appropriate for small volumes of impacted material and for small volumes unsuitable for containment.
	Heavy metal impacts in fill There are currently suitably licensed waste facilities in the Sydney Metropolitan region capable of accepting the identified contaminants.	A potentially applicable option but inferior to on-site containment (option 4) due to additional costs and environmental impacts. More appropriate for large volumes of impacted material. Potentially appropriate for small volumes of impacted material and for small volumes unsuitable for containment.

Remedial Option	Discussion	Conclusion
	Biologicals/TPH As above (Option 1), however, additional time, energy and costs are incurred to take materials off site	A potentially applicable option but inferior to on-site containment (option 2 & 4) due to additional costs and environmental impacts.
4. Consolidation and isolation of the soil by on-site containment with a properly designed barrier and ongoing management.	Asbestos in fill material Asbestos is suitable for consolidation and isolation within an on-site containment structure, given that it is not leachable and not volatile (refer to Section 5.2.3 for consideration of ANZECC 1999 guidance. This option is cost effective and results in less environmental impacts than other options involving off-site truck movements	The preferred option.
	Heavy metals impacts in fill material The identified metal contaminants are broadly suitable for consolidation and isolation within an on-site containment structure, given that they are relatively immobile (refer to Section 5.3.1 for consideration of ANZECC 1999 guidance.	The preferred option.
	Biologicals/TPH As above (Option1), drying out and then encapsulation of biologically impacted material would be a suitable option (refer to Section 5.3.1 for consideration of ANZECC 1999 guidance.	The preferred option.

5.3 Preferred Remedial Strategy

With consideration to clients preferred remediation methodology, the preferred remediation strategy is outlined as follows:

- Excavation of asbestos impacted material and onsite containment in dedicated containment cells (physical separation by covering), or removal for off-site disposal at appropriately licensed facilities;
- On-site containment of asbestos impacted material from the site, and potentially from other Edmondson Park development areas, within the containment cells, where there is sufficient material to warrant containment;
- Where there is insufficient material to warrant on-site containment, then material will be disposed off-site at appropriately licensed facilities;
- Excavation of areas of metal impacted soil/sediment requiring removal;
- On-site containment of lead impacted material from the site within the containment cells;
- Excavation and on-site treatment of biologically (E.Coli) impacted soil/sediments and on site treatment via landfarming/aeration, followed by on-site reuse, potentially as part of the capping media, or off-site disposal;
- Ongoing management via the development and implementation of an Environmental Management Plan (EMP) for the management of contaminated materials within containment cells where constructed and utilised.

It should be noted that six potential containment cell locations have been identified (Cells 1-6) should containment be warranted. The areas are shown on **Figures 6a to 6f**. These cells are described in **Section 6**, but include:

- Cell 1: Eastern Oxidation Pond;
- Cell 2: STP Area, west of access road;
- Cell 3: Cleared area east of STP;
- Cell 4: STP Area and cleared area east of STP;
- Cell 5: Western Oxidation Pond; and
- Cell 6: Western Oxidation Pond and clearing.

5.3.1 Cap and Containment

As noted in **Table 5.1** on-site containment is preferred where there is sufficient material to warrant containment on site as opposed to disposal off site. There may be insufficient contaminated material from the current STP site to warrant on-site containment. However, the site offers potential for containment cells to effectively manage similar contaminated materials from UGNSW's broader Edmondson Park development area, depending on the volume of such material that may be encountered and the benefits of on-site containment or off-site disposal.

In assessing the type of containment system(s) required for the site and the identified contaminants, reference has been made to ANZECC 1999[12], in addition to the *Management of asbestos in the non-occupational environment* (enHealth 2005). In relation to asbestos, on-site containment is identified as the preferred approach for sites impacted with asbestos (enHealth 2005).

Physical separation by covering to preclude the release of airborne asbestos fibres is all that is required to control the potential risks posed by this contaminant at the site.

[12] *Guidelines for the Assessment of On-Site Containment of Contaminated Soils, ANZECC* (1999).

With respect to the identified chemical contaminant impacted soils at the site, the TPH (C_{10}-C_{36}) and lead compound impacts fall within Group 9 and Group 5 as listed in Table 1 of the ANZECC (1999) on-site containment guidelines. For these contaminant groups, inhalation of vapours is not a primary exposure route. Therefore, implementation of a 'cap and contain' strategy comprising physical separation via capping as indicated in Table 2, ANZECC (1999), in conjunction with appropriate control measures, is appropriate.

It should be noted that any material brought onto the site from other Edmondson Park development areas for containment will also be subject to the ANZECC 1999 guidelines, with any other potential COPCs within imported material assessed against the ANZECC 1999 guidelines.

5.4 Scope of Remediation Works

A summary of the remedial scope of works is provided in the following sections.

5.4.1 Site Establishment

The boundary of the contaminated areas will be defined and the areas contained to ensure that all safety and environmental controls are implemented, including necessary contractor briefings and inductions for the remediation workforce. The boundaries of the containment cells will be defined and surveyed as part of the future EMP.

The details of such controls are provided in **Section 8.**

5.4.2 Demolition of STP Structures

This RAP does not extend to providing an appro roach to demolition of structures at the site. However, demolition of structures is required to achieve future landuse objectives, and appropriate validation of the site.

In order to conduct remedial works and, if appropriate, complete containment cells including the former STP area and portions of the oxidation pond areas, it is necessary to remove all pavements and structures present on the site. This includes removal of some relatively deep structures in the STP area, including the primary settling tanks which extend to approximately 8 to 10 m bgs, sludge digestors which extend to approximately 6 to 8 m bgs, and pump house which extends to approximately 6 to 8 m bgs. ERM (2011) provides some further information in relation to STP structures and demolition.

Caution should be taken during demolition to ensure hazardous materials in STP structures, including identified lead-based paint and asbestos materials, and potential mercury in bearings of the trickle filter pivot mechanism.

The trickle material (gravels) within the trickle filters have had some assessment (JBS&G 2013) however following removal from the concrete tanks further validation assessment of the material is warranted to verify on-site reuse or off-site disposal requirements (refer **Section 7**).

Demolition materials should be removed off site for recycling or disposal at appropriately licensed facilities, consistent with the material content. Demolition materials containing ACM or other hazardous materials or contaminants should not be mixed with other demolition materials that are not impacted. Appropriate controls should be in place to protect human health and the surrounding environment, including measures to ensure demolition does not cause contamination of soil, surface water or groundwater.

Where no hazardous materials have been identified in the structures the concrete could be crushed and utilised at the site or placed within containment cells.

5.4.3 Pond Dewatering & Sediment Removal

As previously note, water in the oxidation ponds has historically been used by a nearby golf course for irrigation, with any overflow discharging to a small intermittent creek to the northeast, and from there to the east into bushland, or drying out in dry conditions. The creek flows intermittently after periods of heavy rain.

Prior to use as containment cells, any water remaining in the oxidation ponds will need to be removed. Given the oxidation ponds currently overflow (when full) to the intermittent creek, it is proposed to discharge water to the creek. JBS&G (2013) reported that heavy metal and organic contaminant concentrations in oxidation pond surface water were considered not to represent an unacceptable risk to sensitive receptors at, or down-gradient of the site.

Should testing be requested/required prior to discharge, potential analyses may include the following:

- TPH;
- Heavy metals;
- pH;
- Ammonia;
- Total Suspended Solids; and
- Biologicals, including E.Coli.

Treatment of the water prior to discharge may be required. Subsequent testing of the treated water must be completed prior to discharge.

Appropriate sediment and erosion controls will need to be implemented prior to discharge to the creek.

After the removal of the water from the oxidation ponds, the sediment from the oxidation ponds will require aeration. If water does not ingress into the former oxidation ponds, the material can be dried out within the ponds, alternately a cleared area will be required to be set up for drying.

Based on limited assessment it is considered validation assessment will be required to provide better characterisation of relevant COPC distribution throughout the sediment in each pond (Refer **Section 7**).

Aeration of the sediment will be achieved by the spreading and turning regularly of the sediment until the appropriate moisture content reduction is achieved (i.e. not necessary to be dry).

Once dried appropriately, resampling will be completed to assess for biologicals and metals (as per Validation Plan in **Section 7**). Any impacted sediments will require separation from the non-impacted material where practicable prior to on-site reuse, containment or off-site disposal.

5.4.4 Define the Boundary of Contamination

<u>Non-friable ACM in Soil Impacts</u>

Fill material at sample location TP19, in the embankment of the eastern oxidation pond, has been found to be impacted with non-friable ACM.

Further assessment of the pond walls within the eastern oxidation pond must be completed after draining of the pond to assess for any further asbestos impacts beyond TP19. ACM impacted fill materials should be excavated, and validated as per **Section 7**.

Additionally, minor ACM fragments on the ground surface were observed on the boundary of and outside the south-eastern portion of the STP boundary. The ACM present on the ground surface should be removed through picking.

The impacted material can then be removed for off-site disposal or placed within an on-site containment cell.

Lead Impacts

Sediment within the western oxidation pond, at sample location OP WS-01, has been found to be impacted with lead (and E.Coli). As noted above, further validation assessment of sediments from oxidation ponds is required to enable appropriate management. After dewatering of the pond has taken place sediment should be excavated to enable aeration, exposing the underlying residual natural soils for validation.

Following aeration to achieve appropriate moisture content, if required, and subject to validation assessment of biologicals on completion of aeration, the sediment can then be reused on site, disposed off-site, or placed within an on-site containment cell, as appropriate based on validation data.

Biological Impacts

A total of three samples collected from the sediment ponds contained E.Coli above the NSW EPA 1997 guidelines. Additionally, five biological impacts reported in the STP site and one location in oxidation pond reported in the previous assessment (ERM 2010) will also require management.

Further validation assessment of sediments from oxidation ponds is required to enable appropriate management. All sediment from the oxidation ponds should be excavated and aerated to remediate the biological impacts.

Following aeration to achieve appropriate moisture content, if required, and subject to validation assessment of biologicals on completion of aeration, the sediment can then be reused on site, disposed off-site, or placed within an on-site containment cell, as appropriate based on validation data.

TPH Impacts

One location (STPTP014 at 0.1 m) identified in the former drying beds of the STP site in the previous assessment (ERM 2010) was above the adopted site criteria. Given the elapsed time, the soil from this location should be excavated and re-sampled and analysed to assess current TPH concentrations consistent with validation criteria. If elevated concentrations remain the material should be aerated to remediate the TPH impacts.

The material can then be placed within one of the containment cells, or potentially used as a mix with topsoil for the cells, following aeration to achieve appropriate moisture content, if required

5.4.5 Remedial Works-Cap and Containment of Contaminated Soils

All remedial works will be undertaken by an appropriately licensed asbestos removal contractor.

For the works to remove the non-friable ACM fragments within the eastern oxidation pond, a contractor holding a Class B licence will be appropriate.

It should be noted that asbestos impacted materials may be imported from other sites if containment is warranted. Should friable asbestos being imported to the site it must be undertaken by a contractor holding a Class A licence.

The remedial works for the cap and containment of contaminated soils, if on-site containment is warranted, will be completed by:

- Construction of unlined containment cells, for excavated asbestos materials, lead, biological and other contaminated material assessed as suitable for such containment as per ANZECC 1999 to be placed, compacted and then capped with a suitable capping layer (physical separation by covering).

Further discussion regarding containment cells and capping is presented in **Section 6**.

5.4.6 Further Assessment

Based on the previous assessments (JBS&G 2013), further environmental assessment of the oxidation ponds sediments and walls should be completed subsequent to the draining of the ponds. The sediments of the western oxidation pond must be validated for biological and lead impacts. The eastern oxidation pond walls must be validated for asbestos. The sampling requirements are outlined in **Section 7**.

Additionally, geotechnical assessment within the Western Oxidation Pond and cleared area should be completed should both areas be considered as viable options for containment cells.

Further geotechnical investigations may be warranted to verify the depth to the hard Shale unit and to obtain greater detail regarding depths to which conventional earthworks equipment is able to excavate before ripping or rock breaking is required, in particular in the area of Cells 1 to 3 (STP and east of STP) where the top of this unit is encountered at shallower depths.

Additionally, geotechnical testing in the eastern and western oxidation ponds will be completed to confirm the suitability for containment and whether any further material is to be removed in addition to sediments for aeration and/or remediation.

5.4.7 Validation

Validation of the remedial works is required to demonstrate that the works have been undertaken in accordance with the requirements outlined in this RAP and the remediation objectives have been achieved. Details of the validation program are provided in **Section 7**.

5.4.8 Site Dis-establishment

On completion of the remediation works all plant/equipment and safety/environmental controls shall be removed from the site.

5.4.9 Environmental Management Plan (EMP)

An Environmental Management Plan (EMP) will be prepared to detail the ongoing management and monitoring requirements for individual parts of the site as discussed in **Section 7.5.1**.

6 Cap and Containment

6.1 Containment Cell Options

As noted previously, there is the potential that on-site containment of contaminated material from the site and other UGNSW Edmondson Park development stages may offer benefits over off-site disposal, depending on potential volumes.

Six potential containment cell locations and configurations are shown in **Figures 6, 6a** to **6f**. A total of six containment cell options are considered possible, as presented in **Table 6.1**. The cell option numbering is based on discussion with the client and Aver regarding potential staging of containment (i.e. commencing at Cell 1 and progressing through to Cell 6), should containment proceed. Each cell would only proceed where a need is identified by UGNSW, and staging may differ from that indicated herein. Material could also be disposed offsite, if required.

Cells 1 to 4 are to be wholly within the future Regional Park to be managed by NSW Office of Environment and Heritage (OEH). It is noted that containment cell options for future Public Open Space land (Cells 5 and 6) are contingent on agreement of Liverpool Council as the ultimate custodian of this area based on current zoning.

The containment cells 1 to 4 have approximately 89,500 m^3 capacity. While containment cells 5 & 6 have approximately 75,000 m^3 capacity. It is noted that there may be no need for containment, and where a need is identified, the total estimated containment capacity of any cell may not be utilised.

Table 6.1 Containment Cells

Containment Cell	Location	Estimated Containment Volume (m^3)*
Future State Regional Environmental Park Areas		
Cell 1	Eastern Oxidation Pond	31,500
Cell 2	STP Area, west of access road	34,000
Cell 3	Cleared area east of STP, east of access road	16,000
Cell 4	STP Area and cleared area east of STP	58,000
Total Potential Estimated Containment Volume (i.e. total Cells 1 & 4)		**89,500 m^3**
Future Council Public Open Space Area (Contingent)		
Cell 5	Western Oxidation Pond	52000**
Cell 6	Western Oxidation Pond and clearing	75,000**
Total Potential Estimated Containment Volume (i.e. total Cell 6)		**75,000 m^3**

Notes: * Estimated volumes are approximate only based on inferred geological conditions and geotechnical interpretation, and will be subject to final design and construction. Volumes assume approximate cell outlines and batter slopes as noted on Figures. The base of cells is assumed to be 5 m below ground level for all cell options based on observed geological conditions.

** Geotechnical investigations in this area were not part of the scope of work. Inferred geological conditions area based on the nearest geotechnical borehole and test pits and relevant environmental boreholes and test pits.

6.2 Design Parameters

Schematic cross-sections for the cell options 1, 2, 3 and 5 are provided in Figures 7a to 7d respectively. Potential layouts (in 3D) are provided in **Figures 8a** to **8h**.

Containment cell design and capping should be consistent with relevant EPA-made or endorsed guidelines including ANZECC (1999). The requirements are partly dependent on the type of materials and contaminants to be contained, and their relative mobility (potential to leach). Relatively immobile materials, such as some demolition materials, asbestos containing material (ACM), and contaminants bound to a matrix such that they do

not readily leach, can be contained without the need for impermeable liners, leachate collection and treatment systems or groundwater monitoring. It is these types of materials that are assumed to be proposed for encapsulation in containment cells at the site. Refer **Section 5.2.3** for discussion of the appropriateness of containment of identified COPC.

Capping the containment cells is required to minimise infiltration of surface/storm water into contaminated materials and to prevent contaminant exposure to human and ecological receptors on the surface. Capping consistent with existing encapsulation and capping of immobile (asbestos) and relatively immobile (lead associated with small arms ammunition) contaminated materials in other areas of former Defence land in Edmondson Park, is considered to be appropriate.

The capping should comprise the following minimum requirements:

- A marker layer placed over carefully placed contaminated materials and/or appropriate demolition materials, to identify the top of contained material (and base of capping). A readily identifiable marker layer should be installed to provide adequate visual warning during any future ground disturbance;
- A capping layer of minimum 400 mm thick compacted clay. The clay should have low to medium plasticity resulting in very low permeability when compacted to required specification. Placement would be preferable in 200 to 300 mm (loose thickness) layers and compacted by vibrating pad-foot roller or similar to the minimum 400 mm thickness. A minimum relative compaction level of 98% maximum dry density (MDD) and permeability of no less than 1.0×10^{-9} cm/sec would be appropriate. Moisture content of ± 2% is recommended; and
- A growing medium (topsoil) layer of minimum 200 mm thickness should be placed over the clay capping layer. This topsoil layer should also be placed in loose layers and track-rolled by dozer or equivalent to the required 200 mm thickness and relative compaction level of 85% MDD, and with an appropriate moisture content. This topsoil layer thickness should be able to be vegetated with shallow rooted grasses and/or low shrubs. Discussion is provided below should vegetation include deeper rooted trees.

