School Infrastructure NSW
c/- Richard Crookes Constructions

Environmental Site Assessment

Proposed Public School
Buchan Avenue, Edmondson Park NSW

21 May 2021

60756/137554 (Rev 0)

JBS&G

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Abbreviations

Term	Definition
APECs	Areas of Potential Environmental Concern
ACM	Asbestos Containing Material
AHD	Australian Height Datum
ASS	Acid Sulfate Soil
bgl	Below Ground Level
BTEX	Benzene, toluene, ethylbenzene and xylenes
B(a)P	Benzo(a)pyrene
CLM Act	Contaminated Land Management Act 1997
COPCs	Constituents of Potential Concern
CSM	Conceptual Site Model
DP	Deposited Plan
DPI	Department of Planning and Infrastructure
EMP	Environmental Management Plan
EPA	NSW Environment Protection Authority
ESA	Environmental Site Assessment
GIL	Groundwater Investigation Level
Ha	Hectare
HIL	Health Investigation Level
JBS&G	JBS&G Australia Pty Ltd
LEMP	Long Term Environmental Management Plan
LOR	Limit of Reporting
OCPs	Organochlorine Pesticides
PAHs	Polycyclic Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls
POEO	Protection of the Environment Operations Act 1997
QA/QC	Quality Assurance / Quality Control
RAP	Remedial Action Plan
SAS/SAR	Site Audit Statement/Report
TRH	Total Recoverable Hydrocarbons (C_6-C_{10}, >C_{10}-C_{16}, >C_{16}-C_{34}, >C_{34}-C_{40})

Executive Summary

JBS&G Australia Pty Ltd (JBS&G) was engaged by Richard Crookes Construction (RCC, the client) to undertake an environmental site assessment (ESA) of the proposed public school site located at Buchan Avenue, Edmondson Park, NSW (the site) as shown in **Figure 1** (**Attachment 2**). The site is legally identified as part Lots 1 and 2 on DP 1257105 and comprises part of the former Landcom Precinct 9 Edmondson Park Town Centre redevelopment site. The site has a total area of approximately 6 hectares (ha), of which approximately 2 ha are proposed for the new primary school.

The ESA has been requested as part of the state significant development approval (SSDA) process with the Department of Planning, Industry and Environment (DPIE) for the proposed development of the new primary school. DPIE issued Planning Secretary's Environmental Assessment Requirements (SEARs) on 10 December 2010 (SSD-10224) requesting site assessment reports as required under State Environmental Planning Policy No. 55 (SEPP55). The ESA has been prepared as consistent with current guidelines made or approved by the NSW EPA. Sampling and analysis data to support the ESA has been utilised from a range of previous investigations.

The objective of the ESA is to identify potential site contamination issues that will require to be addressed during the construction works prior to the use of the site for a primary school. The findings of the ESA are proposed to inform the potential development of a Remedial Action Plan (RAP) to be implemented prior to the construction works such that the site can be demonstrated as suitable for the proposed land use as required under SEPP55.

The scope of work completed for the ESA comprised a review of previous site contamination assessment/investigation reports available for the site, a review of the proposed development information, development of a Conceptual Site Model (CSM) specific to the environmental characteristics of the site and the proposed development; and development of conclusions with regards to the suitability of the site or recommendations on issues requiring management/remediation. The completed scope of work addressed SEARs requirements 18 and 20 and satisfied the requirements of SEPP55.

Based on the scope of work completed for this assessment and subject to the Limitations in **Section 8**, the following is concluded:

- Review of currently available previous site assessment documents has identified that there is sufficient existing data to characterise soil and groundwater conditions within the area of the proposed development in order to establish a CSM;
- Each of the environmental data sets (as sourced from Environ (2013), PSM (2019) and JBS&G (2021)) were found to be reliable for the purposes of making decisions as part of this assessment. It is noted that data summarised in Environ (2013) was generated several years ago. However, from a review of the site history since 2013, the site use has remained relatively unchanged and therefore the data is considered to be sufficiently representative of current conditions for the purposes of developing the CSM;
- Based on the results and CSM presented herein, there were no potential unacceptable health risks identified with respect to the proposed development.
- On the basis of the current investigation, it is considered that the site is suitable for residential with accessible soil land uses, including gardens and accessible soil, day care centre, pre-school, primary and secondary school and park, recreational open space, playing fields without the preparation of a RAP.

- Further, assessment of acid sulfate soil and site salinity conditions identified that there is no requirement for specific management of such conditions associated with the site or the proposed land use.

An unexpected finds protocol (UFP) should be prepared to establish framework for management, whereby any isolated unexpected occurrences could be identified and disposed of appropriately.

1. Introduction

1.1 Background

JBS&G Australia Pty Ltd (JBS&G) was engaged by Richard Crookes Construction (RCC, the client) on behalf of School Infrastructure NSW (SINSW) to undertake an environmental site assessment (ESA) of the proposed public school site located at Buchan Avenue, Edmondson Park, NSW (the site) as shown in **Figure 1** (**Attachment 2**). The site is legally identified as part Lots 1 and 2 on DP 1257105 and comprises part of the former Landcom Precinct 9 Edmondson Park Town Centre redevelopment site. The site has an area of approximately 6 hectares (ha), of which approximately 2 ha are proposed for the new primary school.

JBS&G understands that a portion of the site is proposed to be redeveloped as a future school following divestment by Landcom to SINSW. The contamination assessment was requested in order to assess potential contamination management requirements for the proposed development. JBS&G has previously completed environmental assessment and validation works for Landcom. On the basis of these works, a Site Audit Statement (SAS) was prepared by a NSW EPA accredited site auditor for the property in October 2013. The SAS indicated that the site was suitable for residential land use with accessible soils.

As part of a broader land parcel, the site has previously been the subject of environmental assessment, remediation and validation activities (JBS 2013[1]) and a subsequent site audit (Environ 2013[2]) that identified the site as being suitable for the purposes of 'residential with gardens and accessible soil' and other less sensitive uses including schools, open space and commercial, subject to compliance with the environmental management plan (EMP) relevant to the proposed open space areas within RZNRA (JBS&G 2013[3]). This EMP does not relate to the footprint of this site.

The site is a portion of a greater area formerly used by Department of Defence as a training facility. Investigation of the greater site area identified military objects (concertina wire, weapons pits, etc.), waste material on the ground surface and buried in pits and trenches, unexploded ordnance (UXO), exploded ordnance waste (EOW) and small arms ammunition (SAA) from military training exercises, and lead impacted material used to form tracks. Remediation of the site was undertaken to remove waste material, UXO, EOW and SAA, asbestos and lead impacted material. UXO, EOW and SAA was generally disposed off-site, whilst lead and asbestos impacted material was retained within land situated to the south of the railway line, remote from the site. Groundwater within the site and in the greater site area was assessed prior to and following remediation. Heavy metals concentrations in groundwater exceeded ecological criteria, however were considered indicative of background conditions associated with the regional geology, comprising the Wianamatta Group shale formation.

Since the finalisation of the remediation/validation works and issue of the final site audit statement (Environ 2013), the site has been managed by Landcom, or an appointed principal contractor as associated with subdivision construction activities nearby to the site. This resulted in use of the site at times as a temporary stockpiling yard for broader site generated excess fill material. The

[1] *Validation Report – RZNRA, prepared for Landcom, Zouch Road, Edmondson Park*. JBS Environmental. 24 September 2013 (JBS 2013)

[2] *Site Audit Report – Residential Zone North of Rail Alignment, Zouch Road Edmondson Park NSW*, prepared for Landcom, ENVIRON Australia Pty Ltd. October 2013 (Environ 2013)

[3] *Urban Growth, Public Open Space, Site Environmental Management Plan, Residential Zone North of Rail Alignment, Zouch Road, Edmondson Park, NSW'*, JBS&G (NSW & WA) Pty Ltd. 2 September 2013 (JBS&G 2013)

stockpiled material was subsequently assessed (JBS&G 2018[4], 2020a[5], 2020b[6] and 2020c[7]) as suitable for beneficial reuse as part of subdivision and road construction works and the material has been relocated outside of the site boundary for future re-use during construction of the Buchan Avenue upgrades.

The ESA has been requested as part of the state significant development approval (SSDA) process with the Department of Planning, Industry and Environment (DPIE) for the proposed development of the new Edmondson Park primary school the details of which are discussed in **Section 1.4**. DPIE issued Planning Secretary's Environmental Assessment Requirements (SEARs) for the proposal on 10 December 2010 (SSD-10224) requesting site assessment reports as required under State Environmental Planning Policy No. 55 (SEPP55) in addition to acid sulfate soil and salinity (SEARS 18 and 20). The ESA has been prepared as consistent with current guidelines made or approved by the NSW EPA. Sampling and analysis data to support the ESA has been utilised from a range of previous investigations.

1.2 Objective

The objective of the ESA was to characterise potential contamination and other soil related issues at the site and assess the suitability of the site for the proposed primary school use, or to make recommendations to enable such assessments to be made in the future such that the site can be demonstrated as suitable for the proposed land use as required under SEPP55. It is further an objective to address the requirements of SEARs 18 and 20 to support the SSDA process.

1.3 Scope of Works

The scope of works completed comprised:

- Review of previous site contamination assessment/investigation reports as made available to JBS&G with respect to the suitability of the data for use in evaluating the current contamination conditions across the various properties within the extent of the proposed public school site;
- Review of available geotechnical investigation reports as made available;
- Development of a conceptual site model (CSM) as specific to the environmental characterisation of the site and the proposed development; and
- Drawing conclusions with regard to the current suitability of the site from a contamination viewpoint and providing recommendations on issues that will need to be addressed to support the proposed redevelopment of the site.

1.4 Proposed Development

The SSDA seeks approval for a new core 35 primary school accommodating 1,012 students and a coldshell 40-place pre-school at the site. The works comprise:

- Site preparation and excavation.
- Land use for the purpose of a new primary school and pre-school.
- Construction of new buildings including:

[4] *Material Classification – Edmondson Park Precinct 9 Stockpile Assessment, Edmondson Park, NSW*. JBS&G 9 March 2018 (JBS&G 2018)
[5] *Material Classification – Edmondson Park Precinct 9 Stockpile 1 Assessment Part 2, Buchan Avenue, Edmondson Park NSW*. JBS&G 15 June 2020 (JBS&G 2020a)
[6] *Material Classification – Edmondson Park Precinct 9 Stockpile 1 Assessment Part 3, Buchan Avenue, Edmondson Park NSW*. JBS&G 19 June 2020 (JBS&G 2020b)
[7] *Material Classification – Edmondson Park Precinct Fly Tipped Stockpile Assessment, Buchan Avenue, Edmondson Park NSW*. JBS&G 10 July 2020 (JBS&G 2020c)

- A three-storey building on the western portion of the site primarily addressing Faulkner Way comprising 36 homebases, 4 special support unit teaching spaces, staff room, administration office at the ground floor and library at the first floor addressing the corner of Buchan Avenue and Faulkner Way, and student amenities.
- A single storey coldshell preschool building for educational programs for children the year before they commence kindergarten, accommodating 40 places. The pre-school building will be connected at the southern end of the three-storey building; and
- A single storey building on the eastern portion of the site comprising a communal hall, out of school hours care facility, 8 homebases and covered outdoor learning area.

- Landscaping and public domains works including tree planting, a sports court and creation of various assembly, play and learning zones.
- A drop-off and pick-up zone, and bus zone on Buchan Avenue.
- An at-grade staff carpark in the southern part of the site with ingress and egress provided off Faulkner Way at the south-west corner of the site.
- Primary pedestrian entrance from Buchan Avenue and an additional entrance on Faulkner Way for the ground floor support unit.
- Other ancillary infrastructure and utilities works and digital signage.

The proposed development layout is presented as an overlay to **Figure 3**.

1.5 Previous Assessments

This ESA has been prepared on the basis of a range of previous assessments. This has included:

- *Validation Report – RZNRA, prepared for Landcom, Zouch Road, Edmondson Park*. JBS Environmental. 24 September 2013 (JBS 2013);
- *Site Audit Report – Residential Zone North of Rail Alignment, Zouch Road Edmondson Park NSW*, prepared for Landcom, ENVIRON Australia Pty Ltd. October 2013 (Environ 2013);
- *School Infrastructure NSW (SINSW) Results of Geotechnical Investigation on Landcom 6.0 ha Land*, Pells Sullivan Meynink (PSM). 14 February 2019 (PSM 2019); and
- *Site Contamination Assessment – Edmondson Park Precinct 9, Buchan Avenue, Edmondson Park NSW*. JBS&G Australia Pty Ltd, 27 April 2021 (JBS&G 2021).