There is potential for the clay and shale excavated from with the locations of the containment cells, that are not impacted, could be used for the capping layer.

Depending on the materials to be encapsulated, nominated areas within the cells can be utilised for sub-cells, and certain materials (e.g. lead particulate material) can be placed in separate layers, so that these materials can be separately managed should re-excavation be required in future. Such sub-cells and distinct material layers should be surveyed to enable accurate location for management.

It is assumed that existing ground levels would need to be maintained such that current topography and drainage are not altered.

Assuming no leachable materials are contained, existing geological materials can be utilised for cell floors and walls, with appropriate batter slopes on walls.

It is noted that, should deeper rooted trees be proposed over any constructed containment cells, a greater growing medium (topsoil) thickness will be required to support trees to avoid root systems penetrating into the compacted clay layer The growing medium thickness will need to be appropriate for the tree species proposed. NEPC (2013) indicates that the top 2 m of soil corresponds to the root zone and habitation zone of many species. To maintain ground levels and appropriate clay capping thickness, additional growing medium thickness (2 m) across cell areas would reduce potential contaminated

material containment capacity, with approximate volume reductions for each cell as follows:

- Cell 1 – approximate 11,000 m^3 reduction to approximately 20,500 m^3;
- Cell 2 – approximate 13,000 m^3 reduction to approximately 21,000 m^3;
- Cell 3 – approximate 5,000 m^3 reduction to approximately 11,000 m^3;
- Cell 4 – approximate 19,000 m^3 reduction to approximately 39,000 m^3;
- Cell 5 – approximate 16,000 m^3 reduction to approximately 36,000 m^3; and
- Cell 6 – approximate 23,000 m^3 reduction to approximately 52,000 m^3.

6.3 Excavation and Batters

During the previous assessments (JBS&G 2013) of the site, geotechnical investigations were completed, with the exception of the Public Open Space area to be returned to Council (Cells 5 & 6).

Existing geological conditions generally include:

- Surface topsoil and fill material of variable depth but typically less than 1 m below ground level (bgl);
- Residual clay soils of variable thickness from < 1 m to approximately 4.5 m bgl;
- Highly to extremely weathered shale (Shale 1) encountered at depths between 0.8 and 4.5 m bgl; and
- Moderately weathered shale (Shale 2) encountered at depths between 1.1 and 5 m bgl.

The Shale 2 unit was generally shallower in the topographically higher STP and east of STP areas (Cells 1-3).

Geotechnical advice in November 2013 from Pells Sullivan Meynink (PSM 2013[13]) provides the following guidance:

- Existing topsoil is not suitable as engineered fill, but could be reused for landscaping, while most of the remaining materials would be suitable as engineered fill on site;
- Earthworks (cut and fill) will require preparation of a detailed earthworks specification, which should address the following aspects, among others;
- Existing oxidation ponds are anticipated to have floors comprising softened residual clay soils and sediments, which may need to be removed. Similarly the pond 'bunds' will need to be removed and replaced. Reuse as engineered fill may be subject to drying out or blending;
- Density ratios to control potential shrink swell of clayey fill and variability effects is 98 to 102 % standard compaction, and moisture content of ±2%;
- Appropriate inspection and testing requirements;
- Excavation in topsoil, existing fill, residual clay soil, and Shale 1 units should be achievable using conventional earthmoving equipment; and
- Excavation of the Shale 2 unit should be achievable using a combination of conventional earthmoving equipment, ripping and some rock-breaking. PSM noted that the 20 tonne excavator with toothed bucket used during investigations refused on Shale 2 at a number of locations within the STP area and east of the STP.

Permanent batters of 2H:1V are recommended for Engineered Fill (fill placed per above specifications), residual soil and Shale 1 units, and permanent batters of 0.33H:1V are

[13] Sewer Treatment Plant, Campbelltown Road, Edmondson Park, NSW, Geotechnical Investigation, PSM Report PSM2294-003R, November 2013 (PSM 2013).

suggested for Shale 2 unit subject to design and inspection. It is noted the Shale 2 batters should be inspected by an experienced geotechnical engineer during excavation to confirm the batter advice and assess the need for localised support (or reduced batters) as excavations progress.

Safe work methods will need to be implemented when working above or below the batters.

The Geotechnical report is provided in **Appendix A**.

7 Validation Plan

Validation data are required to be collected to:

- Verify the effectiveness of the remediation works; and
- Document the condition of the site as being suitable for the proposed future use.

7.1 Data Quality Objectives

DQO's have been developed for the validation assessment, as discussed in the following sections.

7.1.1 State the Problem

Lead, asbestos, TPH and biologically impacted fill material is present at the site, which requires excavation, management and/or removal. The preferred remediation approach includes:

- Excavation of lead and asbestos impacted material and off-site disposal or placement within containment cells as per **Section 6**; and
- Excavation of biologically, lead and TPH impacted sediments from oxidation ponds and STP site, drying out of soils/sediment and then use of sediment with topsoil for capping mixture or off-site disposal.

Validation data is required to be collected to verify the effectiveness of the remediation works and document the condition of the site as being suitable for the proposed potential future land use.

7.1.2 Identify the Decision

The following decisions are required to be made during the validation works:

- Are there any unacceptable risks to future on-site or off-site receptors from any surface or fill soil contamination following the remediation/management of contaminated soil?
- Does fill material across the site contain any unacceptable aesthetic issues?
- If containment is required, was the impacted soil suitably placed within the containment cells and capped in accordance with the RAP?
- If off-site disposal is required, was the impacted material suitably classified and disposed off-site to a facility licensed to accept the classified waste?
- If materials are imported to the site, was the material validated as suitable for the intended use on site?
- Is an ongoing site management strategy required?

7.1.3 Identify Inputs to the Decision

The inputs to the decisions are:

- Physical observations during site activities;
- Documentation to verify appropriate removal and placement of the impacted material;
- Material tracking information, including waste disposal documentation (if required);
- Survey plans to verify appropriate capping and containment construction;
- Soil analytical data from samples collected from the base and walls of the excavation formed by the removal of impacted soil;
- Relevant guideline criteria for the site; and

- Material characterisation documentation accompanying imported fill materials on site, or soil analytical data collected from any imported fill materials for material characterisation purposes.

7.1.4 Define the Study Boundaries

The lateral and vertical extent of areas subject to remediation is discussed in **Section 5.4.3**.

7.1.5 Develop a Decision Rule

It is noted that the adopted soil remediation acceptance criteria, as detailed below, are selected from criteria published as investigation levels.

Soil analytical data will be assessed against relevant EPA endorsed criteria:

- Contaminated Sites: *Guidelines for NSW Site Auditor Scheme, April 2006 (DEC 2006)*.
- National Environment Protection (Assessment of Site Contamination) *Amendment Measure 2013 (No. 1), National Environment Protection Council, 2013* (NEPC 2013).

Asbestos Validation

After the draining of the eastern oxidation pond, an inspection and characterisation of the walls of the pond must be completed for ACM to confirm the extent of impact requiring remediation and validation.

Following the removal of identified asbestos impacts, a visual validation inspection of the site surface will be undertaken to ensure remediation of ACM fragments meets the site validation criteria outlined in **Section 7.5**.

Soils on the walls/floor of excavations and soils which have been remediated will be subjected to both an inspection and a quantification assessment to ensure the remediation meets the site assessment criteria outlined below.

If an excavation validation sample fails the validation criteria, further remediation (by excavation of soils) and subsequent validation of the affected area will be required.

Lead Impacted Soils

After the draining of the western oxidation pond, sampling of the walls of the pond must be completed for lead impacts to confirm the volume of material impacted with elevated lead concentrations.

Following the removal of the identified lead impacts, soils on the walls/floor of excavations and soils which have been remediated will be subjected to both an inspection and a quantification assessment to ensure the remediation meets the site assessment criteria outlined below.

If an excavation validation sample fails the validation criteria, further remediation (by excavation of soils) and subsequent validation of the affected area will be required.

Biological Impacts

Following the draining of the oxidation ponds water and all sediment within the ponds is considered to potentially contain biological impacts. Soils on the walls/floor of excavations and soils which have been remediated will be subjected to both an inspection and assessment to ensure the remediation meets the site assessment criteria outlined below.

Additional impacts were reported in the STP site. Once the infrastructure is removed, all surface soils (<0.1 m) present will require validation for biological impacts and will be subject to inspection and assessment. .

The sediment excavated from the oxidation ponds will be dried out in a designated area. Once dry, the material will be resampled for biological impacts and if found to be below the adopted criteria may be reused on site, utilised with topsoil for capping purposes or disposed off-site.

TPH Impacts

Following the removal of the identified TPH impacts, soils on the walls/floor of excavations and soils which have been remediated will be subjected to both an inspection and a quantification assessment to ensure the remediation meets the site assessment criteria outlined below.

The impacted material will be dried out in a designated area. Once dry, the material will be resampled for TPH impacts and if found to be below the adopted criteria may be reused on site, utilised with topsoil for capping purposes or disposed off-site.

Imported Fill

Impacted materials e.g. ACM, lead and other impacted soil will be imported onto the site to fill the containment cells. The importation of this material will require documentation and provide information regarding it its characterisation including leachability of any COPCs. The importation of material to be placed in the containment cells must meet the regulations provided in **Section 11**.

Additionally, soils may be imported onto the site to fill validated excavations, or placement of 100 mm of clean fill material above soils containing ACM below the site assessment criterion for sub-surface soils. Imported fill will be accompanied by certification that the material is either virgin excavated natural material (VENM) or excavated natural material (ENM) and will be sampled and compared against selected validation criteria, as per **Section 7.5.2** and **Table 7.3**.

STP Site

Following the demolition of the STP site compound validation is required beneath the former trickle filters and buildings as per **Table 7.3**.

Following demolition of the STP infrastructure, the impacted asbestos impacts will be excavated and removed either off-site or into the containment cells.

The TPH impacts and biological will be dried out in a designated area. Once dry, the material will be resampled for TPH and biological impacts and if found to be below the adopted criteria may be reused on site, utilised with topsoil for capping purposes or disposed off-site.

Capping Material (if containment cells required)

The capping materials could be utilised from natural soil material excavated to form the various containment cells following removal of any impacted soils. A minimum of 400 mm of capping material is required.

Should additional material be required then imported VENM material or ENM suitable for the required capping material could be used as per above.

The decision rules adopted to answer the decisions identified in **Section 7.1.2** are summarised in **Table 7.1**.

Table 7.1: Summary of Decision Rules

Decision Required to be Made	Decision Rule
1. Are there any unacceptable risks to future on-site or off-site receptors from any fill/residual soil contamination following the remediation of contaminated soil?	Soil analytical data will be compared against EPA endorsed criteria as summarised in **Table 7.5**. Statistical assessment (EPA 1995) is not appropriate for asbestos. If the criteria are satisfied, the decision is No and the site is suitable for use without further validation. If the criteria are not satisfied, the decision is Yes and the site is not suitable for use and subject to further remediation/management.
2. Does fill material on-site contain any unacceptable aesthetic issues?	If there are any ACM fragments on the ground surface or surface soils (<0.1m), any unacceptable odours, soil discolouration or anthropogenic materials observed, the decision was Yes. Otherwise, the decision was No.
3. If containment is required, was the impacted soil suitably placed within the containment cells and capped in accordance with the RAP?	Material placed in the containment cells will be documented, with the capping layer documentation to be provided If the documentation is not provided then the answer is No. If the documentation is provided and is suitable then the answer is yes.
4. If off site disposal is required, was the impacted material suitably classified and disposed off-site to a facility licensed to accept the classified waste?	Soil analytical data will be compared against NSW EPA 2014 Waste Classification Guidelines. Statistical analyses of the data in accordance with relevant guidance documents will be undertaken, if appropriate, to facilitate the decisions (as detailed above). If the criteria stated above are satisfied, the decision is Yes, or if receipts are provided recording the disposal of material to an off-site licensed facility, the decision is Yes. If the material fails the criteria, and no disposal receipts are provided, the answer is No.
5. If materials are imported to the site, was the material validated as suitable for the intended use on site?	Soil characterisation reports will be reviewed or if no material characterisation provided, soil analytical data will be compared against relevant EPA endorsed criteria. If material characterisation reports detail the imported material as VENM, or if the soil analytical data meets the relevant adopted criteria, the answer is Yes. If the material is classified as anything other than VENM, or it fails the specified criteria, the answer is No.
5. Is an ongoing site management strategy required?	Is the answer to any of the above decisions Yes? If yes, a site management strategy will be required to be developed. If no, a site management strategy is not required. The requirement for site management can be precluded by remediation of the areas of environmental impact that causes a site decision to be yes.

7.1.6 Specify Limits of Decision Error

This step is to establish the decision maker's tolerable limits on decision errors, which are used to establish performance goals for limiting uncertainty in the data. Data generated during this project must be appropriate to allow decisions to be made with confidence.

Specific limits for this project have been adopted in accordance with the appropriate guidance from the NSW EPA, NEPC (2013), appropriate indicators of data quality (DQIs used to assess quality assurance / quality control) and standard JBS&G procedures for field sampling and handling.

To assess the usability of the data prior to making decisions, the data will be assessed against pre-determined Data Quality Indicators (DQIs) for to precision, accuracy, representativeness, comparability, completeness and sensitivity (PARCCS parameters). The acceptable limit on decision error is 95% compliance with DQIs.

The pre-determined DQIs established for the project are discussed below in relation to the PARCCS parameters, and are shown in **Table 7.2**.

- **Precision** - measures the reproducibility of measurements under a given set of conditions. The precision of the laboratory data and sampling techniques is assessed by calculating the Relative Percent Difference (RPD)[14] of duplicate samples.
- **Accuracy** - measures the bias in a measurement system. The accuracy of the laboratory data that are generated during this study is a measure of the closeness of the analytical results obtained by a method to the 'true' value. Accuracy is assessed by reference to the analytical results of laboratory control samples, laboratory spikes and analyses against reference standards.
- **Representativeness** –expresses the degree which sample data accurately and precisely represent a characteristic of a population or an environmental condition. Representativeness is achieved by collecting samples on a representative basis across the site, and by using an adequate number of sample locations to characterise the site to the required accuracy.
- **Comparability** - expresses the confidence with which one data set can be compared with another. This is achieved through maintaining a level of consistency in techniques used to collect samples; and ensuring analysing laboratories use consistent analysis techniques; and reporting methods.
- **Completeness** – is defined as the percentage of measurements made which are judged to be valid measurements. The completeness goal is set at there being sufficient valid data generated during the study.
- **Sensitivity** – expresses the appropriateness of the chosen laboratory methods, including the limits of reporting, in producing reliable data in relation to the adopted site assessment criteria.

[14] $RPD(\%) = \frac{|C_o - C_d|}{C_o + C_d} \times 200$

Where C_0 is the analyte concentration of the original sample
C_d is the analyte concentration of the duplicate sample

Table 7.2: Summary of Data Quality Indicators for Soil Validation Program

Data Quality Indicators	Frequency	Data Quality Criteria
Precision		
Split duplicates (intra laboratory)	1 / 20 samples	<50% RPD[1]
Blind duplicates (inter laboratory)	1 / 20 samples	<50% RPD[1]
Laboratory Duplicates	1 / 20 samples	<50% RPD[1]
Accuracy		
Surrogate spikes	All organic samples	70-130%
Laboratory control samples	1 per lab batch	70-130%
Matrix spikes	1 per lab batch	70-130%
Representativeness		
Sampling appropriate for media and analytes	All samples	-[2]
Samples extracted and analysed within holding times.	-	Soil: organics (14 days), inorganics (6 months)
Laboratory Blanks	1 per lab batch	<LOR
Trip spike	1 per lab batch	70-130% recovery
Storage blank	1 per lab batch	<LOR
Rinsate sample	1 per sampling event/media	<LOR
Comparability		
Standard operating procedures for sample collection & handling	All Samples	All Samples
Standard analytical methods used for all analyses	All Samples	NATA accreditation
Consistent field conditions, sampling staff and laboratory analysis	All Samples	All samples[2]
Limits of reporting appropriate and consistent	All Samples	All samples[2]
Completeness		
Sample description and COCs completed and appropriate	All Samples	All samples[2]
Appropriate documentation	All Samples	All samples[2]
Satisfactory frequency and result for QC samples		95% compliance
Data from critical samples is considered valid	-	Critical samples valid
Sensitivity		
Analytical methods and limits of recovery appropriate for media and adopted Site assessment criteria	All samples	LOR<= Site assessment criteria

[1]. If the RPD between duplicates is greater than the pre-determined data quality indicator, a judgment will be made as to whether the excess is critical in relation to the validation of the data set or unacceptable sampling error is occurring in the field.
[2]. A qualitative assessment of compliance with standard procedures and appropriate sample collection methods will be completed during the DQI compliance assessment.

7.1.7 Optimise the Design for Obtaining Data

The purpose of this step is to identify a resource-effective field investigation sampling design that generates data that are expected to satisfy the site manager's decision performance criteria, as specified in the preceding steps of the DQO Process. The output of this step is the sampling design that will guide development of the field sampling and analysis plan. This step provides a general description of the activities necessary to generate and select data collection designs that satisfy decision performance criteria.

Validation sampling will be undertaken as per **Table 7.3**. Imported materials, if required, will also be validated where required (**Table 7.3 and Section 7.5.2**).