2. Site Description

2.1 Site Identification

The site location and current layout are shown in **Figures 1** and **2**, respectively. Site details are summarised in **Table 2.1** and described in detail in the following sections.

Table 2.1: Summary Site Details

Lot/DP	Parts Lots 1 and 2 on DP1257105
Address	Buchan Avenue, Edmondson Park
Local Government Authority	Liverpool City Council
Approximate MGA Coordinates (MGA 56)	East: 301662.2, North: 6239479.822
Site Zoning	R1 General Residential, State Environmental Planning Policy (State Significant Precincts) 2005
Current Use	Open and Vacant Land
Proposed Use	Primary School within the western portion of the site
Site Area	Approximately 6 ha of which approximately 2 ha is proposed for the primary school development

2.2 Site Inspection

A detailed site inspection was conducted on 05 May 2021 by one of JBS&G's trained and experienced environmental consultants. The site comprised an approximately rectangular shaped block, located between the rail line to the south and the Buchan Avenue extension to the north.

At the time of investigation, the site was identified to be vacant land, with the previous temporary stockpile footprint characterised as exposed clay soil and shale. Various stockpiles of imported construction materials were identified during the site inspection in the western and eastern portions of the site (however, it is understood that the on-site contractors had removed these stockpiles prior to issue of this final report). The entire site was devoid of trees or with minimal vegetation observed in the north-western and south eastern corners of the site.

The land parcel inclusive of Lots 1 and 2 DP1257105 was secured with permanent fencing at the street/rail corridor boundaries with access controlled via a lockable gate on Buchan Avenue. The areas to the north and east of the site were identified as part of an adjacent construction site, and there was no fencing observed separating these site boundaries.

There were no indications of discoloured, stained and/or odorous soil conditions with the exposed surface materials.

A photograph log of the site and surrounding area is provided in **Appendix B**.

2.3 Site History

From a review of previous investigations, the following summarises the key aspects of the greater IAC site history. It is noted that not all these activities would have taken place within the current site boundary:

- 1819 - Original land grant, private ownership, farming usage likely.
- 1939 - Defence hired 'vacant land' near Ingleburn Camp as a 'manoeuvre area'. Usage by Defence continued through the WW2 period.
- 1953 - Purchased by Commonwealth of Australia. Land within the wider Ingleburn area was acquired by the Army and used to establish camps and to conduct training for wartime expansion. The IAC was used primarily for infantry training purposes. First features developed at the site were a small arms firing range, golf course, grenade throwing bay and impact zone and cricket pitch.

The grenade range was located in the centre of the IAC and was used for live grenade throwing practices and possibly also mortar practice bombs for up to 30 years.

- 1970-1978 - Increasing vegetation cover.
- 1989 - Purchased by NSW Land and Housing Corporation (now known as Landcom). Usage by Defence ceased.
- 2005 - 2009 Various investigations of IAC undertaken.
- 2012 - Remediation activities.
- 2020 – Transfer of land from Landcom to SINSW.

The validation report (JBS 2013) conclusions were endorsed by the appointed site auditor in a Site Audit Statement in 2013, noting that in addition to the residential land uses with accessible soil, the site was also considered suitable for less sensitive land uses including schools.

To evaluate the potential activities across the site area since the 2013 site audit, historical aerial imagery sourced from NearMaps are provided in **Appendix C** and discussed below.

May 2014 – The site and surrounding area appeared predominately cleared with dirt trails running to and across the site. The railway line was apparent to the south. The area was characterised as partially grassed with scattered small trees.

June 2014 – To the north west of the site, earthworks had commenced and stockpiling of material was apparent on the site. Additionally, a large area around the base of the stockpile had been stripped of vegetation. To the east of the stockpile area a long square stockpile was also apparent.

January 2015 – The construction site to the west of the site, Landcom Precinct 4 had been cleared of all vegetation and the bulk earthworks were in progress. The stockpile identified onsite had significantly increased in volume. Smaller stockpiles could be seen to the north east and east of the larger stockpile. The area to the north east of the site remained similar to the June 2014 aerial.

May 2015 –The stockpile appeared to have further increased in volume. Roads had been constructed on Precinct 4 to the west of the site. Several stockpiles were observed around the base of the main stockpile including one to the north, north west and east. The site surroundings appeared similar to the January 2015 aerial.

October 2015 –The stockpiles appeared to be similar in size and character to the May 2015 aerial. The roads within the Precinct 4 development had been paved and the pads for the housing appeared to have been completed to the west of the site. The smaller stockpiles observed on the site remained similar to those identified in the previous historical aerial May 2015, however they appeared to have been shaped.

January 2018 – The stockpiles appeared to be similar in size and character to that evident in the October 2015 aerial, with the exception that the stockpile had now been vegetated. Houses to the west of the site had been completed. Earthworks had started in the area to the north of the site.

April 2020 - The stockpiles appeared to be similar in size and character to that shown in the January 2018 aerial, with the exception of increased vegetative cover. The houses to the west of the site had all been completed and the site had been fenced to the western and southern aspects. The balance of the site appeared to have increased vegetative cover and no areas of active ground disturbance was apparent at the time of the imagery.

August 2020 – Removal of the identified stockpiles appears in progress, with a haul road constructed from the south-east corner of the site to the placement location of the material to the north-east of the site across the Buchan Ave upgrade, outside of the current site boundary.

October 2020 – The large stockpile and associated smaller stockpiles, as identified in the April 2020 image, has been removed from the site, resulting in the stockpile footprint characterised with exposed soil and with associated ground disturbance across the site.

December 2020 – The site remains largely unchanged from the October 2020 image, with ongoing construction earthworks to the north of the site associated with construction of Buchan Ave.

2.4 Topography and Hydrology

JBS&G (2021) report that a review of regional topographical data via the Spatial Information exchange indicated the site has an elevation of between 56 m and 70 m Australian Height Datum (AHD) with the highest portion of the site being located in the south-western corner and ground levels observed to fall toward the north-eastern corner, with minor undulations associated with an ephemeral drainage line that crosses the northern portion of the site in a west to east direction.

An unnamed tributary of Maxwells Creek is present to the east of site, that ultimately flows into Cabramatta Creek, located approximately 6.5 km north-east of the site.

Rainfall is anticipated to infiltrate unsealed soils at the site, and surface water run-off to follow the local topography of the land and flow into stormwater infrastructure and ultimately towards the unnamed tributary.

2.5 Geology

JBS&G (2021) reported that a review of the Penrith 1:100,000 Geological Sheet Edition indicated that the site is located in an area underlain by Bringelly Shale which is found within the Wianamatta Group formation. Typical geological characteristics of the Bringelly Shale are fine to medium grained shale, carbonaceous claystone and claystone.

JBS&G (2021) identified that soils at the site and surrounding area are part of the Blacktown landscape characterised by gently undulating rises on Wianamatta Group shales, with local relief to 30 m and slopes usually less than 5%. Landforms can include broad rounded crests and ridges with gently inclined slopes. Vegetation is usually cleared eucalypt woodland and tall open-forest. Soils tend to be shallow to moderately deep hard setting mottled texture contrast soils, with red and brown podzolic soils on crests grading to yellow podzolic soils on lower slopes and in drainage lines. Limitations of this soil type include localised seasonal waterlogging, water erosion hazard, moderately reactive highly plastic subsoils, localised soils surface movement potential.

As summarised in Environ (2013) subsurface conditions at the site and surrounds were generally characterised by the presence of clayey silt/silty clay topsoil to depths of 0.05 – 0.5 mm below ground level (bgl), with isolated areas of fill material overlying residual silty clay soil and shale bedrock at depths of between 0.2 m to 3.2 m bgl.

From the intrusive investigation competed, JBS&G (2021) identified that the site lithology was characterised by shallow fill (gravelly clay and silty clay) with the total depth of fill occurrence ranging from 0 to 0.3m bgl (TP06). The underlying natural clay soils were observed to be red to red/grey stiff clay, with underlying weathered grey shale identified at TP08. No anthropogenic materials were observed at the test pit locations.

2.5.1 Potential for Acid Sulfate Soils

JBS&G (2021) reported that based on the NSW Office of Environment and Heritage Acid Sulfate Soils Risk database there is “no known occurrence” of acid sulfate soils identified for the site or the surrounding areas. Given the subsurface conditions as identified in PSM (2019) confirm the absence of soils of alluvial origin, there is considered no risk of acid sulfate soil occurrence at the site. As such, no further consideration of potential requirements for acid sulfate soils management is considered necessary.

2.6 Hydrogeology

As reported in Environ (2013), a post-remediation groundwater monitoring event was completed across the IAC site using the available wells. Groundwater monitoring in October 2012 reported standing water levels of between 1.6 m (BH291) and 7.1 m (BH558) below ground level. This corresponds to standing water elevations of between 46.75 m AHD (BH2) to the west and outside of current site boundaries, and 51.28 m AHD in the east and also outside of the current site boundaries.

Based on local topography and geology, regional groundwater is expected to be present in cracks and fissures within the underlying Bringelly Shale. Regional groundwater is anticipated to flow in an easterly to north-easterly direction toward the Georges River.

2.6.1 Salinity

The Salinity Potential in Western Sydney map (DIPNR 2003[8]) indicates that the site exists within an area of 'moderate salinity potential' outside of drainage line areas. Areas with this classification exhibit scattered scalding and indicator vegetation, but soil concentrations have not been mapped. Saline areas are identified as potentially existing within these areas.

During a JBS&G site inspection and intrusive sampling at the site in February 2021, there was no visible indication of saline soils on the ground surface and there was no evidence of salt scarring identified at the site.

The PSM (2019) investigation reported that eight samples from five locations across the site were assessed for salinity classification. These samples, obtained from across the 6 ha site at depths of between 0.5 m and 4.0 m below current ground level reported salinity classes ranging from non-saline to moderately saline.

Samples obtained from BH01 (in the southern portion of the site as shown in **Figure 3**) were reported as moderately saline in nature. PSM (2019) refer to clause 4.8.2 of the Australia Standard AS3600-2009 and note that the assessed soil electrical conductivity (EC_e) was less than the upper limit of the A2 exposure classification.

It is noted that the location of the reported moderately saline subsoil materials is outside the proposed primary school (2ha) development envelope, as shown on **Figure 3**. In addition, the proposed development plans identify the works will include importation of approximately 42,000m^3 of fill material across the site, effectively reducing the potential exposure/disturbance of existing site soils which may influence mobilisation of stored salt.

Based on the scope of assessment completed to address SEAR18 at the site and with consideration to the proposed development details, it is considered that no further assessment or ongoing management of site salinity conditions is necessary.

2.7 Meteorology

A review of average climatic data for the nearest Bureau of Meteorology monitoring location Badgery's Creek AWS (BOM, 2021[9]) indicates the site is located within the following meteorological setting:

- Mean maximum temperature ranges from 17.5°C in July to 30.3°C in January,
- Mean minimum temperature ranges from 4.1°C in July to 17.3°C in January;
- The average annual rainfall is approximately 658 mm with rainfall greater than 1mm occurring on an average of 67.5 days of the year; and

[8] *Salinity Potential in Western Sydney*. Department of Infrastructure, Planning and Natural Resources, March 2003, (DIPNR 2003)

[9] Commonwealth of Australia, 2019 Bureau of Meteorology, http://www.bom.gov.au/climate/averages/tables/cw_067108.shtml prepared on 29 April 2021 - accessed by JBS&G on 3 May 2021

- On average, July received the least amount of rain with a mean rainfall of 24.8 mm, while February receives the most rain, with a mean of 108.4 mm.

2.8 NSW EPA Public Register Search Records

A search of the NSW EPA's public register maintained under the Protection of the Environment Operations Act (POEO) 1997 was undertaken and is included in **Appendix F**.

The search identified that, for the site, there were:

- No prevention, clean up or prohibition notices;
- No suspension, surrender or revocation of environmental protection licences.

A search was undertaken through the EPA's public contaminated land register and is included as **Appendix F**. The search identified that there have been no notices issued under the Contaminated Land Management Act 1997 (CLM Act) for the site.

The site has not been notified to the EPA under section 60 of the CLM Act with regards to contamination. Review of the list of properties notified to the EPA did not identify any nearby properties that may represent a contamination migration risk to the site.

A search was also undertaken through the EPAs PFAS register of contaminated sites. The search identified that there are no sites within vicinity of the site notified to the EPA with regards to PFAS contamination.

3. Potential for Contamination

3.1 Areas of Potential Concern

Areas of Potential Environmental Concern (APEC) and Constituents of Potential Concern (COPC) have been identified for the site on the basis of the identified former and current sites uses. Constituents of Potential Concern have been identified in general accordance with DUAP (1998)[10] with consideration of the history of the site. APECs and COPCs are presented in **Table 3.1**.

Table 3.1: Site APECs and COPCs

Area of Potential Environmental Concern (APECs)	Constituents of Potential Concern (COPCs)
Soil impacts from historical stockpiling and general site contractor area use since issue of the 2013 SAS	Heavy metals, total petroleum hydrocarbons (TPH), polycyclic aromatic hydrocarbons (PAHs), organochlorine pesticides (OCPs), polychlorinated biphenyls (PCBs) and asbestos

The site history indicates that there have been potentially contaminating activities mostly from historical stockpiling of materials of unknown origin and use of the area as a construction staging yard.

If fill materials are present to depth, or soils have been disturbed, there is a potential that environmental impact may be present at depths consistent with the depth of the disturbance. Anthropogenic materials are commonly present in impacted fill materials and can be used as an indication of the depth of disturbance. Where fill materials impacted with chemical based contaminants are identified, there is a likelihood the impact may have migrated laterally and vertically below the fill material.

Given the broader historical activities associated with the military training grounds, there is the potential that PFAS may be present at the site as associated with surface soils. Given its known ability to migrate within the environment, in addition to surface soils, activities within the site and broader surrounds may also have resulted in PFAS impacts to subsurface natural soils and/or groundwater at the site.

More broadly, groundwater is considered to be a potentially impacted media given the proximity to the historical activities of the site as a Defence training facility. There is also potential for contamination of groundwater to have occurred from historical land uses of the site.

3.2 Potentially Impacted Media

Each of the APECs and corresponding COPCs identified in **Section 3.1** have the potential to impact:

- Soils;
- Groundwater; and
- Surface water.

[10] *Managing Land Contamination: Planning Guidelines, SEPP 55 – Remediation of Land*. Department of Urban Affairs and Planning, 1998 (DUAP 1998)

4. Data Quality Objectives

Data Quality Objective (DQO) were developed for the investigation, as discussed in the following sections.

4.1 State the Problem

The site, part of a historical army camp, located at Edmondson Park is proposed to be redeveloped for a new primary school development. Site validation activities (JBS 2013) were completed to enable a subsequent Site Audit Statement (SAS) (Environ 2013). Given the SAS was completed in 2013, and site construction activities have since had the potential to impact contamination conditions, including stockpiling of materials assumed to be generated from the civil construction adjacent to the site. The development is proposed on the western portion of the investigation site, as seen on **Figure 3**.

A conceptual site model (CSM) requires to be developed for the assessment of the environmental contamination status of the land and potential human and ecological interactions that may occur with the proposed development. Through a review of the site environmental status and development of the CSM potentially unacceptable health impacts to users of the proposed development, or otherwise exacerbation of potential ecological effects to ecological receptors within and in proximity of the development, require to be identified. The mitigation of these potential impacts (if any) would require to be detailed within a Remedial Action Plan (RAP) to address SEPP55/SEARs requirements.

Potential data gaps to the characterisation of the site will also require to be identified and an assessment made as to whether they are able to be reasonably dealt with in the execution of a future RAP.

4.2 Identify the Decision

The following decisions have been identified for this assessment:

- Is sufficient existing data available in previous assessments to characterise soil and groundwater conditions in the area of the site boundaries?
- Is the data available in the previous assessments considered reliable?
- By comparison to published assessment criteria, are any of the levels of environmental constituents measured at a concentration that may pose a potential health or ecological risk?
- What are the potential exposure routes to contaminants associated with the proposed development?
- On the basis of levels of constituents and potential exposure pathways, are there any potentially unacceptable health risks present with regard to the proposed development?
- Where a potentially unacceptable health risk and/or a potential exacerbation of an ecological risk are identified, what measures are required to be implemented with the development to mitigate the risk(s)?

4.3 Identify Inputs to the Decision

- Previous environmental data as collected and presented in the validation of the site (JBS 2013) and subsequent site audit as completed on the greater IAC area (Environ (2013)), PSM (2019) and JBS&G (2021);
- The proposed use of the site as detailed in site plans provided to JBS&G; and
- Assessment criteria made or approved by the NSW EPA.

4.4 Define the Study Boundaries

The study boundaries have been defined laterally as the extent of Lots 1 and 2 on DP 1257105 as shown in **Figure 2**. The depth of the JBS&G (2021) assessment has been restricted to fill identified across the site, noting that there is a plan to import approximately 42,000 m^3 of clean fill material for the development in the western portion of the site.

The temporal study boundaries were limited to the period of assessment works previously undertaken from approximately 2012 to 2021.

4.5 Develop a Decision Rule

The following decision rules have been adopted in the completion of the assessment for potential human health effects:

- Soil data collected on site has been compared to:
    - Health screening levels for Residential with garden/accessible soils, childcare centres, preschools and primary school land-uses (HIL-A) as provided to National Environment Protection (Assessment of Site Contamination) Measure, 1999 Amendment No 1, National Environment Protection Council (NEPC 2013);
    - Generic ecological investigation and screening levels for Residential with garden/accessible soils, childcare centres, preschools and primary school land-uses (EIL) as provided to NEPC (2013); and
    - Aesthetic impacts have been interpreted by on-site observations of indicators of soil staining and/or ACM.

The following decision rules have been adopted in the completion of the assessment of potential ecological impacts:

- Soil data collected on the site has been compared to the Ecological investigation levels for areas of residential with garden/accessible soils, childcare centres, preschools and primary school land-use as provided to NEPC (2013); and

The assessment of groundwater data collected on and in proximity of the site has been compared to the criteria for species protection in freshwater ecosystems presented in ANZG (2018).Each of the adopted investigation levels are summarised for each analyte and media in the result summary tables provided as **Appendix A**, and are further summarised in **Section 4.9**.

A qualitative assessment of the whole of the data set has been made on the basis of the project objectives (**Section 1.2**) and conceptual site model (prepared as **Section 6**). This has not considered strict decision rules, but instead a consideration of an acceptable level of risk to human and ecological receptors.

4.6 Specify the Limits on 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.

There are two types of decision error identified in Australia Standards (AS) 4482.1-2005 *'Guide to the investigation and sampling of sites with potentially contaminated soil Part 1: Non-volatile and semi-volatile compounds*.' This includes:

a) Deciding that the site is acceptable when it actually is not; and

b) Deciding that the site unacceptable when it is.

Limits are required to be set on each type of error presented here. AS4482.1-2005 nominates that a 5% probability of (a) and 20% probability of (b). It is noted that the application of this relationship assumes a uniform distribution of impact over the site area.

4.7 Develop a Sampling Plan

The following sampling and analysis works have been documented in JBS (2013) and summarised in the SAS (Environ 2013), PSM (2019) and JBS&G (2021), and premise this assessment:

- Environ (2013) audit report summarised site contamination characterisation data in soil from the broader RZNRA site, including the current investigation site and surrounds. This included approximately 479 soil investigation locations comprising test pits, hand augered holes and drilled boreholes, completed on a grid of approximately 32 m spacing with additional targeted locations associated with drainage lines, stockpiles and observed contaminant conditions;
- PSM (2019) conducted a geotechnical investigation via the advancement of boreholes at five locations within the boundaries of the site. Two boreholes were converted into monitoring wells and standing groundwater levels were subsequently monitored.
- JBS&G (2021) completed soil sampling at 30 locations within the site. In addition, three borehole locations were converted into a groundwater monitoring wells. The soil and groundwater samples were analysed for heavy metals, PAHs, TPH, BTEX, OCPs, PCBs, PFAS and asbestos (soil samples only).

4.8 Assessment Methodology

Environ (2013) indicate that soil samples were collected from stockpiles by shovel, hand trowel, hand auger or excavator bucket. Samples from stockpile footprints and lead particulate excavation were collected by hand trowel or excavator bucket. Groundwater wells were purged and sampled using low flow Micropurge pump system. Wells purged dry were sampled using disposable bailers. All laboratory analysis was conducted at a NATA accredited laboratory for the required analysis.

Soil sampling in PSM (2019) was undertaken by advancing boreholes with augers to a maximum depth of 8.5 m bgl and collecting samples directly off the auger. Groundwater monitoring was undertaken by gauging the wells with an oil / water interface probe. No groundwater sampling was undertaken during this assessment.

Soil sampling in JBS&G (2021) was undertaken by test pitting to a maximum depth of 0.5 m bgl. Groundwater sampling in JBS&G (2021) was undertaken by boreholes advanced by solid flight auger (SFA). The boreholes were subsequently converted into a groundwater monitoring wells to a maximum depth of 15.5 m bgl and developed prior to sampling. Groundwater sampling was conducted by low-flow sampling methods comprising a Micropurge pump in which the physio-chemical parameters were measured and samples were placed into appropriate bottles for laboratory analysis when the parameters had stabilised.

All laboratory analysis was conducted at NATA accredited laboratory for the required analysis.

4.9 Assessment Criteria

The assessment criteria as adopted for this assessment have been considered by a review of the sources as nominated in **Section 4.5**.

The soil and groundwater assessment criteria are summarised in **Tables 4.1** to **4.5** following.

Table 4.1: Chemical Contaminants in Soil Health Based Criteria (All units in mg/kg)

	Limit of Reporting	Laboratory Method	Health Based Assessment Criteria		
			Residential HIL-A[1]	Screening Level – Vapour intrusion	Management Limits – Residential / Parkland
METALS					
Arsenic	2.0	ICP-AES (USEPA 200.7)	100	-	-
Cadmium	0.4	ICP-AES (USEPA 200.7)	20	-	-
Total Chromium	1.0	ICP-AES (USEPA 200.7)	100	-	-
Copper	1.0	ICP-AES (USEPA 200.7)	6 000	-	-
Nickel	1.0	ICP-AES (USEPA 200.7)	400	-	-
Lead	1.0	ICP-AES (USEPA 200.7)	300	-	-
Zinc	1.0	ICP-AES (USEPA 200.7)	7 400	-	-
Mercury (inorganic)	0.05	Cold Vapour ASS (USEPA 7471A)	40	-	-
TRH					
F1 C_6-C_{10}	20	Purge Trap-GCMS (USEPA8260)	-	-	800
F2 >C_{10}-C_{16}	50	Purge Trap-GCMS (USEPA8260)	-	50/280*	1000
F3 >C_{16}-C_{34}	100	Purge Trap-GCFID (USEPA8000)	-	-	3500
F4 >C_{34}-C_{40}	100	Purge Trap-GCFID (USEPA8000)	-	-	10000
BTEX					
Benzene	0.1	Purge Trap-GCMS (USEPA8260)	-	0.7	-
Toluene	0.1	Purge Trap-GCMS (USEPA8260)	-	480	-
Ethylbenzene	0.1	Purge Trap-GCMS (USEPA8260)	-	NL	-
Total Xylenes	0.3	Purge Trap-GCMS (USEPA8260)	-	110	-
Naphthalene	0.1	Purge Trap-GCMS (USEPA8260)	-	5	-
OCPs					
DDT + DDD + DDE	0.3	GCECD (USEPA8140,8080)	240	-	-
Aldrin + Dieldrin	0.2	GCECD (USEPA8140,8080)	6	-	-
Chlordane	0.1	GCECD (USEPA8140,8080)	50	-	-
Endosulfan	0.3	GCECD (USEPA8140,8080)		-	-
Endrin	0.1	GCECD (USEPA8140,8080)	10	-	-
Heptachlor	0.1	GCECD (USEPA8140,8080)	6	-	-
Methoxychlor	0.1	GCECD (USEPA8140,8080)	300	-	-
PAHs					
Carcinogenic PAHs (as B(a)P TPE)	0.5	GCMS (USEPA8270)	3	-	-
Total PAHs	0.5	GCMS (USEPA8270)	300	-	-
PCBS					
PCBs (total)	0.5	GCECD (USEPA8140,8080)	1	-	-

*F1 (C6-C10 minus BTEX)/ F2 (C10-C16 less Naphthalene)

Table 4.2: Chemical Contaminants in Ecological Based Criteria (All units in mg/kg)

	Limit of Reporting	Laboratory Method	Ecological Investigation/ Screening Levels	
			Residential Site Specific EIL[2]	Urban Residential for fine soil ESL
METALS				
Arsenic	2.0	ICP-AES (USEPA 200.7)	50	-
Cadmium	0.4	ICP-AES (USEPA 200.7)	-	-
Total Chromium	1.0	ICP-AES (USEPA 200.7)	230	-
Copper	1.0	ICP-AES (USEPA 200.7)	100	-
Nickel	1.0	ICP-AES (USEPA 200.7)	75	-
Lead	1.0	ICP-AES (USEPA 200.7)	270	-
Zinc	1.0	ICP-AES (USEPA 200.7)	180	-
TRH				
F1 C_6-C_{10}	20	Purge Trap-GCMS (USEPA8260)	-	
F2 >C_{10}-C_{16}	50	Purge Trap-GCMS (USEPA8260)	-	180/120*
F3 >C_{16}-C_{34}	100	Purge Trap-GCFID (USEPA8000)	-	1300
F4 >C_{34}-C_{40}	100	Purge Trap-GCFID (USEPA8000)	-	5600
BTEX				
Benzene	0.1	Purge Trap-GCMS (USEPA8260)	-	65
Toluene	0.1	Purge Trap-GCMS (USEPA8260)	-	105
Ethylbenzene	0.1	Purge Trap-GCMS (USEPA8260)	-	125
Total Xylenes	0.3	Purge Trap-GCMS (USEPA8260)	-	-
Naphthalene	0.1	Purge Trap-GCMS (USEPA8260)	170	-
OCPs				
DDT + DDD + DDE	0.3	GCECD (USEPA8140,8080)	180	-
PAHs				
Benzo(a)pyrene	0.5	GCMS (USEPA8270)	-	0.7

Asbestos in soil thresholds adopted for the site assessment are nominated in **Table 4.3** below.