Table 7.3: Soil Validation Sampling

Item	Further Investigation Sampling required	Validation Sampling Frequency			Analytes
		Excavation floors	Excavation walls	Materials	
Excavation formed by the removal of lead impact	-	1 / 25 m^2 (5 m grid)		N/A	Lead
Excavation formed by the removal of biologicals impacted surface soils	-	1 / 25 m^2 (5 m grid)		N/A	Biologicals including Salmonella spp, E.Col and Faecal Coliforms, helminths ova, Reovirus, Enterovirus and Adenovirus
Western Oxidation Pond Base	13 locations based on 4700 m^2	1/100 m grid based on findings of additional assessment		N/A	Biologicals including Salmonella spp, E.Col and Faecal Coliforms, helminths ova, Reovirus, Enterovirus and Adenovirus, TCLP (metals)
Eastern Oxidation Pond Base	11 locations based on 3700 m^2	1/100 m grid based on findings of additional assessment		N/A	Biologicals including Salmonella spp, E.Col and Faecal Coliforms, helminths ova, Reovirus, Enterovirus and Adenovirus, TCLP (metals)
Eastern Oxidation Pond Walls		1/100 m^2 linear (10 m grid)		N/A	Asbestos
Treated Oxidation Sediments	-	1/25 m^3 up to 200 m^3 for onsite retention and or offsite disposal. 1/100 m^3 for stockpiles over 200 m^3		N/A	Biologicals including Salmonella spp, E.Col and Faecal Coliforms, , metals, TCLP (metals) 10% of samples will be analysed for helminths ova, Reovirus, Enterovirus and Adenovirus
Trickle Filters	-	1 / 25 m^2 (5 m grid) – Excavations to extend to approx.10 m		N/A	Heavy Metals Asbestos (500 mL)
STP Infrastructure Removal	5 location based on 550 m^2	1 / 25 m^2 (5 m grid) – Excavations to extend to approx.10 m		N/A	Heavy metals TPH/BTEX OCPs/PCBs PAHs Asbestos Biologicals including Salmonella spp, E.Col and Faecal Coliforms. 10% of samples will be analysed for helminths ova, Reovirus, Enterovirus and Adenovirus

Item	Further Investigation Sampling required	Validation Sampling Frequency			Analytes
		Excavation floors	Excavation walls	Materials	
ACM surface fragments	-	5 m transects (no excavation required)	N/A	N/A	Visual inspection of impacted area
Excavation formed by the removal of asbestos impact	-	1 / 25 m^2 (5 m grid)	1 / 5 m (from each distinct horizon / material type / 1 m vertical soil profile)	N/A	Asbestos (500 mL)
	-	10 litre sample (per fill stratum, per metre, per location) of soil be collected and placed on plastic sheeting with a contrasting colour, spread out and inspected using a 7 mm diameter teethed rake.			Collection of ACM fragments for quantification
Footprint of former Asbestos impacted stockpiles, if required	-	1 / 100 m^2 (10 m grid)	N/A	N/A	Asbestos (500 ml) No visible ACM
Footprint of former biologically impacted stockpiles	-	1 / 100 m^2 (10 m grid)	N/A	N/A	Biologicals including Salmonella spp, E.Col and Faecal Coliforms, helminths ova, Reovirus, Enterovirus and Adenovirus
Waste classification of material requiring off-site disposal, if required	-	1 / 25 m^3 (up to 200 m^3) then 1/100 m^3			Heavy metals TPH/BTEX OCPs/PCBs PAHs Asbestos TCLP Metals and PAHs
Imported soil of VENM[1], if required	-	N/A	N/A	Minimum of 3 samples per source site	Heavy metals TPH/BTEX PAHs OCPs/PCBs Asbestos

Item	Further Investigation Sampling required	Validation Sampling Frequency			Analytes
		Excavation floors	Excavation walls	Materials	
Imported soil of ENM[2], if required	-	N/A	N/A	As per EPA 2012	Heavy metals TPH/BTEX PAHs pH EC RTA 276 (foreign materials) Asbestos
Imported soil for containment cells[3]	-	N/A	N/A	N/A	None
Final Site Surface	-	N/A	N/A	N/A	Validation Inspection

1. Required only if not accompanied by suitable letter of VENM certification as defined in EPA (2014).
2. Required only if not accompanied by suitable letter of ENM certification as defined in EPA (2012).
3. Suitable letter of waste classification as defined in EPA (2014).
4. Previous results show E.Coli only exceeding adopted criteria.

7.2 Sampling Rationale

The sampling and analytical regime presented in **Table 7.3** is based on the following rationale:

- Soil sample densities indicate the minimum required to demonstrate compliance with NEPC (2013) with respect to the validation of removal works.

7.3 Soil Sampling Methodology

Soil sampling methods appropriate for the relevant task will be determined by the appropriately trained and experienced field scientist/engineer at the time of sampling. It is anticipated that sampling methods may include:

- Test pits/grab samples using an excavator/backhoe buckets for in-situ material characterisation and validation of excavations; and
- Stockpile sampling using a shovel, trowel or excavator bucket, etc.

Reference will be made to the general requirements for sampling using various types of equipment as outlined in NEPC (2013). Re-useable sampling equipment will be thoroughly decontaminated using phosphate free detergent and distilled water between each sampling location.

During the collection of soil samples, features such as seepage, discolouration, staining, odours and other indications of contamination shall be noted on field reporting sheets / borelogs.

Collected soil samples shall be immediately transferred to sample containers of appropriate composition (glass jars). 500 mL sub-samples shall be additionally collected and placed in new zip lock bags where asbestos analysis is required. Sample labels shall record sample identification number and date and time of sampling. Sample containers shall be transferred to a chilled ice box for sample preservation prior to and during shipment to the testing laboratory. A chain-of-custody form shall be completed and forwarded with the samples to the testing laboratory, containing the following information:

- Sample identification;
- Signature of sampler;
- Date of collection;
- Type of sample;
- Number and type of container;
- Inclusive dates of possession; and
- Signature of receiver.

7.4 Laboratory Analyses

NATA accredited laboratories shall be used for all analysis of samples. Appropriate methods and limit or reporting (LOR) are required for comparison to relevant criteria.

7.5 Validation Criteria

Based on the proposed land use and in accordance with the decision process for assessment of urban redevelopment sites (DEC 2006), concentrations of contaminants in the soil will be compared against published levels as presented in **Tables 7.5, 7.6** and **7.7,** sourced from the following:

HILs:

- HIL C - Public open space such as parks, playgrounds, playing fields (e.g. ovals), secondary schools and footpaths. This does not include undeveloped public open space where the potential for exposure is lower and where a site-specific assessment may be more appropriate;

HSLs:

- HSL C - recreational / open space (broadly equivalent to the HIL A, HIL B and HIL C land use scenarios); and

EILs and ESLs:

- Urban residential/public open space.

It is not considered necessary for validation of groundwater based on the ERM (2010) and JBS&G (2013) findings.

Table 7.5: Health Based Soil Investigation Criteria (all units in mg/kg)

	Limit of Reporting	Laboratory Method	Health Investigation/ Screening Levels
			Recreational/ Open Space HIL-C
Metals			
Arsenic	4.0	ICP-AES (USEPA 200.7)	300
Cadmium	0.4	ICP-AES (USEPA 200.7)	90
Chromium	1.0	ICP-AES (USEPA 200.7)	300
Copper	1.0	ICP-AES (USEPA 200.7)	17 000
Nickel	1.0	ICP-AES (USEPA 200.7)	1200
Lead	1.0	ICP-AES (USEPA 200.7)	600
Zinc	1.0	ICP-AES (USEPA 200.7)	30 000
Mercury (inorganic)	0.1	Cold Vapour ASS (USEPA 7471A)	80
POLYCYCLIC AROMATIC HYDROCARBONS			
Carcinogenic PAHs (as B(a)P TPE)[3]	0.028	GCMS (USEPA8270)	3
Total PAHs[4]	0.4	GCMS (USEPA8270)	300
BTEX			
Benzene	1.0	Purge Trap-GCMS (USEPA8260)	NL
Toluene	1.0	Purge Trap-GCMS (USEPA8260)	NL
Ethylbenzene	1.0	Purge Trap-GCMS (USEPA8260)	NL
Total Xylenes	3.0	Purge Trap-GCMS (USEPA8260)	NL
TOTAL RECOVERABLE HYDROCARBONS			
F1 C_6-C_{10}	10	TPH Purge Trap-GCMS (USEPA8260)	NL
F2 >C_{10}-C_{16}	50	TPH Purge Trap-GCMS (USEPA8260)	NL
F3 >C_{16}-C_{34}	100	Purge Trap-GCFID (USEPA8000)	-
F4 >C_{34}-C_{40}	100	Purge Trap-GCFID (USEPA8000)	-
ORGANOCHLORINE PESTICIDES			
DDT + DDD + DDE	0.3	GCECD (USEPA8140,8080)	400
Aldrin + Dieldrin	0.2	GCECD (USEPA8140,8080)	10
Chlordane	0.1	GCECD (USEPA8140,8080)	70
Endosulfan	0.3	GCECD (USEPA8140,8080)	340
Endrin	0.1	GCECD (USEPA8140,8080)	20
Heptachlor	0.1	GCECD (USEPA8140,8080)	10
HCB	0.1	GCECD (USEPA8140,8080)	10
Methoxychlor	0.1	GCECD (USEPA8140,8080)	400
PCBs			
Total PCBs	0.7	GCECD (USEPA8140,8080)	1
VOLATILE ORGANIC COMPOUNDS			
PCE	1.0	Purge Trap-GCMS (USEPA8260)	40
TCE	1.0	Purge Trap-GCMS (USEPA8260)	0.4
Cis 1,2 DCE	1.0	Purge Trap-GCMS (USEPA8260)	2
VC	1.0	Purge Trap-GCMS (USEPA8260)	0.5
OTHER			
Bonded ACM	-	Field Quantification	0.02%
Asbestos	Presence	PLM / Dispersion Staining	No asbestos capable of being detected via visual identification and sample analysis by a NATA accredited laboratory, and no Free Asbestos (FA) and Asbestos Fines (AF) above 0.001%

Notes:

1. Guideline values presented are for Chromium (VI) in absence of total Chromium values. Where total Chromium results are elevated, samples will be analysed for Chromium (VI).
2. Guideline values are for inorganic mercury. Where elevated mercury concentrations are encountered and/or site information suggests the potential presence of elemental mercury and/or methyl mercury, consideration of applicability would be needed.

3. Carcinogenic PAHs calculated as per Benzo(a)pyrene Toxicity Equivalent Factor requirements presented in NEPC (2013)
4. Total PAHs calculated as per requirements presented in NEPC (2013).
5. Soil Health Screening Levels for Vapour Intrusion: Sand Soils. Values presented are those for 0 to <1 m bgs as the most conservative level. Reference should be made to results tables for further detail of levels at greater depths. NL: Non-limiting.
6. Values for F1 C6-C9 are obtained by subtracting BTEX (Sum) from laboratory result for C6-C9 TRH. Naphthalene is not subtracted as there is separate limits for Naphthalene.
7. No EPA endorsed criteria, The LOR is proposed as a screening level in the absence of endorsed site specific criteria.

Biological data will be compared against the NSW EPA 1997. The results will be assessed against the criteria in **Table 7.6** below:

Table 7.6 Biosolid Based Soil Criteria

Parameter	Standard
Enteric Viruses	<1 PFU per 4 g total dry solids
Helminths ova	<1 per 4 g total dry solids
E.Coli	<100 MPN per g (dry weight)
Facel Coliforms	<1,000 MPN per g (dry weight)
Salmonella	Not detected/50 g of final product

Table 7.7 Ecological Based Soil Criteria (all units in mg/kg)

	Limit of Reporting	Laboratory Method	EILs/ESLs[1]
			Urban Residential and public open space
Metals			
Arsenic	4.0	ICP-AES (USEPA 200.7)	100
Cadmium	0.4	ICP-AES (USEPA 200.7)	-
Chromium	1.0	ICP-AES (USEPA 200.7)	410
Chromium (VI)	1.0	Alkali leach colorimetric (APHA3500-Cr/USEAP3060A)	-
Copper	1.0	ICP-AES (USEPA 200.7)	220
Nickel	1.0	ICP-AES (USEPA 200.7)	320
Lead	1.0	ICP-AES (USEPA 200.7)	1100
Zinc	1.0	ICP-AES (USEPA 200.7)	520
Mercury (inorganic)	0.1	Cold Vapour ASS (USEPA 7471A)	-
PAHs[2]			
Benzo(a)pyrene	0.5	GCMS (USEPA8270)	0.7
Naphthalene	0.1	GCMS (USEPA8270)	170
BTEX[2]			
Benzene	1.0	Purge Trap-GCMS (USEPA8260)	50
Toluene	1.0	Purge Trap-GCMS (USEPA8260)	85
Ethylbenzene	1.0	Purge Trap-GCMS (USEPA8260)	70
Total Xylenes	3.0	Purge Trap-GCMS (USEPA8260)	105
TPH[2, 3, 4]			
F1 C_6-C_{10}	10	TPH Purge Trap-GCMS (USEPA8260)	180
F2 >C_{10}-C_{16}	50	TPH Purge Trap-GCMS (USEPA8260)	120
F3 >C_{16}-C_{34}	100	Purge Trap-GCFID (USEPA8000)	300
F4 >C_{34}-C_{40}	100	Purge Trap-GCFID (USEPA8000)	2800
OCPs			
DDT	0.1	GCECD (USEPA8140,8080)	180

1. EILs presented for metals other than arsenic are equivalent to the most conservative NEPC (2013) Added Contaminant Level (ACL), including assumed soil pH of 6 for Copper and Zinc. Site-specific EILs can be derived according to NEPC (2013) based on site data for pH, CEC, % Clay and Iron. Generic NEPC (2013) EILs are provided for Arsenic, Naphthalene and DDT. Value for Chromium (III) adopted for evaluation of total Chromium in the absence of known Chromium (VI) source.
2. ESLs for TPH fractions, BTEX and BAP are for coarse soil textures per NEPC (2013).
3. Values for F1 C6-C9 are obtained by subtracting BTEX (Sum) from laboratory result for C6-C9 TRH.
4. Naphthalene (EIL) should not be subtracted from values for F2 >C10-C16 as there is no separate ESL for naphthalene (per NEPC 2013 Errata 29 July 2013).

7.5.1 Containment Validation

After excavation of the 'clean' material and prior to the impacted material being placed within the containment cells, if constructed, the open excavations will be surveyed to accurately document the volume of material to be placed within the cell.

After the impacted material has been placed in the containment cell, a marker layer will be placed and surveyed.

The cap of 400 mm of clean material with then be placed onto of the maker layer. The maker layer should be readily identifiable. The marker layer should be surveyed once completed to identify the top of contained material and base of the capping system.

The subsequent 200 mm topsoil layer will be placed on top of the 'clean' cap. The topsoil must be again tested for compaction and moisture content and permeability and then surveyed. The topsoil layer may need to be thicker if required to accommodate larger deep rooted trees (Refer **Section 6.2**).

7.6 Ongoing Monitoring/Management

Under the preferred on-site containment remediation strategy for the site, ongoing monitoring and management of contained impacted fill based soils will be required to ensure the continued protection of human health and the environment. Should on-site containment not be pursued, materials will either be removed and disposed off site or validated as suitable for reuse on site without containment, and no ongoing monitoring or management would be required unless there are residual impacts requiring management.

Should containment proceed, or residual impacts that require management, an Environmental Management Plan (EMP) will be prepared to detail the ongoing management and monitoring requirements for individual parts of the site where a containment cell is located and/or residual impacts are located, however, the precise nature and extent of the management/monitoring requirements will not be known until intrusive remediation works are conducted and an assessment of the residual impact is quantified. The EMP shall contain the following elements:

- A statement of the objectives of the EMP – i.e., to ensure continued suitability of the site after it has been remediated;
- Description of the residual contamination issue(s) required to be managed, including the type of contamination and location on the site (including a plan prepared by a registered surveyor);
- Description of the environmental controls to manage the residual contamination issue(s);
- Description of responsibilities for implementing various elements of the provisions contained in the EMP;
- Timeframe for implementing the provisions contained in the EMP;
- Health and safety requirements for potential future sub-surface activities in proximity of impacted fill materials and within the containment cells;

- A program of review and audits including assessment of the condition of the containment cell construction measure prior to fulfilment of the reported design life to assess the need for renewal of management measures;
- The provisions in the EMP are feasible (i.e., able to be implemented) and able to be legally enforceable (i.e., a mechanism exists, such as development consent conditions, to give the plan a basis in law); and
- The relevant consent authority is satisfied that the inclusion of a development consent condition relating to the implementation of the EMP is acceptable.

7.7 Reporting

At the completion of the remedial works a Validation Report will be prepared in general accordance with the NSW EPA *Guidelines for Consultants Reporting on Contaminated Sites* (EPA 1997), documenting the works as completed. This report will contain information including:

- Details of the remediation works conducted;
- Information demonstrating that the objectives of the RAP have been achieved, in particular the validation sample results and assessment of the data against both the pre-defined DQO and the remediation acceptance (validation) criteria;
- Details of the cap and containment cells;
- Information demonstrating compliance with appropriate regulations and guidelines;
- Any variations to the strategy undertaken during the implementation of the remedial works;
- Details of any environmental incidents occurring during the course of the remedial works and the actions undertaken in response to these incidents; and
- Other information as appropriate, including requirements (if any) for ongoing monitoring / management.

The report will serve to document the remediation works for future reference.