Table 4.3: Asbestos in Soil Health Based Assessment Criteria (all units in mg/kg)

Form of Asbestos	Health Screening Level (w/w)
	Residential with accessible soil (ResA) including Primary Schools
Bonded ACM	0.01 %
Fibrous asbestos or asbestos fines[3]	0.001 %
All forms of asbestos	No visible ACM for surface soil (0 – 0.1 m bgl).

PFAS in soil thresholds adopted for the site assessment are presented in Table 4.4 below.

Table 4.4: PFAS in Soil Health Based Assessment Criteria (all units in mg/kg)

	Limit of Reporting	Laboratory Method	Health - Residential with accessible soil
Perfluorooctanoic acid (PFOA)	0.005	USEPA 537 Version 1.1	0.1
Perfluorohexanesulfonic acid (PFHxS)	0.005	USEPA 537 Version 1.1	0.01
Perfluorooctanesulfonic acid (PFOS)	0.005	USEPA 537 Version 1.1	0.01
Sum of PFHxS and PFOS	0.005	USEPA 537 Version 1.1	0.01

Table 4.5: Groundwater Investigation Levels (all units are mg/L unless otherwise shown)

	Limit of Reporting	Laboratory Method	ADWG 2018 Health	ANZG (2018) Freshwater 95% toxicant	NEPM 2013 Table 1A(4) Solubility Limit GW for Vapour Intrusion, Clay	PFAS NEMP 2020 Table 5 Freshwater 95%
METALS						
Arsenic (As V)	0.001	ICP-AES (USEPA 200.8)	0.01	0.013	-	-
Cadmium	0.002	ICP-AES (USEPA 200.8)	0.002	0.0002	-	-
Chromium (Cr III+VI)	0.001	ICP-AES (USEPA 200.8)	-	0.001	-	-
Copper	0.001	ICP-AES (USEPA 200.8)	2	0.0014	-	-
Lead	0.001	ICP-AES (USEPA 200.8)	0.01	0.0034	-	-
Nickel	0.001	ICP-AES (USEPA 200.8)	0.02	0.011	-	-
Zinc	0.001	ICP-AES (USEPA 200.8)	-	0.008	-	-
Mercury	0.0001	ICP-AES (USEPA 200.8)	0.001	0.00006	-	-
TOTAL RECOVERABLE HYDROCARBONS						
C_{10}-C_{36} Fraction (Sum of Total)	0.1	P&T GC/MS (USEPA 8020A, 8000)	0.09	-	-	-
C_{10}-C_{40} (Sum of total)	0.1	P&T GC/MS (USEPA 8020A, 8000)	0.09	-	-	-
F1 (C_6-C_{10} minus BTEX)	0.02		-	-	9	-
F2 (C_{10}-C_{16} less Naphthalene)	0.05	P&T GC/MS (USEPA 8020A, 8000)	0.09	-	3	-
BTEX						
Benzene	0.001	P&T GC/MS (USEPA 8020A)	0.001	0.95	59	-
Toluene	0.001	P&T GC/MS (USEPA 8020A)	0.8	0.18	61	-
Ethylbenzene	0.001	P&T GC/MS (USEPA 8020A)	0.3	0.08	3.9	-
m-Xylene	1.0	P&T GC/MS (USEPA 8020A)	0.6 (total Xylene)	0.075	21 (total Xylene)	-
p-Xylene	1.0	P&T GC/MS (USEPA 8020A)				-
o-Xylene	1.0	P&T GC/MS (USEPA 8020A)		0.35		-
POLYCYCLIC AROMATIC HYDROCARBONS						
Anthracene	0.001	GCMS (USEPA8270)	-	0.00001	-	-
Naphthalene	0.001	GCMS (USEPA8270)	-	0.016	0.017	-
Fluoranthene	0.001	GCMS (USEPA8270)	-	0.001	-	-
Phenanthrene	0.01	GCMS (USEPA8270)	-	0.0006	-	-
Benzo(a)pyrene	0.001	GCMS (USEPA8270)	0.00001	0.0001	-	-
PFAS (units in µg/L)						

Perfluoroheptanoic acid (PFHpA)	0.01	P&T GC/MS (USEPA 8020B)	0.56	-	-	220
Perfluorohexanesulfonic acid (PFHxS)	0.01	P&T GC/MS (USEPA 8020B)	0.07	-	-	-
Perfluorooctanesulfonic acid (PFOS)	0.01	P&T GC/MS (USEPA 8020B)	0.07	-	-	0.13
Sum of PFHxS and PFOS	0.01	P&T GC/MS (USEPA 8020B)	0.07	-	-	-

4.10 Data Reliability

Data reliability has been assessed in Environ (2013), PB (2019) and JBS&G (2021). A summary of the JBS&G (2021) data is presented in environmental data sets as prepared and summarised in **Appendix E** are found to be reliable for the purposes of this assessment. It is noted that this area was used as a stockpiling area in the period post the 2013 SAS.

5. Results

5.1 Soils

5.1.1 Field Observations

The lithology encountered at the site during intrusive programs within the site is summarised below with borelogs from the PSM (2019) and JBS&G (2021) investigations included in **Appendix D**. Soil investigation works were as follows:

- A total of 479 soil investigation locations across the greater RZNRA site, including the current investigation site and surrounds as part of the Environ (2013) audit;
- A total of five boreholes were advanced via augers as part of PB (2019); and
- 30 test pit locations completed through test pitting and 3 boreholes converted to monitoring wells as part of JBS&G (2021).

As summarised in Environ (2013) subsurface conditions at the site and surrounds were generally characterised by the presence of clayey silt/silty clay topsoil to depths of 0.05 – 0.5 m bgl, with isolated areas of fill material overlying residual silty clay soil and shale bedrock at depths of between 0.2 m to 3.2 m bgl.

PSM (2019) identified subsurface conditions as fill/topsoil of a pale to dark brown silty clay to depths of 0.1 – 1.5m bgl, with the depth to natural brown to red clay and silty clay ranging 2.0-4.9 m bgl, with bed rock siltstone and laminate identified underlying.

To the depth of the investigation, JBS&G (2021) identified generally the lithology was characterised by fill (gravelly clay and silty clay) with the total depth of fill occurrence ranging from 0 to 0.3m bgl (TP06). The underlying natural clay soils were observed to be red to red/grey stiff clay, with underlying weathered grey shale identified at TP08. No anthropogenic materials were observed at the test pit locations.

A single ACM fragment was encountered on the site's ground surface in the vicinity of TP28 during the JBS&G (2021) investigation. This sample was removed by JBS&G for confirmatory analysis. No additional asbestos fragments were observed across the site.

No further odours, staining or asbestos was observed in the non-vegetated areas at the site.

5.1.2 Soil Analysis

5.1.2.1 Environ (2013)

The audit report presented site contamination characterisation data in soil from the broader RZNRA site, including the current investigation site and surrounds. The summarised site characterisation data as presented in Environ (2013) have been compiled as **Table 5.1** following.

Table 5.1 Environ (2013) Site Soil Characterisation Contaminant Analytical Results Summary (All units in mg/kg)

Analyte	n	Detections	Maximum	n > Health Based Assessment Criteria	n> Ecological Based Criteria
pH	6	Min-5.1	6.2	-	-
Arsenic	641	563	28	0	0
Cadmium	641	0	<0.5	0	-
Total Chromium	641	641	42	0	0
Chromium VI	6	0	<1	-	-
Copper	641	640	55	0	0
Lead	641	641	210	0	0
Mercury (inorganic)	641	74	0.14	0	-

Analyte	n	Detections	Maximum	n > Health Based Assessment Criteria	n> Ecological Based Criteria
Nickel	641	641	40	0	0
Zinc	641	641	810	0	3[1]
TPH (C_6-C_9)	105	0	<20	0	-
TPH (C_{10}-C_{36})	105	2	800	-	0
BTEX	105	0	<0.5	-	0
Phenols	6	0	<0.5	0	-
VCH	5	0	<0.5	-	-
Total PAHs	105	1	0.1	0	0
Benzo(a)pyrene	105	0	<0.1	0	0
OCP/ OPP	83	0	<0.1	0	-
PCBs	83	0	<0.1	0	-
Explosives	101	0	<1	-	-
Asbestos	125	1	-	-	-

n number of samples

- No criteria available/used

[1] As detailed in Environ (2013) these samples were of natural soil from the surface or near surface from locations near a building footing and in the grenade range. They are identified to be unlikely to affect vegetation growth at the site due to their very infrequent occurrence.

VCH Volatile Chlorinated Hydrocarbons

OCP Organophosphorous Pesticides

PCB Polychlorinated Biphenyls

5.1.2.2 PSM (2019)

Laboratory analysis results for soil samples completed by PSM (2019) have been summarised in tables presented in **Appendix D**, with comments discussed below for the various analyte groups.

Soil Chemistry

The salinity test results, as reported in indicate the following :

- pH of the soil samples analysed was in the range of 4.9 to 7.1, with an average of 5.7.
- The 1 :5 soil to water extraction and subsequent electrical conductivity (EC1 s) of the soil samples analysed to be in the range of 82 µSiem to 553 µSiem.
- Resistivity of samples at 25 °C analysed was in the range of 1810 ohm.cm to 12200 ohm.cm.
- Concentrations of chlorides in samples analysed was in the range of 70 mg/kg to 660 mg/kg.
- Concentrations of soluble sulfate in samples analysed was in the range of 20 mg/kg to 290 mg/kg.
- Cation Exchange Capacity (CEC) in samples analysed was in the range 6.0 meq/100g to 12.2 meq/100g.
- Exchange Sodium Percentage (ESP) in samples analysed was in the range of 15.0% to 34.4%.

5.1.2.3 JBS&G (2021)

Laboratory analysis results for soil samples completed by JBS&G (2021) have been summarised in tables presented in **Appendix A**, with comments discussed below for the various analyte groups.

PFAS

PFAS concentrations in the analysed samples were reported below the laboratory level of reporting (LOR), with the following exceptions:

- Perfluorooctanesulfonic acid (PFOS) at QA01 (triplicate of TP01_0-0.1) with reported concentration of 0.0002 mg/kg.

- Perfluorooctanoic acid (PFOA) at QA01 (triplicate of TP01_0-0.1) with reported concentration of 0.0001 mg/kg; and
- Perfluorobutanoic acid (PFBA) at QA01 (triplicate of TP01_0-0.1) with reported concentration of 0.0002 mg/kg.

These concentrations are one order of magnitude below the primary laboratory LOR and two orders of magnitude below the PFOS adopted criteria.

All PFAS contaminant compound concentrations were reported in samples to be less than the adopted site assessment criteria.

Heavy Metals

Concentrations of heavy metals in the analysed samples were reported below the LOR and/ or the adopted assessment criteria.

TRH/BTEX

TRH and BTEX concentrations in the analysed samples were reported below the LOR and/ or the adopted assessment criteria.

OCP/PCB

OCP and PCB concentrations in the analysed samples were reported below the LOR and/ or the adopted assessment criteria.