8 Contingency Plans

A review of remediation works has been undertaken to identify potential risks to meeting the specified site validation criteria.

8.1 Unexpected Finds

The possibility exists for hazards that have not been identified to date to be present within fill materials or underlying pavements on the site. The nature of hazards which may be present and which may be discovered at the site are generally detectable through visual or olfactory means, for example:

- The presence of significant aggregates of friable asbestos materials (visible) as opposed to minor occurrences of fragments or fibre bundles in soil;
- Excessive quantities of construction/demolition waste (visible);
- Hydrocarbon impacted materials (visible/odorous);
- Drums, waste pits, former pipework or underground storage tanks (USTs) (visible);
- Oily ash and/or oily slag contaminated soils/fill materials (visible/odorous);
- Tarry like impacted soil/fill material (visible/odorous).

Other unexpected finds could include:

- Potential presence of mercury in trickle filter bearings which could impact soils if released during demolition;
- Unidentified contamination beneath STP infrastructure;
- More extensive ACM impacts around oxidation pond areas during excavation for containment cells; and
- Greater volume of impacted oxidation pond sediments that will require treatment for biological impacts.

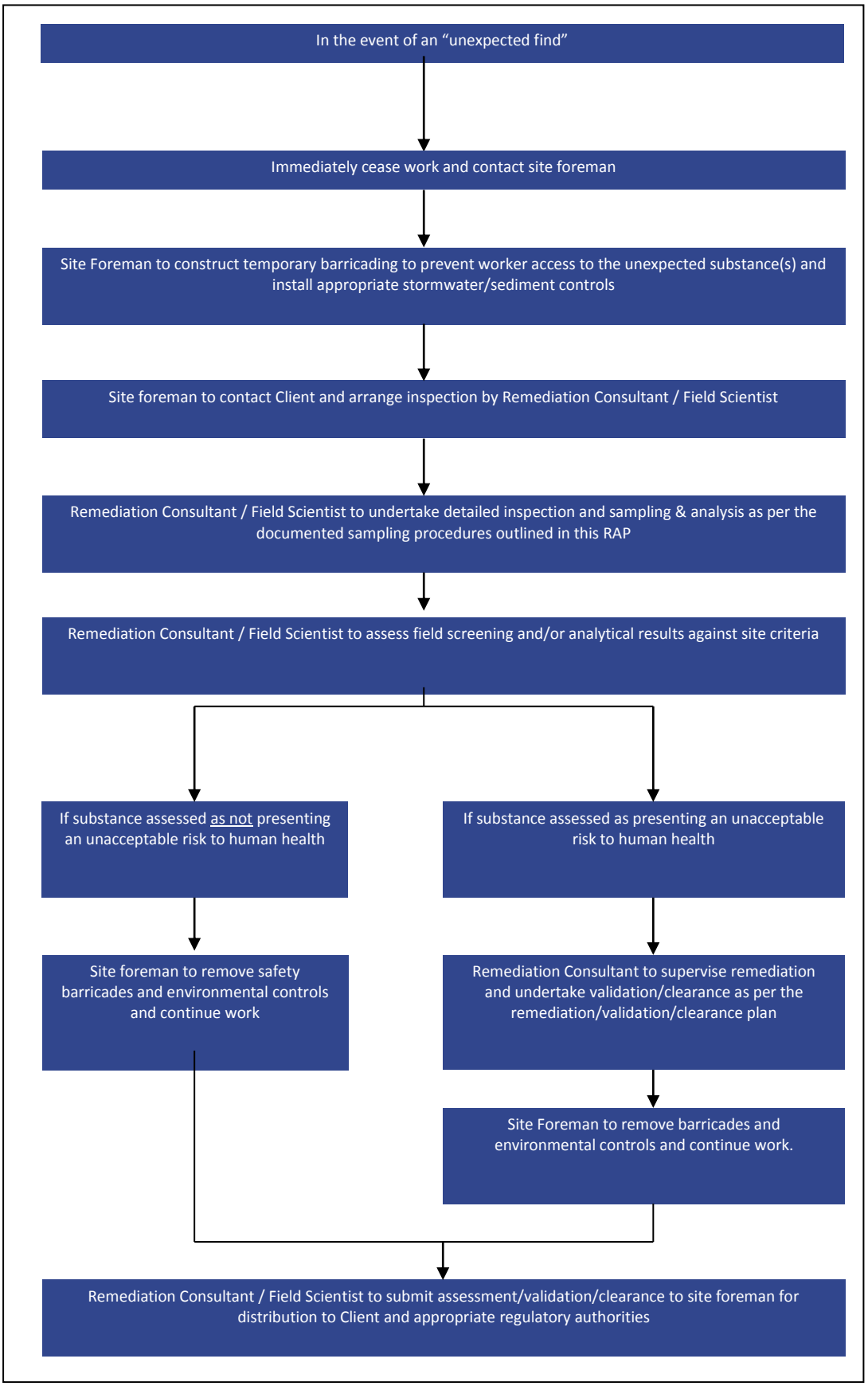
As a precautionary measure to ensure the protection of the workforce and surrounding community, should any of the abovementioned substances (or any other unexpected potentially hazardous substance) be identified, the procedure summarised in **Flow Chart 8.1** is to be followed.

An enlarged version of the unexpected finds protocol, suitable for use on site, should be posted in the site office and referred to during the site specific induction by the remediation contractor.

The sampling strategy for each “unexpected find” shall be designed by a suitably qualified environmental consultant. The strategy will, however, be aimed at determining the nature of the substance – that is, is it hazardous and, if so, is it at concentrations which pose an unacceptable risk to human health or the environment.

The sampling frequency of the identified substance/materials shall meet the minimum requirements outlined in EPA (1995) and NEPC (2013) in addition to those outlined in **Section 7**.

Flow Chart 8.1: Unexpected Finds Protocol



9 Site Management Plan

9.1 Hours of Operation

Remediation works shall only be permitted during the following hours:

- Monday to Friday: 7:00 am to 5:00 pm
- Saturdays: 8:00 am to 1:00 pm
- Sundays and Public Holidays: No work unless approved/permitted.

Emergency work is permitted to be completed outside of these hours.

9.2 Soil and Water Management

All works shall be conducted in strict accordance with the soil and water management measures outlined in this section.

To prevent the migration of impacted soil/sediment off site, silt fences shall be constructed at the down-gradient works area, as per the specifications contained in *Managing Urban Stormwater – Soil and Construction Volume 1, 4th Edition,* NSW Government, March 2004. Any material which is collected behind the sediment controls shall be treated as potentially contaminated and will be suitably managed.

In a storm event, the sediment controls located on-site will be monitored and replaced or altered if necessary. Collected material will be suitably managed in accordance with remediation works.

9.2.1 Site Access

During remediation works, perimeter fencing will be maintained to restrict access to the works area. Only authorised persons will be able to enter the works area.

Vehicle access to the works area shall be stabilised to prevent the tracking of soil around the site and the adjoining driveway/access point to the road will be swept or cleaned on an as-needed basis. Any collected materials shall be treated as potentially contaminated and will be suitably managed.

Should the access way around the site be utilised, it will require stabilisation and grading to be road worthy. Additionally, the concrete bridge used to bridge the small creek in the area will have to be tested for load bearing ability before being used as the primary access to the site.

9.2.2 Stockpiles

The following procedures will be implemented and is to be implemented for the drying of sediment from the oxidation ponds:

- No stockpiles or other materials shall be placed on footpaths or roadways and will be away from all stormwater infrastructure (including drainage lines, stormwater pits, gutters, etc) where possible. Where this is not possible, sediment controls will be placed over stormwater grates to prevent ingress of sediment to stormwater drainages.
- Stockpiles shall be formed with sediment control structures placed immediately down slope to protect other lands and waters from sediment pollution.

9.2.3 Oxidation Ponds and Excavation Pump-out

The oxidation ponds and excavation pump out water (if any) shall be pumped from the excavation by a licensed contractor and disposed of off-site as 'liquid waste' in accordance with NSW EPA (2014) or subject to NSW EPA approval could be discharged to the local waterway.

9.3 Noise

The remediation works shall comply with the *NSW EPA's Environmental Noise Control Manual* for the control of noise from construction sites.

All machinery and equipment used on site will be in good working order and with the fitted with appropriate silencers when necessary.

9.4 Vibration

The use of plant and machinery shall not cause vibrations to be felt or capable to be measured at the neighbouring premises.

9.5 Air Quality

9.5.1 Dust Control

During the remediation of the asbestos, importation of asbestos impacted material and placement within the containment cells, dust levels will be monitored and minimised by using mist sprays as necessary. It is also recommended that asbestos air fibre monitoring be completed in the vicinity of asbestos works.

9.5.2 Odour

No odours should be detectable at the site boundary. Appropriate actions will be taken to reduce the odours, which may include: increasing the amount of covering of excavations / stockpiles; mist sprays; odour suppressants; or maintenance of equipment.

Records of volatile emissions and odours shall be kept by the remediation manager. Equipment and machinery will be adequately maintained to minimise exhaust emissions. No materials shall be burnt on the site.

9.6 Groundwater

No groundwater remediation or dewatering is proposed as part of the works. No approvals are required under the *Water Management Act 2000*.

9.7 Material Transporting

The transporting contractor shall ensure that there is no material tracked out onto the street and that the load is securely covered. In addition, all site vehicles must leave the site in a forward direction.

All appropriate road rules shall be observed and state roads will be selected as far as practicable over local roads when deciding on the transport route to the off-site material disposal location.

Where material is to be imported, controls are to be implemented to maintain separation between contaminated and non-contaminated materials.

9.8 Hazardous Materials

All hazardous and/or intractable wastes (if any) shall be removed and disposed of in accordance with the relevant regulatory requirements. In particular, any hazardous wastes will be transported by a licensed transporter. Additionally, no hazardous wastes will be transported to the site for disposal in the containments cells.

9.9 Containment Cell

Leaving contaminated soil in-situ is an element of the remediation strategy for the site. Any materials to be retained on site will have regard to the requirements outlined in the *Guidelines for the Assessment of On-site Containment of Contaminated Soil* (ANZECC 1999) and any ongoing management provisions shall meet the requirements outlined in *Contaminated Sites Guidelines for the NSW Site Auditor Scheme, 2nd Edition* (DEC 2006).

Implementation of the ongoing EMP will manage risks associated with disturbance of the contained material.

9.10 Disposal of Contaminated Soil

All soil to be disposed of offsite will be classified, managed and disposed in accordance with the *Waste Classification Guidelines Part 1: Classifying Waste* (NSW EPA 2014).

9.11 Imported Fill

If any materials are required to be imported on site, then only material meeting the requirements outlined in **Section 7** will be accepted onto the site.

9.12 Site Signage and Contact Numbers

Throughout the duration of the works appropriate signage shall be erected around the remediation area and stockpiles with the contact details of the remediation contractor and project manager.

9.13 Complaint Reporting and Resolution

Complaints from adjoining site occupants or workers on site will be directed initially to the civil contractor on site. Following that, discussion with the environmental consultant and the complainant will investigate the issue and remedy it as required or applicable.

10 Health and Safety

The objectives of the health and safety plan are:

- To apply standard procedures that reduce risks resulting from the above works;
- To ensure all employees are provided with appropriate training, equipment and support to consistently perform their duties in a safe manner; and
- To have procedures to protect other site workers and the general public.

These objectives will be achieved by:

- Assignment of responsibilities;
- An evaluation of hazards;
- Establishment of personal protection standards and mandatory safety practices and procedures; and
- Provision for contingencies that may arise while operations are being conducted at the site.

This health and safety section does not provide safety information specific to construction and other demolition or excavation activities carried out by contractors, such as the safe operation, maintenance and inspection of plant, etc. Contractors will be required to prepare their own Safe Work Method Statements for their work activities. All parties working on the site shall comply with all applicable Health and Safety legislation, regulations, codes and guidelines.

10.1 Responsibilities

10.1.1 Remediation Supervisor

The remediation supervisor is responsible for ensuring that the work is carried out in accordance with the health and safety plan. This will include:

- Ensuring a copy of the health and safety plan is available at the site during the remediation/validation activities;
- Confirming individuals are competent in performing allotted tasks;
- Liaison with the contractor representatives, as appropriate, regarding safety matters; and
- Investigation and reporting of incidents and accidents.

The remediation supervisor will be confirmed by the nominated contractors prior to the commencement of site remediation works.

10.1.2 Other Members of the Site Workforce

Every individual worker is responsible for conducting their allocated tasks in a safe manner and in accordance with their training and experience. They must give due consideration to the safety of all others in their proximity and cooperate in matters of health and safety. All workers must leave their work areas in such a condition that the location will not be hazardous to others at any time.

10.2 Hazards

The known or potential hazards associated with the work activities described in **Section 6** are listed below:

- Inhalation hazards associated with the presence of ACM fragments on the ground surface;
- Chemical hazards associated with the presence of contaminated soil;
- Biological hazards associated with the presence of E. Coli in the pond sediments;
- Physical hazards, including:
  - work in or near excavations, including the containment cell batters;
  - operating machinery;
  - heat stress and UV exposure;
  - underground or overhead services;
  - manual handling; and
  - noise.

In the event of the discovery of any condition that would suggest the existence of a situation more hazardous than anticipated, or of any new hazard that could potentially cause serious harm to personnel or the environment, work will be suspended until the Project Manager has been notified and appropriate instructions have been provided to field personnel.

10.2.1 Inhalation Hazards

The main inhalation hazards from the remediation/validation works are consequent of the presence of asbestos.

Measures require to be put in place to prevent/ minimise the generation of airborne fibres. Where airborne emissions are may potentially be generated, Personal Protective Equipment (PPE) shall be required to be worn to prevent potential exposure, as described in **Section 10.3**.

10.2.2 Chemical Hazards

Major chemical hazards are not expected to be encountered on-site as part of the proposed remedial works. However, in the unexpected event that chemical hazards are identified, care must be taken to ensure that the contamination is not introduced to the worker via ingestion, inhalation or absorption. PPE and decontamination requirements related to the remedial works are summarised in **Sections 10.3** and **10.4**.

10.2.3 Biological Hazards

Biological hazards have been identified within the pond sediments. During the remediation of the sediments, care must be taken to ensure that biological impacts is not introduced to the workers through ingestion, inhalation or absorption. PPE and decontamination requirements related to the remedial works are summarised in **Sections 10.3** and **10.4**.

10.2.4 Physical Hazards

<u>Operating Machinery</u>

Heavy plant and equipment operating in the vicinity of field personnel presents a risk of physical injury. Personnel should be cognisant of their position in relation to operating machinery at all times.

Never walk behind or to the side of any operating equipment without the operator's knowledge. Do not assume that the operator knows your position. Personnel should stay at least 1 m from the operational area of heavy equipment and should not stand directly below any load or piece of equipment (e.g. backhoes).

Work In or Near Excavations

All excavations shall be shored, sloped or otherwise constructed so as to minimise the potential for collapse. No excavations greater than 1.0m depth are proposed to be created.

Cuts and Abrasions

The manual work associated with the remediation works gives rise to the risk of cuts and abrasions to personnel working in the area. As well as the direct consequences of any cut or abrasion, such injuries can lead to the possibility of exposure to contaminants through the wound as well as diseases such as tetanus. To minimise the risk of direct or indirect injury, personnel will wear the PPE described in **Section 10.3**.

Heat Stress and UV Exposure

Site personnel may experience heat stress due to a combination of elevated ambient temperatures and the concurrent use of personal protection equipment; this depends in part on the type of work and the time of year.

In addition to heat stress, overexposure to UV radiation in sunlight can result in sunburn to exposed skin. The use of a high protection sunscreen (SPF15 or greater) on all exposed skin is recommended. Hats (including hard hats in specified areas) will also provide additional sun protection during the peak (i.e. 10:00 am to 3:00 PM) sun period. Sunglasses should be worn (where appropriate) to protect eyes from effects of UV exposure.

Underground Services

There is the potential for underground services (electricity, natural gas lines, water, telephone, sewer, and stormwater) to be present beneath the work area. The remediation contractor shall ensure that appropriate procedures will be taken to minimise the risk associated with excavation near services.

Aboveground Electrical Hazards

All electrical plant and equipment must comply with the requirements of Australian Standard AS 3000. Hand held portable tools shall comply with AS/NZS 3160 *Hand-held Portable Electric Tools* and shall be double insulated. Cord connected portable hand lamps shall comply with AS/NZS 3118. A Residual Current Device (RCD) shall protect plug-in portable equipment, which is connected to a supply above Extra Low Voltage - 12-24volts (including equipment supplied from a generator or welding set). RCD protection shall be provided during use of portable electrical equipment at all times while the equipment is connected to a power supply above Extra Low Voltage, irrespective of whether power is switched ON or OFF. RCD's shall comply with AS 3190 and shall be type II units, rated to trip at or below 30 milliamps within 40 milliseconds.

All equipment shall be operated in compliance with the NSW WorkCover (2006) *Work Near Overhead Power Lines: Code of Practice*. Minimum approach distances for all equipment should exceed:

- 3.0m for nominal phase to phase ac voltage lines up to 132,000 Volts;
- 6.0m for 132,000 to 330,000 Volts;
- 8.0m for greater than 330,000 Volts; and
- 3.0m for nominal pole to earth dc voltage up to and including 1500 +/- volts.

Manual Handling

When lifting or handling heavy objects, use correct lifting techniques, bending the knees not the back. If the item to be lifted is too heavy or awkward for one person to lift, seek assistance from other company employees or use mechanical help.

Noise

Long-term exposure to high levels of noise is unlikely. However, operating machinery may cause significant noise exposures for short periods. Earplugs or earmuffs should be worn in any situation where noise levels make normal conversation difficult.

10.3 Personal Protective Equipment

All workers who may come into direct contact with contaminated soil will wear the following personal protective equipment:

- Overalls or long sleeved collared shirt;
- Heavy duty outer gloves (e.g. leather) where there is a risk of cuts or abrasions, otherwise PVC outer gloves if in direct contact with contaminated soil;
- Steel capped boots;
- Safety glasses;
- High visibility vest or jacket; and
- Hard hat.

It is further noted that additional PPE may be required as part of the WorkCover permitting process. If this occurs, then the above PPE requirements will be upgraded to reflect WorkCover's requirements.

In addition to the above, the following personal protective equipment will be worn by the licensed personnel responsible for removing the asbestos impacted fill material, or potentially exposed to airborne emissions during the importation of impacted fill to be placed into the containment cell:

- During any work with the asbestos impacted materials, overalls, gloves, rubber soled work shoes or gum boots should be work by personnel involved in the wet work. These shoes will remain inside the work area for the duration of the work.
- Approved respirators shall be worn in the asbestos impacted areas, including the containment cell, at all times to provide respiratory protection. The minimum protection is an approved properly fitting P2 disposable respirator or half faced respirator fitted with a particulate cartridge. However it is expected that the contractor will conduct a risk assessment in relation to the works and should consider the requirement for positive pressure, hood or full-face powered air-purifying respirator fitted with an approved Class M filter.
- The contractor shall supply and keep in good order, two complete sets of protective clothing and respirators for authorised inspection personnel. These will remain the property of the contractor at the end of the contract.
- Respirators should be issued for personal use only and shall be kept in a clean condition. Alcohol based antiseptic swabs should be made available for the cleaning of respirators.
- Any respirator defects should be reported for subsequent repair. They should be maintained in a clean and safe working condition.
- Employees must receive instruction in the correct method of using the respirator and on the importance of correct facial fit and maintenance. No person with a beard shall

be allowed within the asbestos work area except using an approved positive pressure continuous airflow hood.

In the event that the PPE detailed above differs from those required by the Class A licensed contractor, the requirements of the Class A contractor will prevail.

It is further noted that, as part of the WorkCover permitting process, additional PPE may be required. If this occurs, then the above PPE requirements will be upgraded to reflect WorkCover's requirements.

10.4 Monitoring Procedures

It is prudent practice to conduct monitoring for airborne asbestos fibres during asbestos works. The results of air monitoring can be used:

- To identify failures in containment;
- To identify poor work practices; and
- To provide proof of containment for occupiers and regulatory authorities and to provide evidence of good work practices for both present and future needs.

Monitoring will be conducted in accordance with the Safe Work Australia (2011) *How to Safely Remove Asbestos, Code of Practice 2011* and *Guidance Note on the Membrane Filter Method for the Estimating of Airborne Asbestos Fibres* [NOHSC 3003(2005)] and must be completed by a licenced asbestos assessor.

The appropriate levels are:

- Amosite - 0.1 fibre/mL;
- Chrysotile – 0.1 fibre/mL;
- Crocidolite - 0.1 fibre/mL;
- Other forms of asbestos - 0.1 fibre/mL; and
- Any mixture of these, or where the composition is unknown - 0.1 fibre/mL.

With consideration to these levels the following trigger levels have been developed:

- If airborne fibre levels reach 0.01 fibres/mL the source of fibre release is to be found and rectified. Work in the affected area does not have to stop; and
- If airborne fibre levels reach 0.02 fibres/mL work in the work area should stop and additional controls measures employed. This will involve additional water spraying during excavations.

Air monitoring results will be obtained within 24 hours of sample collection. While this precludes "real time" monitoring, visual indications will be made during all excavation works and, if there is any visible dusts, light water spays will be used to wet the excavation and prevent the release of any airborne asbestos fibres

10.5 Decontamination Procedures

The decontamination procedures specified below will be followed whenever personnel, plant or equipment leave the site.

Personnel

The following steps should be taken to ensure personnel do not leave the site with potentially contaminated clothing:

- Wash boots in clean water.
- Remove outer gloves and store for reuse.

- Remove overalls (if used) and store for reuse.
- Remove respirator and goggles (if used) and store clean for reuse or decontamination, as appropriate.
- Thoroughly wash hands and face.

If any part of a worker's body comes into direct contact with any potentially contaminated material, the affected part(s) should be immediately washed with clean water.

Vehicle, Plant and Equipment

All equipment, including personal protective equipment, will be washed or otherwise cleaned to ensure that contaminated soil, water or dust is removed before it leaves the Site. All plant and equipment will have their outer bodies thoroughly cleaned of soil and sediment before moving off the site.

10.6 Emergency Response

The remediation contractor will be responsible for preparing an emergency response plan, which will provide details on appropriate action and evacuation procedures in the event of an emergency.

In the event of an emergency arising on the site, appropriate action should be taken. Site evacuation procedures should be followed, as necessary.

In the event of an accident: evaluate the seriousness of the injury, and contact emergency services, if necessary; provide first aid, as appropriate, and if safe to do so evacuate the injured person via the Decontamination Zone; make the area as safe as possible without jeopardising safety.

If a serious accident occurs, do not disturb the scene, except to make safe and prevent further injury or damage, and keep all unauthorised people out, and report all accidents to the remediation manager.

11 Regulatory Approvals/Licensing

11.1 State Environment Planning Policy Number 55 (SEPP 55) Remediation of Land

The remediation works are understood to have been approved with the development approval provided for the associated site development works.

11.2 Protection of the Environment Operations Act 1997

The proposed remediation/validation activities are not required to be licensed under the *Protection of the Environment Operation Act 1997.*

11.3 Water Management Act 2000

Dewatering is proposed for the both of the settlement ponds. Approval will need to be obtained in advance of the commencement of civil works for dewatering from the Office of Water.

11.4 Protection of the Environment Operations (Waste) Regulation 2005

The regulations make requirements relating to non-licensed waste activities and waste transporting. The proposed works on the site will not require to be licensed. Section 48 of the Reg. requires that wastes are stored in an environmentally safe manner. It is also stipulates that vehicles used to transport waste must be covered when loaded.

The Regulation exempts certain waste streams from the full waste tracking and record keeping requirements. Waste tracking is required only for industrial and hazardous wastes. However these are not anticipated to be present on the site based on the use of the immobilisation approval. Provision is provided in the Regulation for the DECC to approve the immobilisation of contaminants in waste.

11.5 Waste Classification Guidelines (NSW EPA 2014)

All wastes generated and proposed to be disposed off-site shall be assessed, classified and managed in accordance with this guideline.

11.6 Asbestos Removal Regulations and Code of Practice

The removal and disposal of asbestos will be managed in accordance with the Safe Work Australia (2011) *How to Safely Remove Asbestos, Code of Practice 2011* and *Guidance Note on the Membrane Filter Method for the Estimating of Airborne Asbestos Fibres* [NOHSC 3003(2005)], NSW WorkCover Guidelines and the NSW EPA Waste Classification Guidelines.

Removal of non-friable ACM impacts are required to be conducted by a Class B licensed contractor. The appointed contractor is required to notify NSW WorkCover at least 7 days prior to the commencement of works.

Removal of friable asbestos impacts are required to be conducted by a Class A licensed contractor. The appointed contractor is required to notify NSW WorkCover at least 7 days prior to the commencement of works.

12 Site Suitability and Recommendations

It is considered that the site can be made suitable for open space use subject to the successful implementation of the actions contained in this RAP.

13 Limitations

This advice is provided for use by the client who commissioned the works in accordance with the project brief only, and has been based in part on information obtained from the client and other parties. The advice has been prepared specifically for the client for the purposes of the commission. No warranties, express or implied, are offered to any third parties and no liability will be accepted for use or interpretation of this advice by any third party.

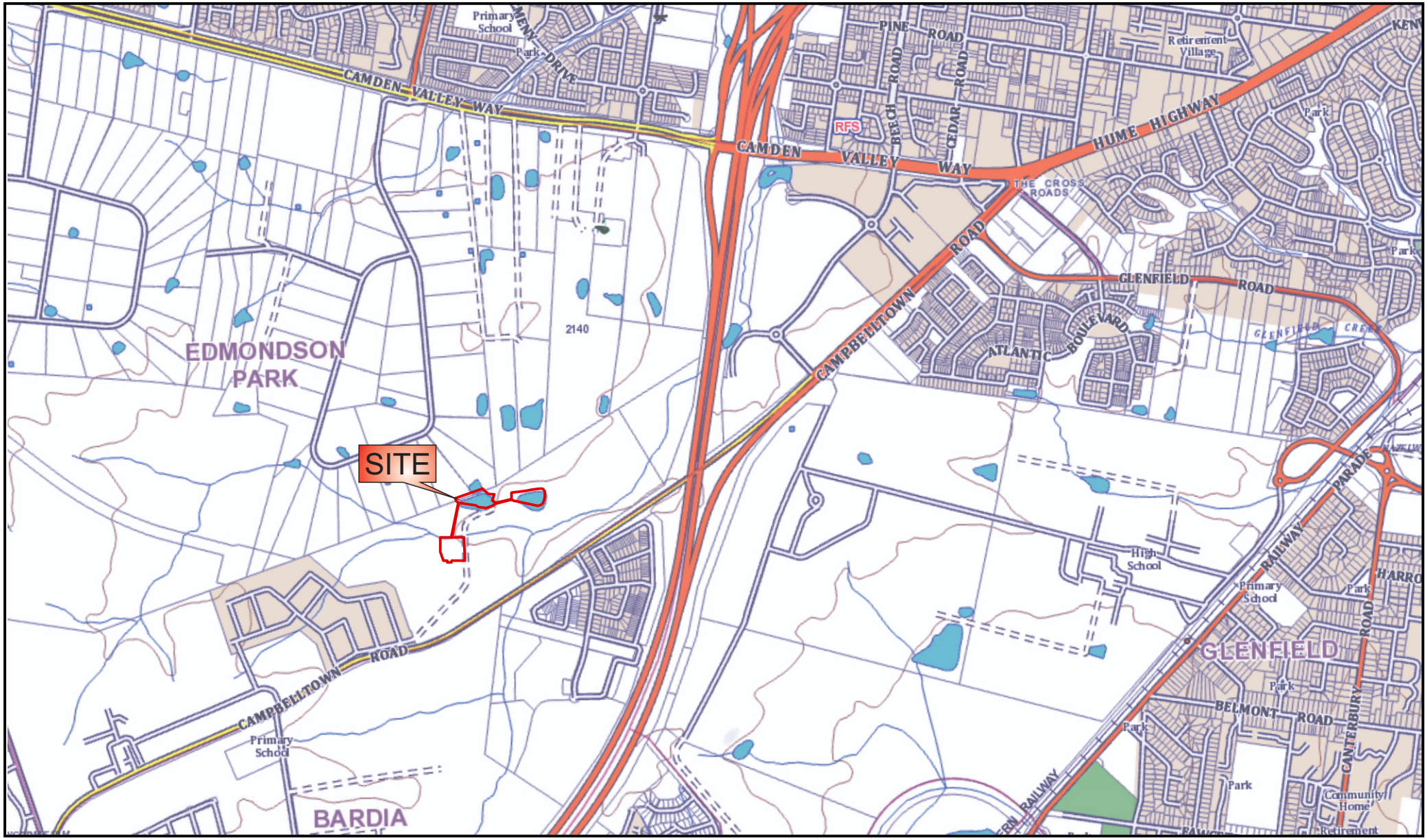
The advice herein relates only to this project and all results conclusions and recommendations made should be reviewed by a competent person with experience in environmental investigations, before being used for any other purpose. This report should not be reproduced without prior approval by the client, or amended in any way without prior approval by JBS&G.

Ground conditions between sampling locations and media may vary, and this should be considered when extrapolating between sampling points. Chemical analytes are based on the information detailed in the site history. Further chemicals or categories of chemicals may exist at the site, that were not identified in the site history and which may not be expected at the site.

Changes to the subsurface conditions may occur subsequent to the advice provided herein, through natural processes or through the intentional or accidental addition of contaminants. The advice is based on the information obtained or available at the time the advice is provided.

This advice is not a complete assessment of the status of the site, and it is limited to the scope of works commissioned. Should information become available regarding conditions at the site including previously unknown sources of contamination, JBS&G reserves the right to review the advice in the context of the additional information.

Figures



Source Base Image - © SIX Maps www.maps.six.nsw.gov.au

0 120 240 480 m

Scale: 1:18,000

Datum: MGA94 Zone 56 - AHD

Rev	Description	Drn.	Date:
A4			
A	Original Issue - R03	SE	11-03-2014

Legend:

— Approximate Site Boundary

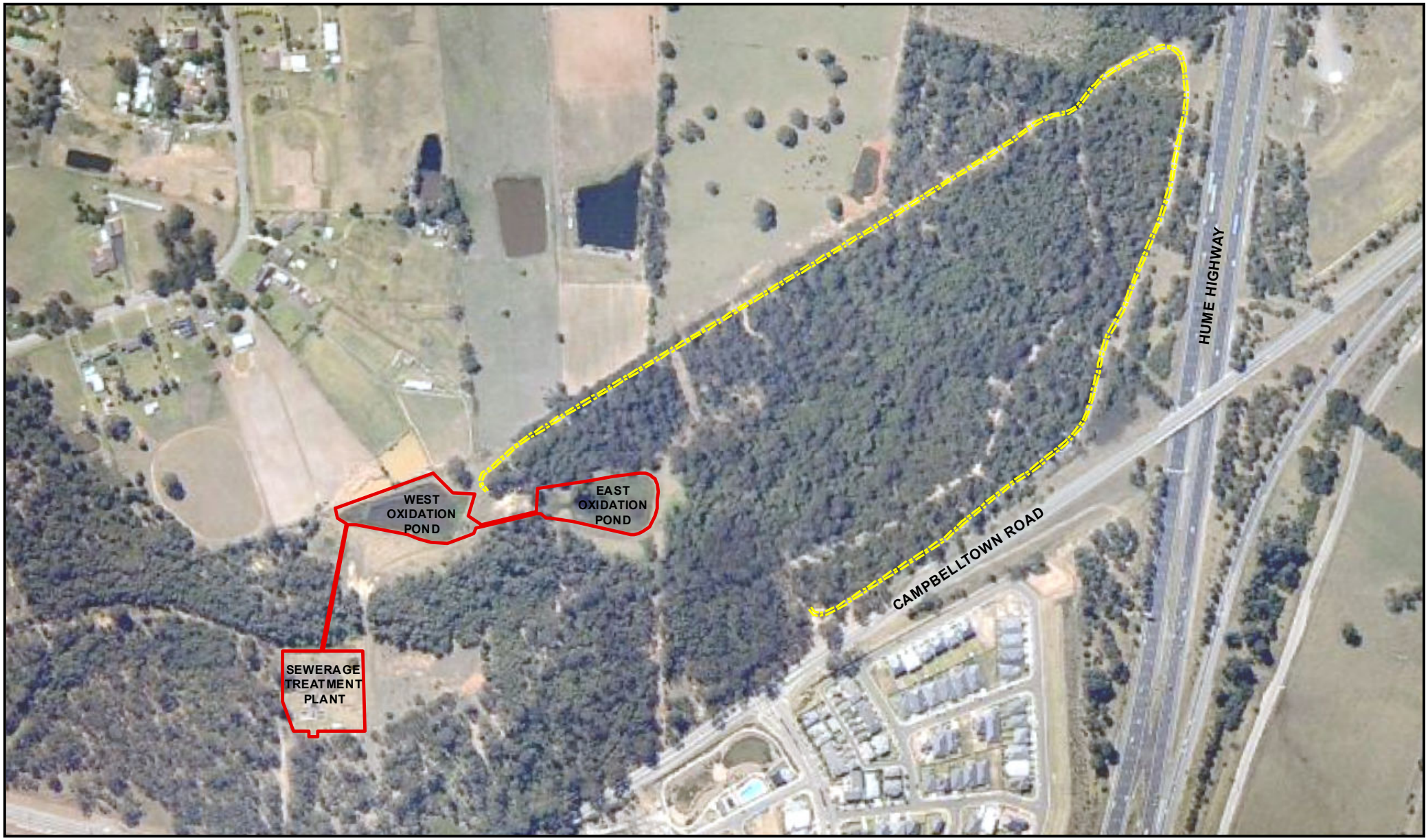
JBS&G

Figure 1: Site Location

Client: UrbanGrowth NSW

Project: Remediation and Validation Edmondson Park - STP

Job No: 43008 File Name: 43008_01



Source: Base Image - © www.nearmap.com.au

0 50 100 200 m

Scale: 1:5,000

Datum: MGA94 Zone 56 - AHD

Rev	Description	Drn.	Date:
A4			
A	Original Issue - R03	SE	11-03-2014

Legend:

- Approximate Site Boundary
- Access Path

JBS&G

Figure 2: Site Layout

Client: UrbanGrowth NSW

Project: Remediation and Validation Edmondson Park - STP

Job No: 43008 File Name: 43008_02

Source: Base Image - © www.nearmap.com.au

0 5 10 20 m

Scale: 1:750

Datum: MGA94 Zone 56 - AHD

Rev	Description	Drn.	Date:
A4			
A	Original Issue - R03	SE	27-03-2014

Legend:

- Approximate Site Boundary
- Previous Groundwater Monitoring Well Location (ERM 2010)
- PreviousTest Pit Location (ERM 2010)
- Monitoring Well Location (JBS&G 2013)
- Oxidation Pond Soil Sample Location (JBS&G 2013)
- Oxidation Pond Surface Water Sample Location (JBS&G 2013)
- Surface Soil Sample Location (JBS&G 2013)
- Surface Water Sample Location (JBS&G 2013)
- Test Pit Location (JBS&G 2013)

JBS&G

Figure 3a: Previous Sample Locations Sewerage Treatment Plant

Client: UrbanGrowth NSW

Project: Remediation and Validation Edmondson Park - STP

Job No: 43008 File Name: 43008_03a

Source: Base Image - © www.nearmap.com.au

0 12.5 25 50 m

Scale: 1:1,250

Datum: MGA94 Zone 56 - AHD

Rev	Description	Drn.	Date:
A4			
A	Original Issue - R03	SE	27-03-2014

Legend:

- Approximate Site Boundary
- Previous Borehole Location (ERM 2010)
- PreviousTest Pit Location (ERM 2010)
- Monitoring Well Location (JBS&G 2013)
- Oxidation Pond Soil Sample Location (JBS&G 2013)
- Oxidation Pond Surface Water Sample Location (JBS&G 2013)
- Test Pit Location (JBS&G 2013)

JBS&G

Figure 3b: Previous Sample Locations Oxidation Ponds

Client: UrbanGrowth NSW

Project: Remediation and Validation Edmondson Park - STP

Job No: 43008 File Name: 43008_03b

STPBH02	Depth
Analyte	(m)
ACM	0.1

STPBH03	Depth	Concentration
Analyte	(m)	
Faecal Coliforms	0.1	2300 MPN/10g

STPTP12	Depth	Concentration
Analyte	(m)	
Taenia OVA.	0.25	2300 MPN/10g

STPTP14	Depth	Concentration
Analyte	(m)	
TPH	0.1	1470 mg/kg
Faecal Coliforms	0.1	35000 MPN/10g
Salmonella	0.1	

STPTP17	Depth	Concentration
Analyte	(m)	
Taenia OVA.	0.5	1400 MPN/10g

STPTP16	Depth	Concentration
Analyte	(m)	
Faecal Coliforms	0.1	1400 MPN/10g

Source: Base Image - © www.nearmap.com.au

0 5 10 20 m

Scale: 1:750

Datum: MGA94 Zone 56 - AHD

Rev	Description	Drn.	Date:
A4			
A	Original Issue - R03	SE	27-03-2014

Legend:

- Approximate Site Boundary
- Previous Groundwater Monitoring Well Location (ERM 2010)
- PreviousTest Pit Location (ERM 2010)
- Monitoring Well Location (JBS&G 2013)
- Oxidation Pond Soil Sample Location (JBS&G 2013)
- Oxidation Pond Surface Water Sample Location (JBS&G 2013)
- Surface Soil Sample Location (JBS&G 2013)
- Surface Water Sample Location (JBS&G 2013)
- Test Pit Location (JBS&G 2013)

JBS&G

Figure 4a: Soil Exceedances Sewerage Treatment Plant

Client: UrbanGrowth NSW

Project: Remediation and Validation Edmondson Park - STP

Job No: 43008 File Name: 43008_04a

Source: Base Image - © www.nearmap.com.au

0 12.5 25 50 m

Scale: 1:1,250

Datum: MGA94 Zone 56 - AHD

Rev	Description	Drn.	Date:
A4			
A	Original Issue - R03	SE	27-03-2014

Legend:

- Approximate Site Boundary
- Previous Borehole Location (ERM 2010)
- PreviousTest Pit Location (ERM 2010)
- Monitoring Well Location (JBS&G 2013)
- Oxidation Pond Soil Sample Location (JBS&G 2013)
- Oxidation Pond Surface Water Sample Location (JBS&G 2013)
- Test Pit Location (JBS&G 2013)

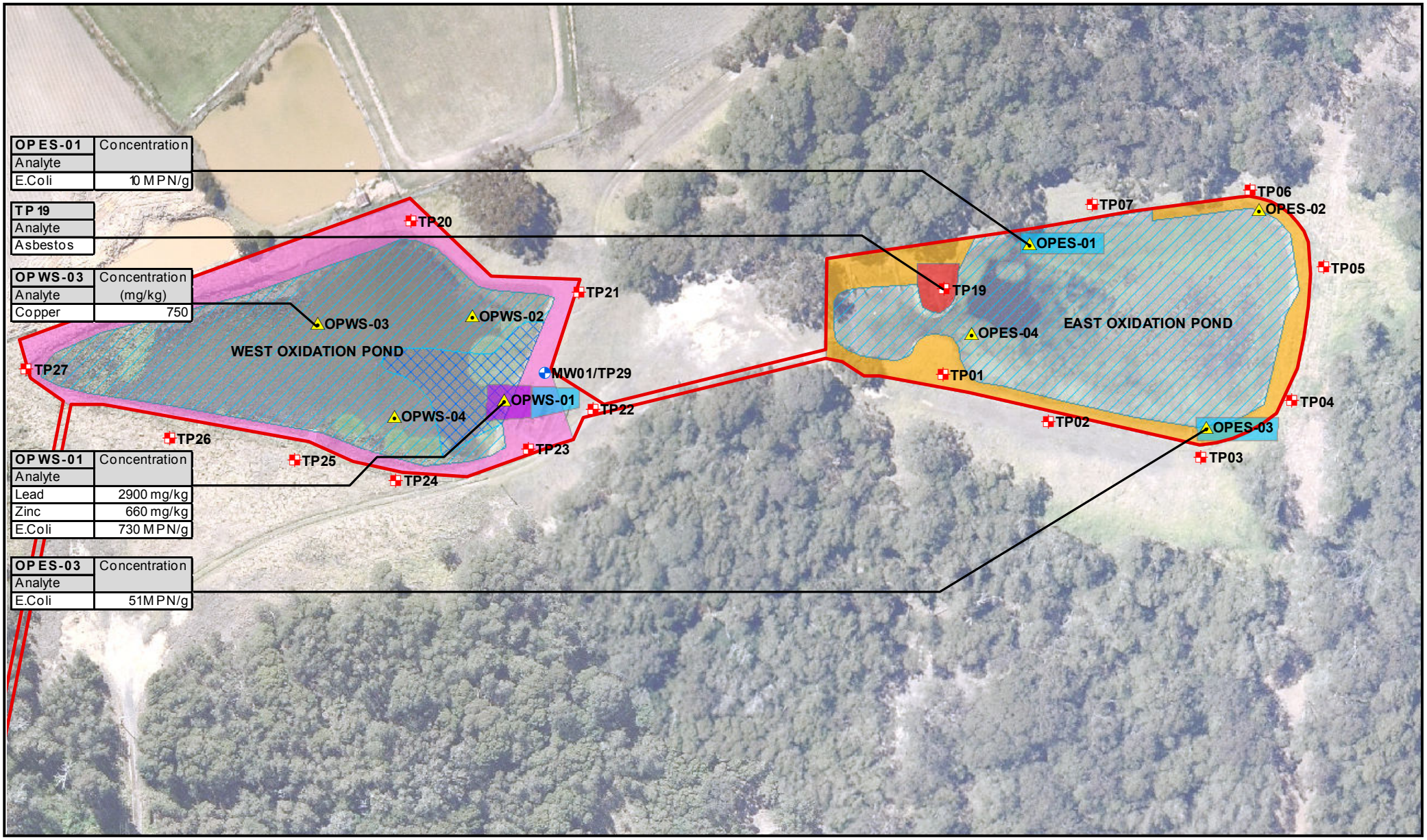
JBS&G

Figure 4b: Soil Exceedances Oxidation Ponds

Client: UrbanGrowth NSW

Project: Remediation and Validation Edmondson Park - STP

Job No: 43008 File Name: 43008_04b



Source: Base Image - © www.nearmap.com.au

0 12.5 25 50 m

Scale: 1:1,250

Datum: GDA 1994 MGA Zone 56 - AHD

Rev	Description	Drn.	Date:
A4			
A	Original Issue - R03	SE	20-04-2015

Legend:

- Monitoring Well Location
- Oxidation Pond Soil Sample Location
- Surface Soil Sample Location
- Test Pit Location
- Approximate Site Boundary
- Further Asbestos Investigation
- Approximate Asbestos Impact
- Approximate Biologicals (E.Coli) Impact
- Approximate Lead Impact
- Possible E.coli Impact
- Possible Lead and E.coli Impact
- Further Leand and E.Coli Investigation

JBS&G **Figure 5: Remedial Extent**

Client: UrbanGrowth NSW

Project: Remediation and Validation Edmondson Park - STP

Job No: 43008 File Name: 43008_05

Source: © www.nearmap.com.au

0 20 40 80 m

Scale: 1:2,000

Datum: MGA94 Zone 56 - AHD

Rev	Description	Drn.	Date:
A4			
A	Original Issue - R03	SE	12-03-2014

Legend

- Potential Containment Cell 1
- Potential Containment Cell 2
- Potential Containment Cell 3
- Potential Containment Cell 4
- Potential Containment Cell 5
- Potential Containment Cell 6
- Sample Location

ID	Area m²
Potential Containment Cell 1	3699.92
Potential Containment Cell 2	5856.63
Potential Containment Cell 3	2955.00
Potential Containment Cell 4	11055.01
Potential Containment Cell 5	4698.21
Potential Containment Cell 6	8814.18

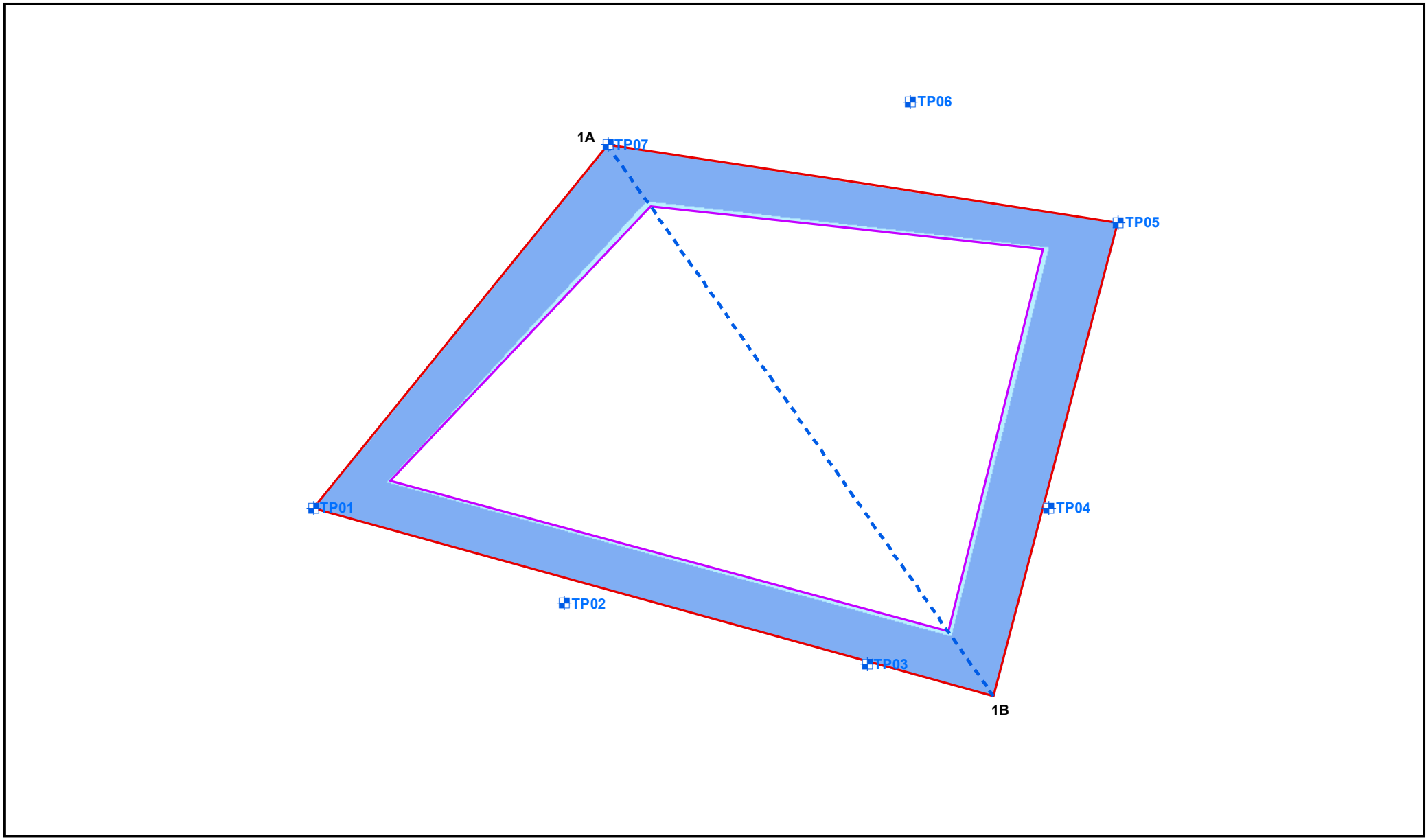
JBS&G

Figure 6: Location of Potential Containment Cells

Client: UrbanGrowth NSW

Project: Remediation and Validation Edmondson Park - STP

Job No: 43008 File Name: 43008_06



0 5 10 20 m

Scale: 1:600

Datum: MGA94 Zone 56 - AHD

Rev	Description	Drn.	Date:
A4			
A	Original Issue - R03	SE	12-03-2014

Legend

- Potential Containment Cell 1 Boundary
- Inner Portion
- Inner Batter (0.33H:1V subject to design/inspection)
- Outer Batter (2H:1V)
- Cross Section
- Sample Location

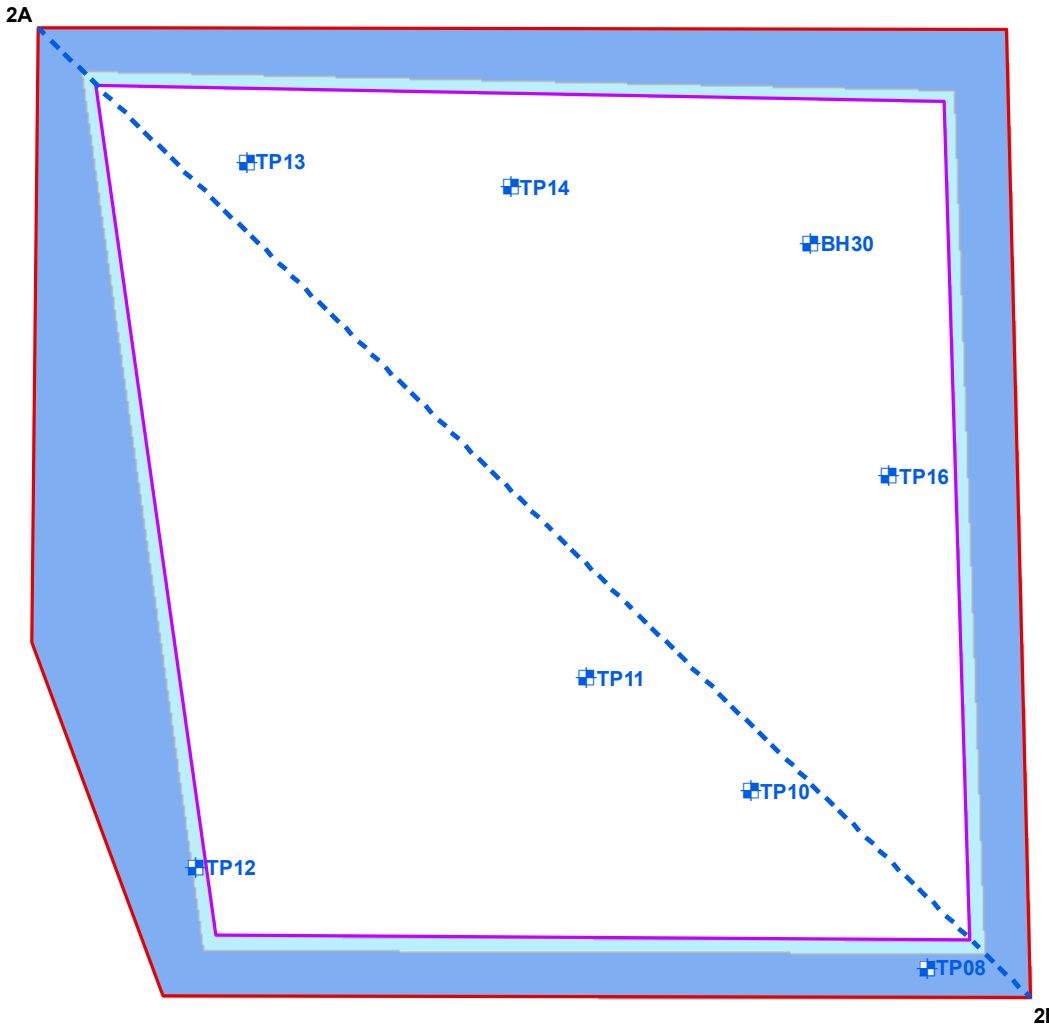
JBS&G

Figure 6A: Potential Containment Cell 1 Cross Section Location

Client: UrbanGrowth NSW

Project: Remediation and Validation Edmondson Park - STP

Job No: 43008 File Name: 43008_06A



0 5 10 20 m

Scale: 1:600

Datum: MGA94 Zone 56 - AHD

A4			
A	Original Issue - R03	SE	12-03-2014
Rev	Description	Drn.	Date:

Legend

- Potential Containment Cell 2 Boundary
- Inner Portion
- Inner Batter (0.33H:1V subject to design/inspection)
- Outer Batter (2H:1V)
- Cross Section
- Sample Location

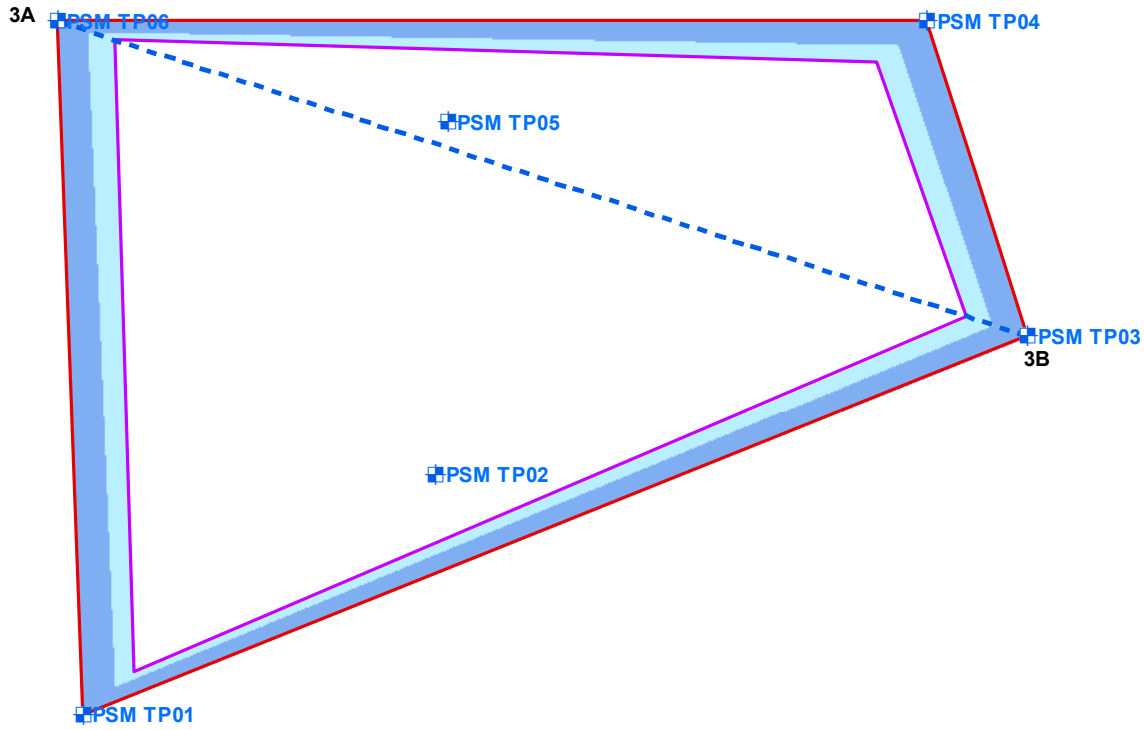
JBS&G

Figure 6B: Potential Containment Cell 2 Cross Section Location

Client: UrbanGrowth NSW

Project: Remediation and Validation Edmondson Park - STP

Job No: 43008 File Name: 43008_06B



0 5 10 20 m

Scale: 1:600

Datum: MGA94 Zone 56 - AHD

Rev	Description	Drn.	Date:
A4			
A	Original Issue - R03	SE	12-03-2014

Legend

- Potential Containment Cell 3 Boundary
- Inner Portion
- Inner Batter (0.33H:1V subject to design/inspection)
- Outer Batter (2H:1V)
- Cross Section
- Sample Location

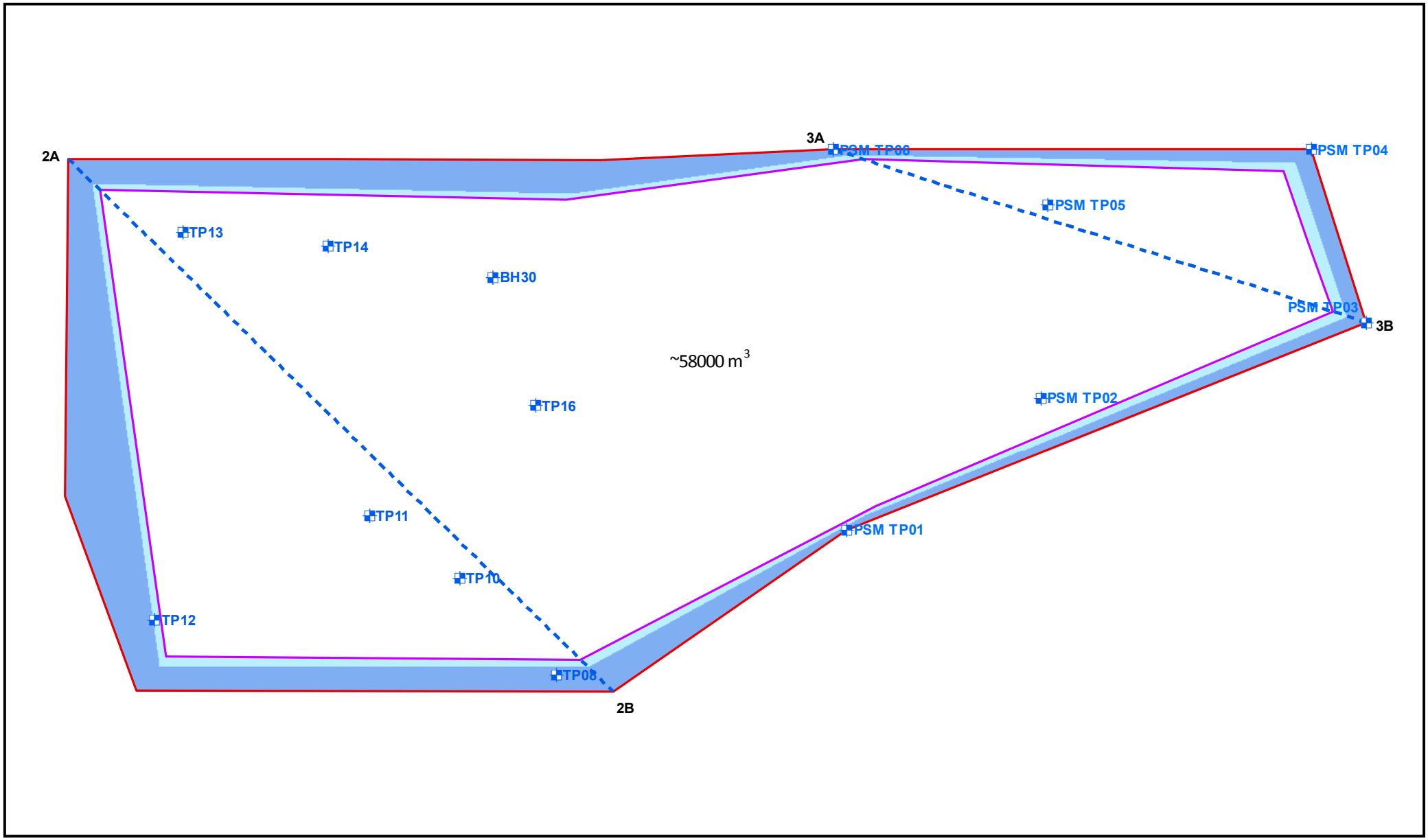
JBS&G

Figure 6C: Potential Containment Cell 3 Cross Section Locations

Client: UrbanGrowth NSW

Project: Remediation and Validation Edmondson Park - STP

Job No: 43008 File Name: 43008_06C



0 5 10 20 m

Scale: 1:750

Datum: MGA94 Zone 56 - AHD

Rev	Description	Drn.	Date:
A4			
A	Original Issue - R03	SE	12-03-2014

Legend

- Potential Containment Cell 4 Boundary
- Inner Portion
- Inner Batter (0.33H:1V subject to design/inspection)
- Outer Batter (2H:1V)
- Cross Section
- Sample Location

Note: Volume is Estimated

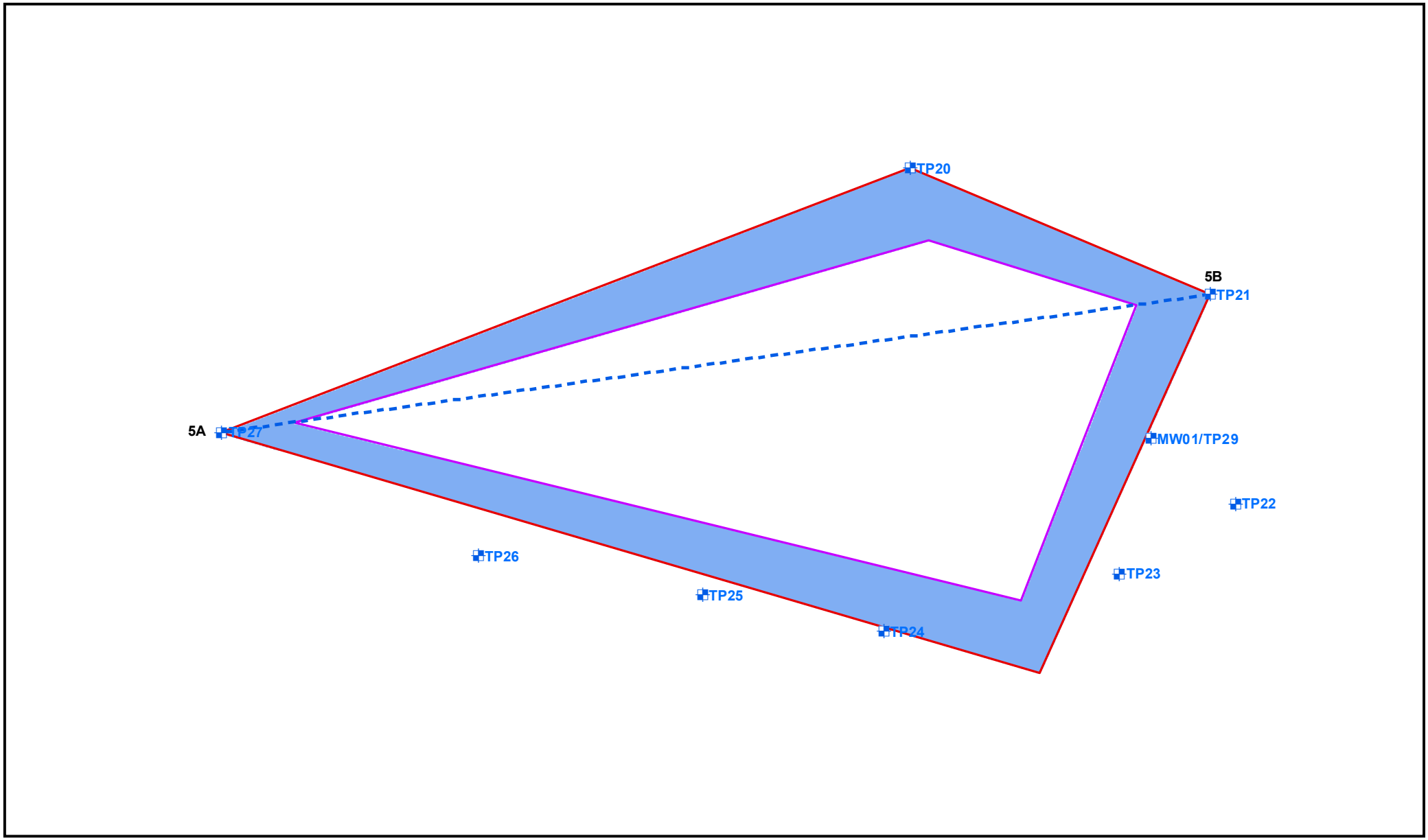
JBS&G

Figure 6D: Potential Containment Cell 4 Cross Section Locations

Client: UrbanGrowth NSW

Project: Remediation and Validation Edmondson Park - STP

Job No: 43008 File Name: 43008_06D



0 5 10 20 m

Scale: 1:700

Datum: MGA94 Zone 56 - AHD

Rev	Description	Drn.	Date:
A4			
A	Original Issue - R03	SE	12-03-2014

Legend

- Potential Containment Cell 5 Boundary
- Inner Portion
- Outer Batter (2H:1V)
- Cross Section
- Sample Location

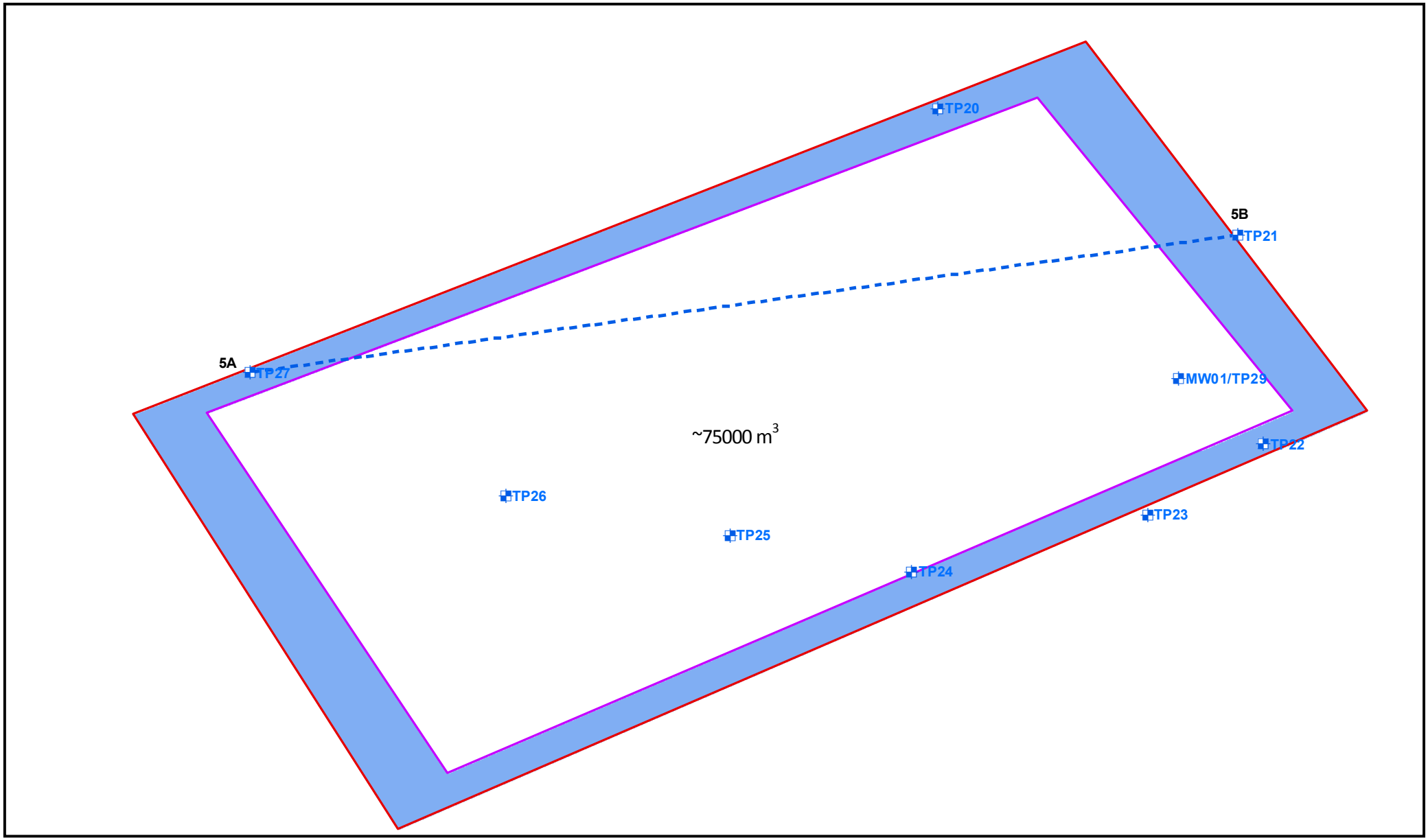
JBS&G

Figure 6E: Potential Containment Cell 5 Cross Section Location

Client: UrbanGrowth NSW

Project: Remediation and Validation Edmondson Park - STP

Job No: 43008 File Name: 43008_06E



0 5 10 20 m

Scale: 1:700

Datum: MGA94 Zone 56 - AHD

Rev	Description	Drn.	Date:
A4			
A	Original Issue - R03	SE	12-03-2014

Legend

- Potential Containment Cell 6 Boundary
- Inner Portion
- Outer Batter (2H:1V)
- Cross Section
- Sample Location