PAH

PAH concentrations in the analysed samples were reported below the LOR and/ or the adopted assessment criteria.

Asbestos

Asbestos concentrations in all samples analysed was reported as no asbestos detected at the reporting limit of 0.001% w/w.

As noted in **Section 5.1.1**, a fragment ACM was observed on the ground surface in the southern portion of the site. This sample was collected from the site and sent to the laboratory for confirmatory analysis. Laboratory analysis confirmed asbestos present in the sample submitted. No additional asbestos fragments were observed across the site.

5.2 Groundwater Sampling

5.2.1 Field Observations

Groundwater sampling was conducted at monitoring wells as shown on **Figure 3** JBS&G (2021).

Field parameters for the samples as collected indicate that the groundwater at the site during the JBS&G (2021) investigation was generally saline, was generally pH neutral, and oxygen concentration indicated aerobic conditions. Standing groundwater levels were reported at depths of between 5.92 m and 8.84 m below the top of the monitoring well collars. Groundwater was observed as turbid, with no odour or sheen identified.

5.2.2 Groundwater Analysis

5.2.2.1 Environ (2013)

Environ (2013) identified heavy metals concentrations in groundwater exceeded the adopted ecological criteria, however were considered indicative of background conditions associated with the Wianamatta Group shale formation. The summarised site characterisation data as presented in Environ (2013) have been compiled as **Table 5.2** following.

Table 5.2 Environ (2013) Post Remediation Groundwater Analytical Results

Analyte	Units	n	Detections	Minimum	Maximum	Max Well	n > Adopted Groundwater Investigation Levels
Temperature	°C	7	7	21.0	23.8	BH558	-
pH	-	7	7	6.8	7.2	BH675	-
EC	µV	7	7	9,210	14,270	BH291	-
TDS	mS	7	7	4.53	7.18	BH291	-
Arsenic	mg/L	7	7	0.004	0.12	BH2	**1** [1]
Cadmium	mg/L	7	0	-	<0.0002	-	0
Total Chromium	mg/L	7	7	0.007	0.014	BH608	**7** [2]
Copper	mg/L	7	5	<0.001	0.004	BH608	**3**
Lead	mg/L	7	7	0.002	0.012	BH675	**6**
Mercury (inorganic)	mg/L	7	0	<0.0001	0.0001	BH291 (Dup)	**1** [3]
Nickel	mg/L	7	7	0.002	0.022	BH675	**4**
Zinc	mg/L	7	3	<0.001	0.07	BH291 (Dup)	**2**
TPH (C_6-C_9)	mg/L	7	0	-	<0.04	-	-
TPH (C_{10}-C_{36})	mg/L	7	0	-	<0.5	-	-
BTEX	mg/L	7	0	-	<0.001	-	0
Phenols	µg/L	7	0	-	<0.5	-	0
VHC	µg/L	7	0	-	<5	-	0
PAHs	µg/L	7	0	-	<0.5	-	0 [4]
OCP/ OPP	µg/L	7	0	<0.01	<0.2	-	0 [5]
PCBs	µg/L	7	0	-	<0.1	-	-
Explosives	mg/L	7	0	-	<0.005	-	-

n number of samples
- No criteria available/used
1 Arsenic III criteria
2 Chromium III criteria
3 Detection limit (0.0001 mg/L) for primary samples is above guideline (0.00006 mg/L)
4 Detection limits for some PAHs (anthracene, benzo(a)pyrene) are above guidelines
5 Detection limits for some OCP/OPP (Aldrin, Dieldrin, Chlorpyrifos) are above guidelines

5.2.2.2 JBS&G (2021)

The groundwater monitoring locations from the JBS&G (2021) investigation are shown on **Figure 3** and JBS&G (2021) summarised laboratory results are presented in **Appendix A**. Analytical results are discussed in the following sections.

PFAS

Groundwater samples collected from MW01 to MW03 were analysed for PFAS. All reported PFAS concentrations were below the adopted assessment criteria.

Detectable levels of 1H.1H.2H.2H-perfluorooctanesulfonic acid (6:2 FTSA) was reported in MW2 and MW3 (and associated QA/QC samples). There is no guideline attributed to this specific analyte.

Heavy Metals

The reported heavy metal concentrations were below the adopted criteria with the following exceptions:

- Chromium (III+IV) which marginally exceeded the freshwater 95% criterion (0.001 mg/L) at all monitoring locations (0.003 mg/L);

- Copper, which exceeded the freshwater 95% criterion (0.0014 mg/L) in all the monitoring wells ranging from 0.004 mg/L at MW3 to a maximum concentration of 0.015 mg/L at QA01 (MW3);
- Nickel which marginally exceeded the freshwater 95% criterion (0.011 mg/L) at MW3 (ranging from 0.015 mg/L at QC01 (MW3) to 0.016 mg/L at MW3) and marginal exceedance of the adopted health criteria (0.02 mg/L) at MW1 (0.022 mg/L) and MW2 (0.064 mg/L); and
- Zinc, which exceeded the freshwater 95% criterion (0.008 mg/L) in all monitoring wells ranging from 0.009 mg/L (MW3) to a maximum concentration of 0.034 mg/L at MW1.

TRH/BTEX

TRH and BTEX concentrations in the analysed samples were reported to be below the LOR and the adopted assessment criteria.

PAHs

PAH concentrations in the analysed samples were reported below the LOR and/ or the adopted assessment criteria.

6. Conceptual Site Model

NEPC (2013) identifies a CSM as a representation of site related information regarding contamination sources, receptors and exposure pathways between those sources and receptors. The development of a CSM is an essential part of all site assessments.

NEPC (2013) identifies the essential elements of a CSM as including:

- Known and potential sources of contamination and contaminants of concern including the mechanism(s) of contamination;
- Potentially affected media (soil, groundwater and ambient air);
- Human and ecological receptors;
- Potential and complete exposure pathways; and
- Any potential preferential pathways for migration.

The following sections present these elements for the site which when considered together comprise the site CSM for the purposes of this assessment.

6.1 Current Extent of Known Impacts

Soil

The concentration of COPCs within all historical soil samples were below the adopted health based criteria. In addition, the concentration of all COPCs were reported below the adopted ecological criteria. These results are consistent with those previously summarised for the site in Environ (2013). On this basis, there are no identified impacts to site soils that require management or remediation with respect to making the site suitable for the proposed development.

It is noted that one small asbestos containing fibre cement fragment was identified on the ground surface during the site inspection/ soil sampling activities. Close inspection of the site ground surface (in areas where this was possible due to the presence of vegetation) did not identify the source of this fragment, or the indicators of a more widespread issue. Given that one isolated fragment was identified, specific management is considered not to be required, as such occurrences would be best managed under a standard construction period environmental management plan (EMP)/unexpected finds protocol (UFP) framework, whereby any isolated occurrences could be identified and disposed of appropriately.

Groundwater

Groundwater concentrations for all organic compounds were reported to be less than the laboratory LOR and below the adopted site assessment criteria. These results are consistent with those previously reported in groundwater at the site in Environ (2013). Comparison of the individual heavy metals groundwater concentrations indicate the same regional groundwater elevations of chromium, copper, nickel and zinc as previously identified across the broader site. Concentrations within the same order of magnitude have been reported for these compounds and as such, the results are considered consistent with those summarised in the 2013 site audit statement for groundwater.

It is noted that the adopted groundwater criteria have been conservatively applied to this assessment whereby they are intended to be applied at the point of discharge within receiving waters. It is important to note that that the adopted screening criteria are not threshold values at which an environmental problem is likely to occur if exceeded, rather, if the criteria are exceeded, then further action is required which may include additional assessment.

6.2 Human and Ecological Receptors

Table 6.1 summarises potential human receptors and associated exposure pathways for the site, based on the range of exposure scenarios that may occur under the proposed school redevelopment of the site.

Table 6.1: Summary of Potential Human Exposure

Receptor	Location (redeveloped site)	Media	Potential Exposure Pathways
Construction worker or intrusive maintenance worker (short duration)	Construction areas/ Excavations	Soil	Inhalation (vapours and particulates) Oral Dermal
		Groundwater	Inhalation (vapours) Oral (infiltrating seepage water) Dermal (infiltrating seepage water)
Future Site User (adult or child)	Within school buildings	Soil	Inhalation (vapours)
		Groundwater	Inhalation (vapours) Oral (infiltrating seepage water within basement if present) Dermal (infiltrating seepage water within basement if present)
	Outside areas	Soil	Inhalation (particulates) Oral Dermal
		Surface Water	Inhalation (vapours) Oral Dermal

Potential ecological receptors within the assessment area include existing and/or future flora and fauna species established within open spaces under the proposed school land-use scenario. Off-site ecological receptors may potentially be impacted by surface/groundwater and windblown dusts discharged from the site. Surrounding open spaces including the riparian corridor and associated surface water bodies (noting the drainage channel that traverses the site and unnamed tributary to the east of the site) are also environments in which potential ecological receptors will be exposed to site impacts, or the migration thereof (if present).

6.3 Potential and Completed Exposure Pathways

Future human receptors on the site will be potentially exposed to soil contaminants by limited oral, dermal and inhalation pathways. Site plans indicate that the majority of the proposed school development site will be imported fill, and as such direct contact to contaminated soils is limited.

Soil data was compared to direct contact criteria (where available), whereby all results were identified to be below the adopted criteria under a residential (with accessible soils) use scenario.

Given the depth to groundwater below current ground levels, the proposed development works will not intersect the groundwater underlying the site and the proposed development will therefore have not direct impact upon groundwater resources.

Inhalation pathways will only be relevant where asbestos, volatile and/or semi-volatile COPCs are present. The results of soil and groundwater investigations to date indicate concentrations of COPCs are less than relevant screening assessment criteria.

With regard to potentially completed ecological exposure pathways on-site, the majority of the site will be covered with imported fill as a result of building and/or accessway construction. If present, vegetation will likely be established in imported materials, rather than within site soils. As such there are considered to be no direct exposure pathways for ecological receptors to soil.

6.4 Potential for Migration from Site

Contaminants generally migrate from site via a combination of windblown dusts, rainwater infiltration, groundwater migration and surface water runoff. The potential contaminants of concern identified as part of the site history review and site inspection are in solid form (e.g. asbestos, metals).

The ground surface of the site is partially grassed with bare areas of exposed underlying soils. As such, there is a moderate potential for windblown contaminants to migrate from the site. It is considered that exposure pathways are limited to dermal, ingestion and inhalation of potentially impacted soil should the soil at the site be disturbed.

The groundwater encountered during investigations is inferred to comprise a system in which all on-site wells assessed. The standing water levels were observed to be influenced by the fractured nature of the underlying bedrock.

As discussed in **Section 6.1**, comparison of the individual heavy metals groundwater concentrations indicate the same regional groundwater elevations of chromium, copper, nickel and zinc as previously identified across the broader site.

6.5 Summary of Accumulated Data

Representative soil samples were analysed for a range of COPCs identified at the site. The reported soil concentrations of all contaminants were below the adopted residential use with accessible soils criteria applicable to this assessment. On this basis, there were no identified contaminants within site soils that would present an unacceptable risk with respect to the proposed school land use.

During the JBS&G (2021) site inspection, one small asbestos containing fibre cement fragment was identified on the ground surface. Close inspection of the site ground surface (in areas where this was possible due to the presence of vegetation) did not identify the source of this fragment, or the indicators of a more widespread issue. Given that one isolated fragment was identified, specific management is considered not to be required, and potential occurrences would be best managed under a standard construction period environmental management plan (EMP)/unexpected finds protocol (UFP) framework, whereby any isolated occurrences could be identified and disposed of appropriately.

Groundwater samples collected from monitoring wells installed during the JBS&G (2021) assessment were analysed for COPCs identified at the site. The results, apart from a number of heavy metals concentrations, did not report concentrations of COPC above the adopted site assessment criteria. Consistent with the previous site characterisation data obtained during previous sampling events and summarised in Environ (2013), a range of elevated heavy metals concentrations representative of background geological conditions were reported in groundwater. Given the regional geology and the depth to groundwater below development levels and the absence of beneficial users, no further assessment of potential risks from groundwater is warranted and there is considered no risk to future sensitive site receptors.

On this basis, there are no data gaps identified with respect to the contamination risk to the proposed landuse.

7. Conclusions

Based on the scope of work completed for this assessment and subject to the Limitations in **Section 8**, the following is concluded:

- Review of currently available previous site assessment documents has identified that there is sufficient existing data to characterise soil and groundwater conditions within the area of the proposed development in order to establish a CSM.
- Each of the environmental data sets (as sourced from Environ (2013), PSM (2019) and JBS&G (2021)) were found to be reliable for the purposes of making decisions as part of this assessment. It is noted that data summarised in Environ (2013) was generated several years ago. However, from a review of the site history since 2013, the site use has remained relatively unchanged and therefore the data is considered to be sufficiently representative of current conditions for the purposes of developing the CSM.
- Based on the results and CSM presented herein, there were no potential unacceptable health risks identified with respect to the proposed development.
- On the basis of the current investigation, it is considered that the site is suitable for residential with accessible soil land uses, including gardens and accessible soil, day care centre, pre-school, primary and secondary school and park, recreational open space, playing fields without the preparation of a RAP.
- Further, assessment of acid sulfate soil and site salinity conditions identified that there is no requirement for specific management of such conditions associated with the site or the proposed land use.
- The completed scope of work addressed SEARs requirements 18 and 20 and satisfied the requirements of SEPP55.

An unexpected finds protocol (UFP) should be prepared to establish framework for management, whereby any isolated unexpected occurrences could be identified and disposed of appropriately.

8. Limitations

This report has been prepared for use by the client who has 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 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.

JBS&G accepts no liability for use or interpretation by any person or body other than the client who commissioned the works. This report should not be reproduced without prior approval by the client, or amended in any way without prior approval by JBS&G, and should not be relied upon by other parties, who should make their own enquiries.

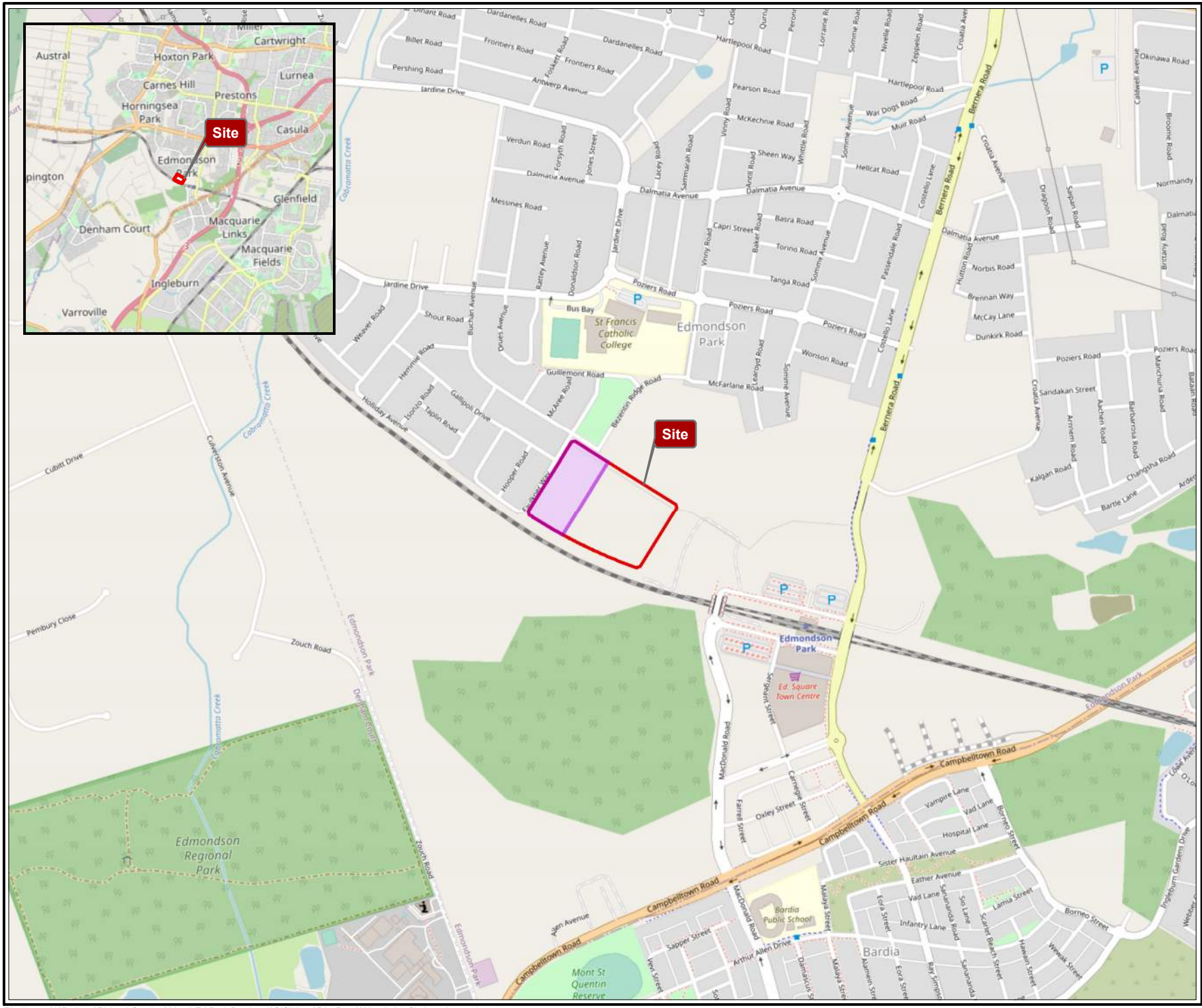
Sampling and chemical analysis of environmental media is based on appropriate guidance documents made and approved by the relevant regulatory authorities. Conclusions arising from the review and assessment of environmental data are based on the sampling and analysis considered appropriate based on the regulatory requirements.

Limited sampling and laboratory analyses were undertaken as part of the investigations undertaken, as described herein. 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, which were not identified in the site history and which may not be expected at the site.

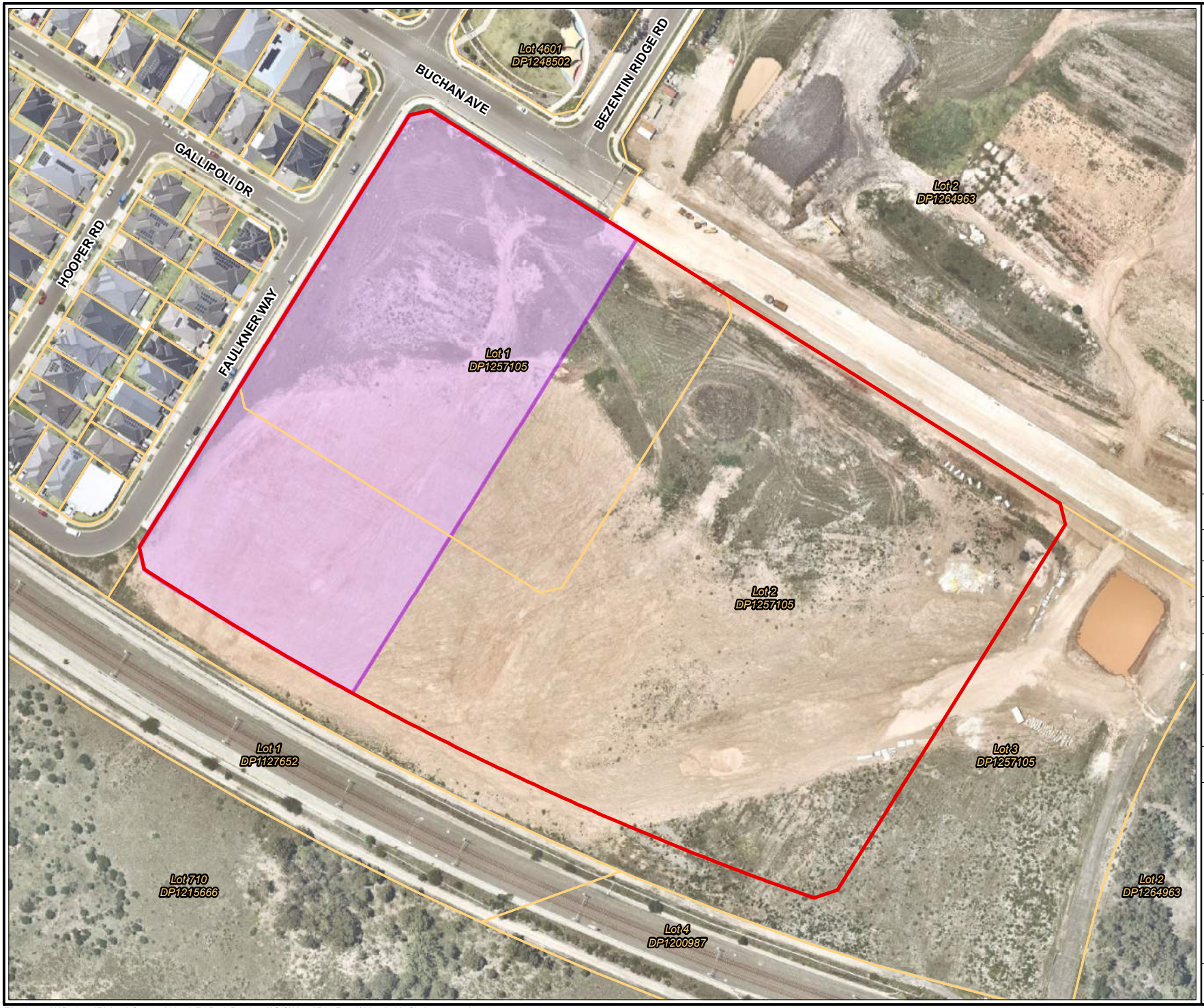
Changes to the subsurface conditions may occur subsequent to the investigations described herein, through natural processes or through the intentional or accidental addition of contaminants. The conclusions and recommendations reached in this report are based on the information obtained at the time of the investigations.

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

Figures



File Name: N:\Projects\Richard Crookes\60756 Ed Park Precinct 9\GIS\Maps\R01 Rev A\60756_01_SiteLocation.mxd
Reference: © OpenStreetMap (and) contributors, CC-BY-SA



Legend

- Approximate Site Boundary
- NSW Cadastre (DFSI, 2021)
- Proposed Public School Site

JBS&G

Job No: 60756

Client: Richard Crookes Construction

Version: R01 Rev A	Date 20/05/2021
Drawn By: JA	Checked By: MD

Scale 1:2,000

0 25 50

metres

Coord. Sys. GDA 1994 MGA Zone 56

Edmondson Park, NSW

SITE LAYOUT

FIGURE 2

File Name: N:\Projects\Richard Crookes\60756 Ed Park Precinct 9\GIS\Maps\R01 Rev A\60756_02_SiteLayout.mxd
Reference: Nearmap - www.nearmap.com.au (Capture Date: 27/12/2020)

Legend

- Approximate Site Boundary
- NSW Cadastre (DFSI, 2021)
- Proposed Public School Site

Historical Sample Locations

- Borehole, PSM 2019
- Monitoring Well, JBS&G 2021
- Test Pit, JBS&G 2021

JBS&G

Job No: 60756	
Client: Richard Crookes Construction	
Version: R01 Rev A	Date 20/05/2021
Drawn By: JA	Checked By: MD

Scale 1:2,000

0 25 50
metres

Coord. Sys. GDA 1994 MGA Zone 56

Edmondson Park, NSW

PROPOSED PUBLIC SCHOOL SITE

FIGURE 3

File Name: N:\Projects\Richard Crookes\60756 Ed Park Precinct 9\GIS\Maps\R01 Rev A\60756_03_SchoolSite.mxd
Reference: Nearmap - www.nearmap.com.au (Capture Date: 27/12/2020)

Appendix A Summary Tables

Table 1: Soil Analytical Results
Project Number: 59033
Project Name: Buchan Avenue Stockpile Assessment

| | | | | | Metals & Metalloids | | | | | | | | TPHs (NEPC 1999) | | | | | TRHs (NEPC 2013) | | | | | | BTEXN | | | | | | PAH | | | | | | | | | | | | | | | | | | | | | | | | Organochlorine Pesticides | | | | | | | | | | | | | | | | | | |

Table 1: Soil Analytical Results
Project Number: 59033
Project Name: Buchan Avenue Stockpile Assessment

| | | | | | Polychlorinated Biphenyls | | | | | | | | PFAS | | | | | | | |

Table 1: Soil Analytical Results
Project Number: 59033
Project Name: Buchan Avenue Stockpile Assessment