Note: Volume is Estimated

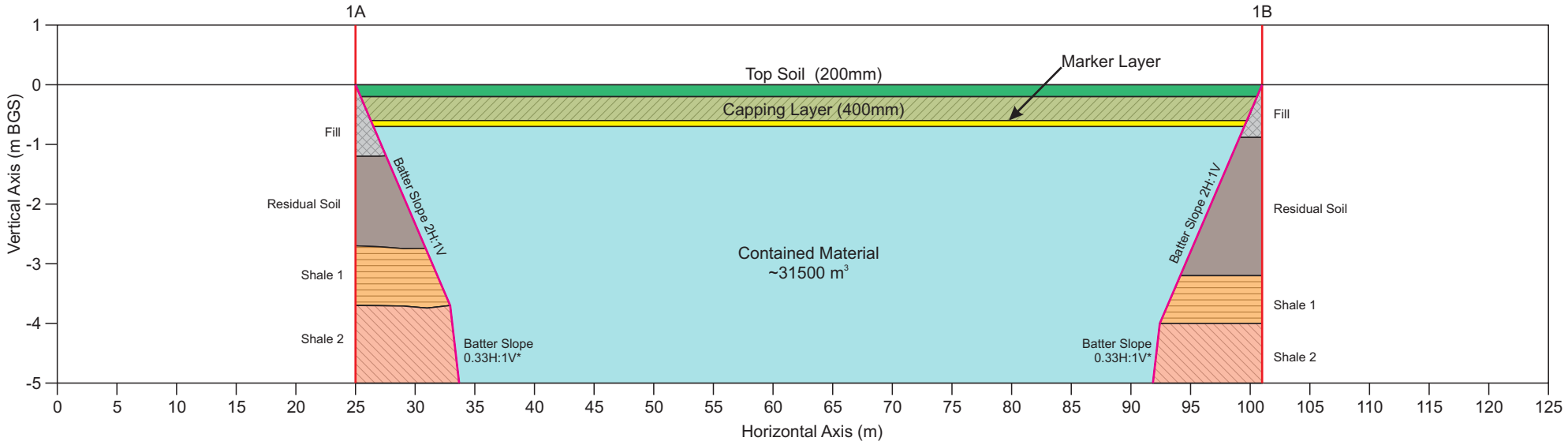
JBS&G

Figure 6F: Potential Containment Cell 6 Cross Section Location

Client: UrbanGrowth NSW

Project: Remediation and Validation Edmondson Park - STP

Job No: 43008 File Name: 43008_06F



0 5 10 20 m

Scale: Approximate - Vertical Exaggeration: 5

Datum: MGA94 Zone 56 - AHD

Rev	Description	Drn.	Date
A4			
A	Original Issue - R03	SE	12-03-2014

Legend:

- Potential Containment Cell 1 Boundary
- Batter
- Engineered Fill
- Residual Soil - Clay
- Shale 1 - highly to extremely weathered
- Shale 2 - moderately weathered
- Top Soil Layer
- Capping Layer
- Marker Layer
- Contained Material

* Subject to design/inspection

Note: Volume is Estimated

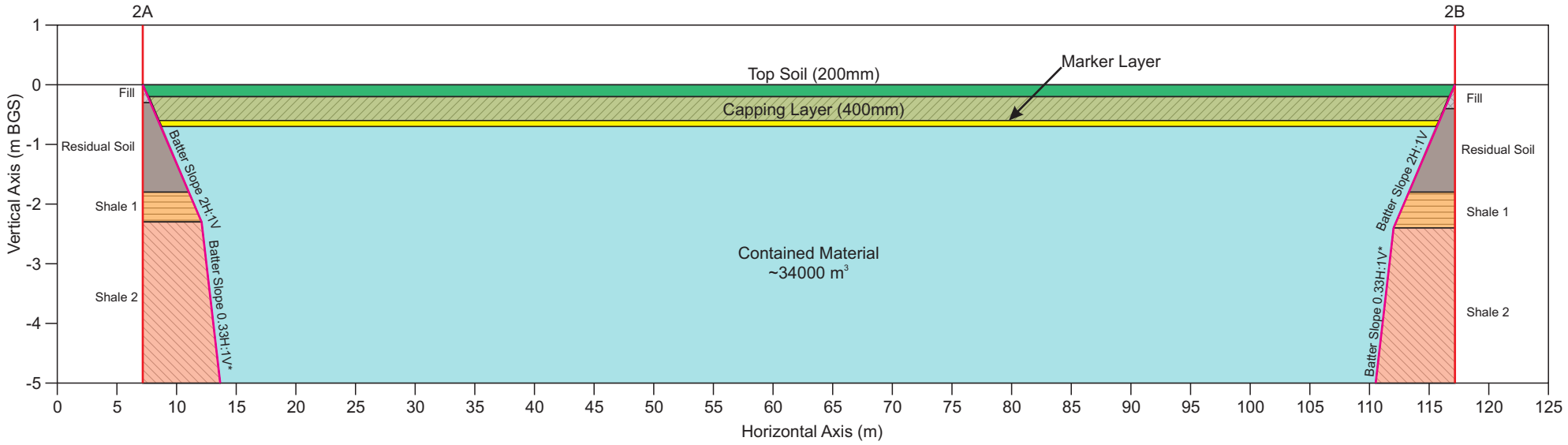
JBS&G

Figure 7A: Cross Sections 1A - 1B Cell 1

Client: Urban Growth

Project: Remediation and Validation Edmondson Park

Job No: 43008 File Name: 43008_07A



0 5 10 20 m

Scale: Approximate - Vertical Exaggeration: 5

Datum: MGA94 Zone 56 - AHD

Rev	Description	Drn.	Date
A4			
A	Original Issue - R03	SE	12-03-2014

Legend:

- Potential Containment Cell 2 Boundary
- Batter
- Engineered Fill
- Residual Soil - Clay
- Shale 1 - highly to extremely weathered
- Shale 2 - moderately weathered
- Top Soil Layer
- Capping Layer
- Marker Layer
- Contained Material

* Subject to design/inspection

Note: Volume is Estimated

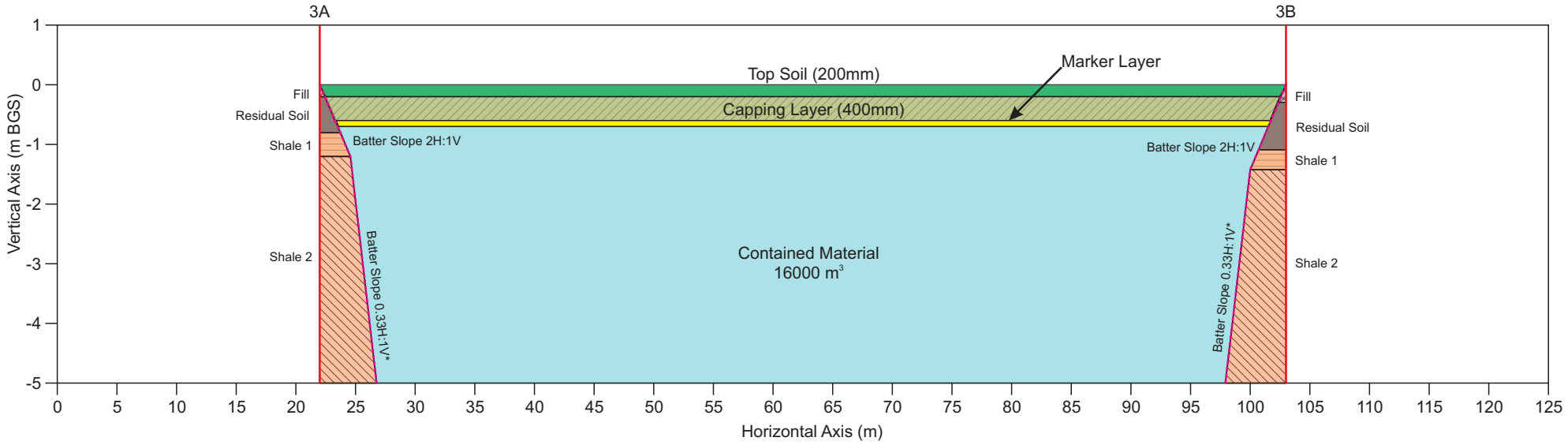
JBS&G

Figure 7B: Cross Sections 2A - 2B Cell 2

Client: Urban Growth

Project: Remediation and Validation Edmondson Park

Job No: 43008 File Name: 43008_07B



0 5 10 20 m

Scale: Approximate - Vertical Exaggeration: 5

Datum: MGA94 Zone 56 - AHD

Rev	Description	Drn.	Date
A4			
A	Original Issue - R03	SE	12-03-2014

Legend:

- Potential Containment Cell 3 Boundary
- Batter
- Engineered Fill
- Residual Soil - Clay
- Shale 1 - highly to extremely weathered
- Shale 2 - moderately weathered
- Top Soil Layer
- Capping Layer
- Marker Layer
- Contained Material

* Subject to design/inspection

Note: Volume is Estimated

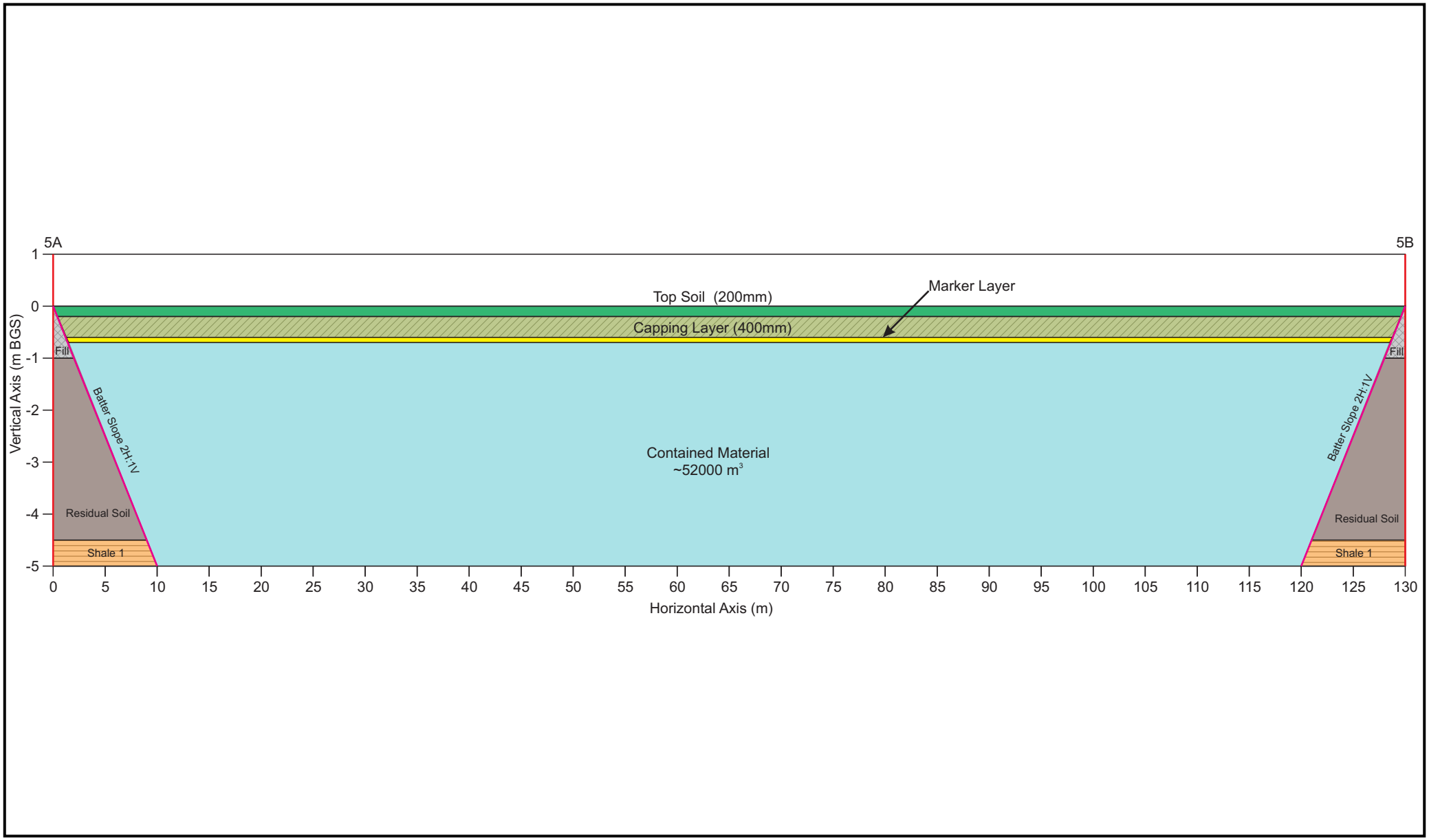
JBS&G

Figure 7C: Cross Sections 3 - 3A Cell 3

Client: Urban Growth

Project: Remediation and Validation Edmondson Park

Job No: 43008 File Name: 43008_07C



0 5 10 20 m

Scale: Approximate - Vertical Exaggeration: 5

Datum: MGA94 Zone 56 - AHD

Rev	Description	Drn.	Date
A4			
A	Original Issue - R03	SE	12-03-2014

Legend:

- Potential Containment Cell 5 Boundary
- Batter
- Engineered Fill
- Residual Soil - Clay
- Shale 1 - highly to extremely weathered
- Shale 2 - moderately weathered
- Top Soil Layer
- Capping Layer
- Marker Layer
- Contained Material

* Subject to design/inspection

Note: Volume is Estimated

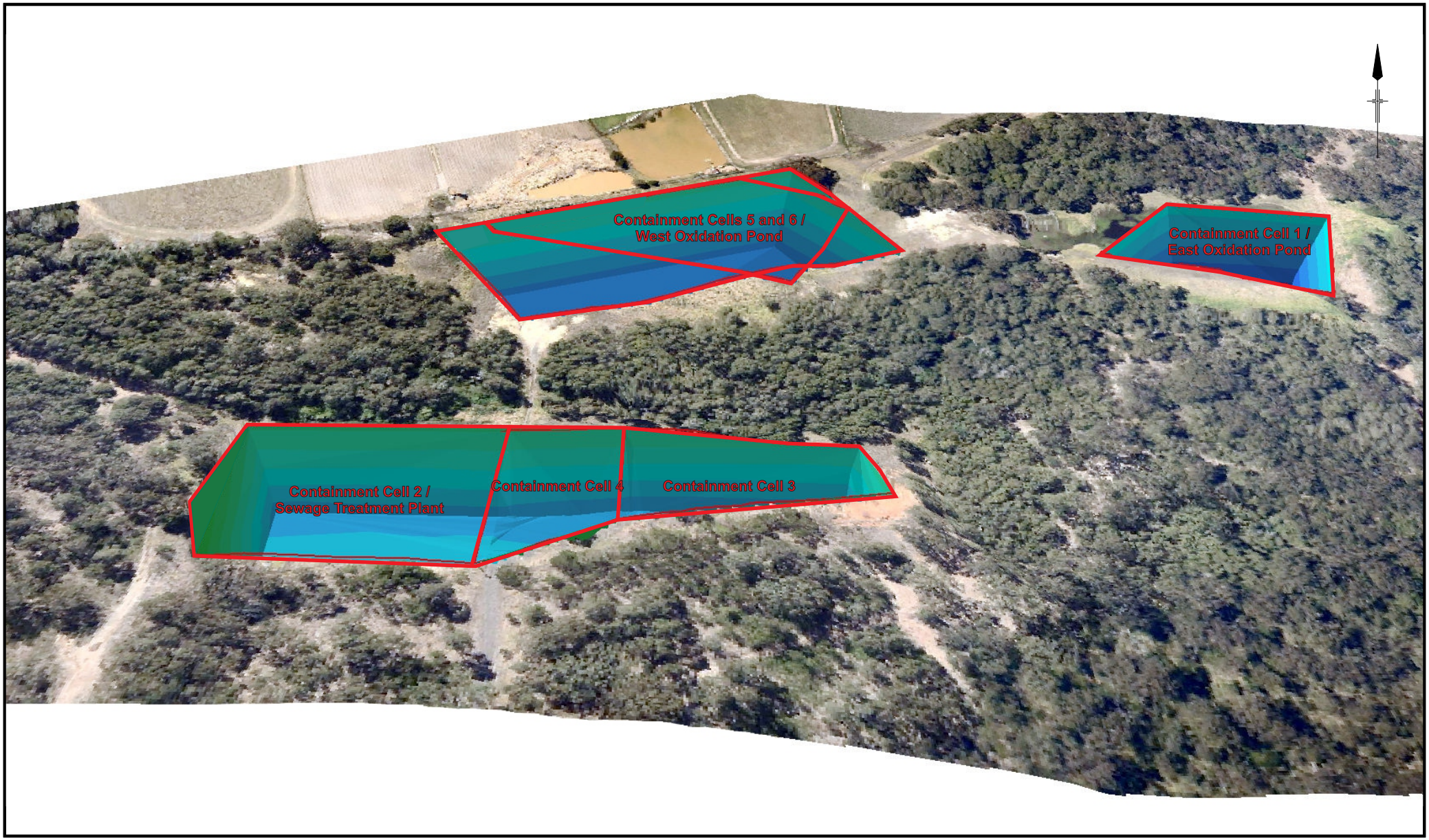
JBS&G

Figure 7D: Cross Sections 5A - 5B Cell 5

Client: Urban Growth

Project: Remediation and Validation Edmondson Park

Job No: 43008 File Name: 43008_07D



Scale: Approximate - Vertical Exaggeration: 6

Datum: MGA94 Zone 56 - AHD

Rev	Description	Drn.	Date
A4			
A	Original Issue - R03	SE	13-03-2014

Legend:

- Containment Cell Boundary
- 50m AHD
- 35m AHD

JBS&G

Figure 8A: Potential Containment Cell Layout - Viewing North

Client: Urban Growth

Project: Remediation and Validation Edmondson Park

Job No: 43008 File Name: 43008_08A