	Asbestos - Eurofins																			Asbestos - Envirolab				Moisture Content	Other		
	ns	Approximate Sample Mass	ns	Mass ACM	ns	Mass Asbestos in ACM	ns	Asbestos from ACM in Soil	ns	Mass FA	ns	Mass Asbestos in FA	ns	Mass AF	ns	Mass asbestos in AF	ns	Asbestos from FA & AF in Soil	ns	Mass Asbestos in FA & AF	ACM - Comment	FA - Comment	AF - Comment	Organic Fibres - Comment	Respirable Fibres - Comment	Synthetic Fibres - Comment	Asbestos Reported Result	Asbestos ID in Soil	Total Asbestos	Asbestos (ACM >7mm) Estimation	Asbestos in soil (<2mm AF/FA) (%w/w)	Moisture Content	Moisture Content (dried @ 103°C)	TOC	Iron (%)
EQL																					Comment	Comment	Comment	Comment	Comment	Comment	Comment	g/kg	g/kg	% (w/w)	% (w/w)	%	%	mg/kg	%
NEPM 2013 Table 1A(1) HILs Res A Soil																																				
NEPM 2013 Table 1A(3) Res A/B Soil HSL for Vapour Intrusion, Clay																																				
0-1m																																				
NEPM 2013 Table 1B(1-5) Site Specific EIL - Urban Residential and Public Open Space																																				
NEPM 2013 Table 1B(6) ESLs for Urban Res, Fine Soil																																				
NEPM 2013 Table 1B(7) Management Limits in Res / Parkland, Fine Soil																																				
NEPM 2013 Table 7 Res A Soil HSL for Asbestos in Soil								0.01										0.001												0.01	0.001				
PFAS NEMP 2020 Table 2 Health Residential accessible soil																																				

Field_ID	Location_Code	Sample_Depth_Range	Sampled_Date_Time	Lab_Report_Number																											
FRAG01	FRAG01		09-02-21	773152	6	0	0	0	0	0	0	0	0	0	Nil	Nil	Nil	Nil	Nil	Nil	Chrysotile; amosite and crocidolite asbestos detected	-	-	-	-	-	-	-	-
QA01	QA01		09-02-21	261400	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	<0.1	<0.01	<0.001	18	-	-	-
QA03	QA03		09-02-21	261400	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	<0.1	<0.01	<0.001	9.8	-	-	-
QC01	TP01_0-0.1		09-02-21	773152	617	0	0	0	0	0	0	0	0	0	Nil	Nil	Nil	Organic fibres detected	No respirable fibres detected	Nil	No asbestos detected at the reporting limit of 0.001% w/w	-	-	-	-	-	15	-	-
QC03	TP27_0-0.1		09-02-21	773152	621	0	0	0	0	0	0	0	0	0	Nil	Nil	Nil	Organic fibres detected	No respirable fibres detected	Nil	No asbestos detected at the reporting limit of 0.001% w/w	-	-	-	-	-	7.6	-	-
TP01_0-0.1	TP01	0-0.1	09-02-21	773152	580	0	0	0	0	0	0	0	0	0	Nil	Nil	Nil	Organic fibres detected	No respirable fibres detected	Nil	No asbestos detected at the reporting limit of 0.001% w/w	-	-	-	-	-	15	2	3.2
TP02_0.2-0.5	TP02	0.2-0.5	09-02-21	773152	516	0	0	0	0	0	0	0	0	0	Nil	Nil	Nil	Organic fibres detected	No respirable fibres detected	Nil	No asbestos detected at the reporting limit of 0.001% w/w	-	-	-	-	-	18	-	-
TP03_0-0.1	TP03	0-0.1	09-02-21	773152	585	0	0	0	0	0	0	0	0	0	Nil	Nil	Nil	Organic fibres detected	No respirable fibres detected	Nil	No asbestos detected at the reporting limit of 0.001% w/w	-	-	-	-	-	19	-	-
TP04_0.1-0.3	TP04	0.1-0.3	09-02-21	773152	644	0	0	0	0	0	0	0	0	0	Nil	Nil	Nil	Organic fibres detected	No respirable fibres detected	Nil	No asbestos detected at the reporting limit of 0.001% w/w	-	-	-	-	-	12	-	-
TP05_0-0.1	TP05	0-0.1	09-02-21	773152	653	0	0	0	0	0	0	0	0	0	Nil	Nil	Nil	Organic fibres detected	No respirable fibres detected	Nil	No asbestos detected at the reporting limit of 0.001% w/w	-	-	-	-	-	15	-	-
TP06_0-0.3	TP06	0-0.3	09-02-21	773152	670	0	0	0	0	0	0	0	0	0	Nil	Nil	Nil	Organic fibres detected	No respirable fibres detected	Nil	No asbestos detected at the reporting limit of 0.001% w/w	-	-	-	-	-	23	-	-
TP07_0.2-0.5	TP07	0.2-0.5	09-02-21	773152	521	0	0	0	0	0	0	0	0	0	Nil	Nil	Nil	Organic fibres detected	No respirable fibres detected	Nil	No asbestos detected at the reporting limit of 0.001% w/w	-	-	-	-	-	20	-	-
TP08_0-0.1	TP08	0-0.1	09-02-21	773152	625	0	0	0	0	0	0	0	0	0	Nil	Nil	Nil	Organic fibres detected	No respirable fibres detected	Nil	No asbestos detected at the reporting limit of 0.001% w/w	-	-	-	-	-	20	-	-
TP09_0-0.1	TP09	0-0.1	09-02-21	773152	692	0	0	0	0	0	0	0	0	0	Nil	Nil	Nil	Organic fibres detected	No respirable fibres detected	Nil	No asbestos detected at the reporting limit of 0.001% w/w	-	-	-	-	-	15	-	-
TP10_0.2-0.5	TP10	0.2-0.5	09-02-21	773152	558	0	0	0	0	0	0	0	0	0	Nil	Nil	Nil	Organic fibres detected	No respirable fibres detected	Nil	No asbestos detected at the reporting limit of 0.001% w/w	-	-	-	-	-	21	-	-
TP11_0-0.2	TP11	0-0.2	09-02-21	773152	530	0	0	0	0	0	0	0	0	0	Nil	Nil	Nil	Organic fibres detected	No respirable fibres detected	Nil	No asbestos detected at the reporting limit of 0.001% w/w	-	-	-	-	-	27	-	-
TP12_0.1-0.5	TP12	0.1-0.5	09-02-21	773152	667	0	0	0	0	0	0	0	0	0	Nil	Nil	Nil	Organic fibres detected	No respirable fibres detected	Nil	No asbestos detected at the reporting limit of 0.001% w/w	-	-	-	-	-	17	-	-
TP13_0.2-0.5	TP13	0.2-0.5	09-02-21	773152	695	0	0	0	0	0	0	0	0	0	Nil	Nil	Nil	Organic fibres detected	No respirable fibres detected	Nil	No asbestos detected at the reporting limit of 0.001% w/w	-	-	-	-	-	13	-	-
TP14_0-0.1	TP14	0-0.1	09-02-21	773152	641	0	0	0	0	0	0	0	0	0	Nil	Nil	Nil	Organic fibres detected	No respirable fibres detected	Nil	No asbestos detected at the reporting limit of 0.001% w/w	-	-	-	-	-	11	1.2	2.9
TP15_0-0.1	TP15	0-0.1	09-02-21	773152	681	0	0	0	0	0	0	0	0	0	Nil	Nil	Nil	Organic fibres detected	No respirable fibres detected	Nil	No asbestos detected at the reporting limit of 0.001% w/w	-	-	-	-	-	12	-	-
TP16_0-0.1	TP16	0-0.1	09-02-21	773152	793	0	0	0	0	0	0	0	0	0	Nil	Nil	Nil	Organic fibres detected	No respirable fibres detected	Nil	No asbestos detected at the reporting limit of 0.001% w/w	-	-	-	-	-	11	-	-
TP17_0.1-0.3	TP17	0.1-0.3	09-02-21	773152	600	0	0	0	0	0	0	0	0	0	Nil	Nil	Nil	Organic fibres detected	No respirable fibres detected	Nil	No asbestos detected at the reporting limit of 0.001% w/w	-	-	-	-	-	17	-	-
TP18_0-0.1	TP18	0-0.1	09-02-21	773152	690	0	0	0	0	0	0	0	0	0	Nil	Nil	Nil	Organic fibres detected	No respirable fibres detected	Nil	No asbestos detected at the reporting limit of 0.001% w/w	-	-	-	-	-	12	-	-
TP19_0-0.1	TP19	0-0.1	09-02-21	773152	616	0	0	0	0	0	0	0	0	0	Nil	Nil	Nil	Organic fibres detected	No respirable fibres detected	Nil	No asbestos detected at the reporting limit of 0.001% w/w	-	-	-	-	-	13	-	-
TP20_0-0.1	TP20	0-0.1	09-02-21	773152	679	0	0	0	0	0	0	0	0	0	Nil	Nil	Nil	Organic fibres detected	No respirable fibres detected	Nil	No asbestos detected at the reporting limit of 0.001% w/w	-	-	-	-	-	12	2	4.2
TP21_0-0.1	TP21	0-0.1	09-02-21	773152	593	0	0	0	0	0	0	0	0	0	Nil	Nil	Nil	Organic fibres detected	No respirable fibres detected	Nil	No asbestos detected at the reporting limit of 0.001% w/w	-	-	-	-	-	10	-	-
TP22_0-0.1	TP22	0-0.1	09-02-21	773152	613	0	0	0	0	0	0	0	0	0	Nil	Nil	Nil	Organic fibres detected	No respirable fibres detected	Nil	No asbestos detected at the reporting limit of 0.001% w/w	-	-	-	-	-	12	-	-
TP23_0.1-0.3	TP23	0.1-0.3	09-02-21	773152	589	0	0	0	0	0	0	0	0	0	Nil	Nil	Nil	Organic fibres detected	No respirable fibres detected	Nil	No asbestos detected at the reporting limit of 0.001% w/w	-	-	-	-	-	9.8	-	-
TP24_0-0.1	TP24	0-0.1	09-02-21	773152	540	0	0	0	0	0	0	0	0	0	Nil	Nil	Nil	Organic fibres detected	No respirable fibres detected	Nil	No asbestos detected at the reporting limit of 0.001% w/w	-	-	-	-	-	16	-	-
TP25_0-0.1	TP25	0-0.1	09-02-21	773152	663	0	0	0	0	0	0	0	0	0	Nil	Nil	Nil	Organic fibres detected	No respirable fibres detected	Nil	No asbestos detected at the reporting limit of 0.001% w/w	-	-	-	-	-	8.8	-	-
TP26_0-0.1	TP26	0-0.1	09-02-21	773152	606	0	0	0	0	0	0	0	0	0	Nil	Nil	Nil	Organic fibres detected	No respirable fibres detected	Nil	No asbestos detected at the reporting limit of 0.001% w/w	-	-	-	-	-	7.6	-	-
TP27_0-0.1	TP27	0-0.1	09-02-21	773152	649	0	0	0	0	0	0	0	0	0	Nil	Nil	Nil	Organic fibres detected	No respirable fibres detected	Nil	No asbestos detected at the reporting limit of 0.001% w/w	-	-	-	-	-	8	-	-
TP28_0-0.1	TP28	0-0.1	09-02-21	773152	693	0	0	0	0	0	0	0	0	0	Nil	Nil	Nil	Organic fibres detected	No respirable fibres detected	Nil	No asbestos detected at the reporting limit of 0.001% w/w	-	-	-	-	-	9.3	-	-
TP29_0-0.1	TP29	0-0.1	09-02-21	773152	561	0	0	0	0	0	0	0	0	0	Nil	Nil	Nil	Organic fibres detected	No respirable fibres detected	Nil	No asbestos detected at the reporting limit of 0.001% w/w	-	-	-	-	-	11	-	-
TP30_0-0.1	TP30	0-0.1	09-02-21	773152	608	0	0	0	0	0	0	0	0	0	Nil	Nil	Nil	Organic fibres detected	No respirable fibres detected	Nil	No asbestos detected at the reporting limit of 0.001% w/w	-	-	-	-	-	11	-	-

Table 2: Groundwater Analytical Results
Project Number: 59033
Project Name: Buchan Avenue Stockpile Assessment

| | | | | | | Metals & Metalloids | | | | | | | | TPHs (NEPC 1999) | | | | | TRHs (NEPC 2013) | | | | | | | BTEXN | | | | | | | PAH | | | | | | | |

Table 2: Groundwater Analytical Results
Project Number: 59033
Project Name: Buchan Avenue Stockpile Assessment

					PFAS																																Ionic Balance		Inorganics
					Perfluorobutanoic acid (PFBA)	Perfluoropentanoic acid (PFPeA)	Perfluorohexanoic acid (PFHxA)	Perfluoroheptanoic acid (PFHpA)	Perfluorooctanoic acid (PFOA)	Perfluorononanoic acid (PFNA)	Perfluorodecanoic acid (PFDA)	Perfluoroundecanoic acid (PFUnDA)	Perfluorododecanoic acid (PFDoDA)	Perfluorotridecanoic acid (PFTrDA)	Perfluorotetradecanoic acid (PFTeDA)	Perfluorooctane sulfonamide (FOSA)	N-Methyl perfluorooctane sulfonamide (NMeFOSA)	N-Ethyl perfluorooctane sulfonamide (NEtFOSA)	N-Methylperfluorooctanesulfonamidoethanol (N-MeFOSE)	N-ethylperfluorooctanesulfonamidoethanol (NEtFOSE)	N-methylperfluorooctane sulfonamidoacetic acid (NMeFOSAA)	N-ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)	Perfluoropropanesulfonic acid (PFPrS)	Perfluorobutanesulfonic acid (PFBS)	Perfluoropentanesulfonic acid (PFPeS)	Perfluorohexanesulfonic acid (PFHxS)	Perfluoroheptane sulfonic acid (PFHpS)	Perfluorooctanesulfonic acid (PFOS)	Perfluorononanesulfonic acid (PFNS)	Perfluorodecanesulfonic acid (PFDS)	1H,1H,2H,2H-perfluorohexanesulfonic acid (4:2 FTSA)	1H,1H,2H,2H-perfluorooctanesulfonic acid (6:2 FTSA)	1H,1H,2H,2H-perfluorodecanesulfonic acid (8:2 FTSA)	1H,1H,2H,2H-perfluorododecanesulfonic acid (10:2 FTSA)	Sum of PFHxS and PFOS	Sum of enHealth PFAS (PFHxS + PFOS + PFOA)*	Sum of US EPA PFAS (PFOS + PFOA)*	Sum of PFAS (WA DER List)	Sum of PFAS	Electrical Conductivity (Lab)	pH (Lab)	Electrical Conductivity (Non Compensated)
					µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µS/cm	pH Units	µS/cm
EQL					0.05	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.05	0.01	0.01	0.01	0.01	0.01	0.05	0.1	10	0.1	1
ADWG 2018 Health									0.56																0.07		0.07								0.07						
ANZG (2018) Freshwater 95% toxicant DGVs																																										
NEPM 2013 Table 1A(4) Solubility Limit GW for Vapour Intrusion, Clay																																									
PFAS NEMP 2020 Table 5 Freshwater 95%									220																		0.13														
Field_ID	**Location_Code**	**Well**	**Sampled_Date_Time**	**Lab_Report_Number**																																					
BLANK			22-02-21	775582	<0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.05	<0.1	-	-	-
MW1	MW1		22-02-21	775582	<0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.05	<0.1	14,000	6.8	-
MW2	MW2		22-02-21	775582	<0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.1	<0.01	<0.01	<0.01	<0.01	<0.01	0.1	0.1	8700	7.1	-
MW3	MW3		22-02-21	775582	<0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.23	<0.01	<0.01	<0.01	<0.01	<0.01	0.23	0.23	13,000	7.1	-
QA01-20210222	QA01-20210222		22-02-21	262550	<0.02	<0.02	<0.01	<0.01	<0.01	<0.01	<0.02	<0.02	<0.05	<0.1	<0.5	<0.1	<0.05	<0.1	<0.05	<0.5	<0.02	<0.02	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.02	<0.01	<0.01	<0.02	<0.02	<0.01	-	<0.01	-	7.3	13,000
QC01-20210222	QC01		22-02-21	775582	<0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.05	<0.1	13,000	7.1	-
Statistical Summary																																									
Number of Results					#NAME?	#NAME?	#######	#######	#######	#######	#NAME?	#NAME?	#NAME?	#######	#######	#NAME?	#######	#NAME?	#######	#######	#NAME?	#NAME?	#######	#######	#######	#######	#######	#NAME?	#######	#NAME?	#######	#######	#######	#######	#NAME?	#######	#NAME?	#NAME?	#NAME?	#NAME?	#NAME?
Number of Detects					#NAME?	#NAME?	#######	#######	#######	#######	#NAME?	#NAME?	#NAME?	#######	#######	#NAME?	#######	#NAME?	#######	#######	#NAME?	#NAME?	#######	#######	#######	#######	#######	#NAME?	#######	#NAME?	#######	#######	#######	#######	#NAME?	#######	#NAME?	#NAME?	#NAME?	#NAME?	#NAME?
Minimum Concentration					#NAME?	#NAME?	#######	#######	#######	#######	#NAME?	#NAME?	#NAME?	#######	#######	#NAME?	#######	#NAME?	#######	#######	#NAME?	#NAME?	#######	#######	#######	#######	#######	#NAME?	#######	#NAME?	#######	#######	#######	#######	#NAME?	#######	#NAME?	#NAME?	#NAME?	#NAME?	#NAME?
Minimum Detect					#NAME?	#NAME?	#######	#######	#######	#######	#NAME?	#NAME?	#NAME?	#######	#######	#NAME?	#######	#NAME?	#######	#######	#NAME?	#NAME?	#######	#######	#######	#######	#######	#NAME?	#######	#NAME?	#######	#######	#######	#######	#NAME?	#######	#NAME?	#NAME?	#NAME?	#NAME?	#NAME?
Maximum Concentration					#NAME?	#NAME?	#######	#######	#######	#######	#NAME?	#NAME?	#NAME?	#######	#######	#NAME?	#######	#NAME?	#######	#######	#NAME?	#NAME?	#######	#######	#######	#######	#######	#NAME?	#######	#NAME?	#######	#######	#######	#######	#NAME?	#######	#NAME?	#NAME?	#NAME?	#NAME?	#NAME?
Maximum Detect					#NAME?	#NAME?	#######	#######	#######	#######	#NAME?	#NAME?	#NAME?	#######	#######	#NAME?	#######	#NAME?	#######	#######	#NAME?	#NAME?	#######	#######	#######	#######	#######	#NAME?	#######	#NAME?	#######	#######	#######	#######	#NAME?	#######	#NAME?	#NAME?	#NAME?	#NAME?	#NAME?
Average Concentration					#NAME?	#NAME?	#######	#######	#######	#######	#NAME?	#NAME?	#NAME?	#######	#######	#NAME?	#######	#NAME?	#######	#######	#NAME?	#NAME?	#######	#######	#######	#######	#######	#NAME?	#######	#NAME?	#######	#######	#######	#######	#NAME?	#######	#NAME?	#NAME?	#NAME?	#NAME?	#NAME?
Median Concentration					#NAME?	#NAME?	#######	#######	#######	#######	#NAME?	#NAME?	#NAME?	#######	#######	#NAME?	#######	#NAME?	#######	#######	#NAME?	#NAME?	#######	#######	#######	#######	#######	#NAME?	#######	#NAME?	#######	#######	#######	#######	#NAME?	#######	#NAME?	#NAME?	#NAME?	#NAME?	#NAME?
Standard Deviation					#NAME?	#NAME?	#######	#######	#######	#######	#NAME?	#NAME?	#NAME?	#######	#######	#NAME?	#######	#NAME?	#######	#######	#NAME?	#NAME?	#######	#######	#######	#######	#######	#NAME?	#######	#NAME?	#######	#######	#######	#######	#NAME?	#######	#NAME?	#NAME?	#NAME?	#NAME?	#NAME?
Number of Guideline Exceedances					#NAME?	#NAME?	#######	#######	#######	#######	#NAME?	#NAME?	#NAME?	#######	#######	#NAME?	#######	#NAME?	#######	#######	#NAME?	#NAME?	#######	#######	#######	#######	#######	#NAME?	#######	#NAME?	#######	#######	#######	#######	#NAME?	#######	#NAME?	#NAME?	#NAME?	#NAME?	#NAME?
Number of Guideline Exceedances(Detects Only)					#NAME?	#NAME?	#######	#######	#######	#######	#NAME?	#NAME?	#NAME?	#######	#######	#NAME?	#######	#NAME?	#######	#######	#NAME?	#NAME?	#######	#######	#######	#######	#######	#NAME?	#######	#NAME?	#######	#######	#######	#######	#NAME?	#######	#NAME?	#NAME?	#NAME?	#NAME?	#NAME?

Data Comments
#1 NIL (+)VE

Appendix B Photographic Log

PHOTO 1: SITE LOOKING NORTH-WEST TO FAULKNER WAY (08/02/2021)

PHOTO 2: SITE LOOKING TOWARDS SOUTH-WEST CORNER (05/05/2021)

PHOTO 3: SITE LOOKING SOUTH ACROSS PROPOSED SCHOOL SITE (05/052021)

PHOTO 4: CURRENT STOCKPILE ON-SITE TO BE REMOVED BY CURRENT CONTRACTORS (05/05/2021)

JBS&G

Job No: 60756	
Client: Richard Crookes Construction	
Version: R01	Date: 12/05/2021
Drawn By: MD	Checked By: SM
Not to Scale	
Coord. Sys n/a	

Edmondson Park Schools Upgrade

Buchan Ave, Edmondson Park

APPENDIX B: PHOTO LOG

Appendix C Historical Aerials Photographs

Legend

Approximate Site Boundary

JBS&G

Job No: 60756

Client: Richard Crookes Construction

Version: Aerial	Date 5/05/2021
Drawn By: JA	Checked By: MD

Scale 1:2,000

0 25 50

metres

Coord. Sys. GDA 1994 MGA Zone 56

Edmondson Park, NSW

HISTORICAL AERIAL PHOTOGRAPH - MAY 2014

AERIAL 2014

File Name: N:\Projects\Richard Crookes\60756 Ed Park Precinct 9\GIS\Maps\Aerials\60756_2014_05_Aerial.mxd
Reference: Nearmap - www.nearmap.com.au (Capture Date: 24/05/2014)

Legend

Approximate Site Boundary

JBS&G

Job No: 60756	
Client: Richard Crookes Construction	
Version: Aerial	Date 5/05/2021
Drawn By: JA	Checked By: MD
Scale 1:2,000	

0 25 50

metres

Coord. Sys. GDA 1994 MGA Zone 56

Edmondson Park, NSW

HISTORICAL AERIAL PHOTOGRAPH - JUNE 2014

AERIAL 2014

File Name: N:\Projects\Richard Crookes\60756 Ed Park Precinct 9\GIS\Maps\Aerials\60756_2014_06_Aerial.mxd
Reference: Nearmap - www.nearmap.com.au (Capture Date: 30/06/2014)

Legend

Approximate Site Boundary

JBS&G

Job No: 60756	
Client: Richard Crookes Construction	
Version: Aerial	Date 5/05/2021
Drawn By: JA	Checked By: MD
Scale 1:2,000	

0 25 50

metres

Coord. Sys. GDA 1994 MGA Zone 56

Edmondson Park, NSW

HISTORICAL AERIAL PHOTOGRAPH - JANUARY 2015

AERIAL 2015

File Name: N:\Projects\Richard Crookes\60756 Ed Park Precinct 9\GIS\Maps\Aerials\60756_2015_01_Aerial.mxd
Reference: Nearmap - www.nearmap.com.au (Capture Date: 08/01/2015)

Legend

Approximate Site Boundary

JBS&G

Job No: 60756	
Client: Richard Crookes Construction	
Version: Aerial	Date 5/05/2021
Drawn By: JA	Checked By: MD
Scale 1:2,000	

0 25 50

metres

Coord. Sys. GDA 1994 MGA Zone 56

Edmondson Park, NSW

HISTORICAL AERIAL PHOTOGRAPH - MAY 2015

AERIAL 2015

File Name: N:\Projects\Richard Crookes\60756 Ed Park Precinct 9\GIS\Maps\Aerials\60756_2015_05_Aerial.mxd
Reference: Nearmap - www.nearmap.com.au (Capture Date: 06/05/2015)

Legend

Approximate Site Boundary

JBS&G

Job No: 60756	
Client: Richard Crookes Construction	
Version: Aerial	Date 5/05/2021
Drawn By: JA	Checked By: MD
Scale 1:2,000	

0 25 50

metres

Coord. Sys. GDA 1994 MGA Zone 56

Edmondson Park, NSW

HISTORICAL AERIAL PHOTOGRAPH - OCTOBER 2015

AERIAL 2015

File Name: N:\Projects\Richard Crookes\60756 Ed Park Precinct 9\GIS\Maps\Aerials\60756_2015_10_Aerial.mxd
Reference: Nearmap - www.nearmap.com.au (Capture Date: 16/10/2015)

Legend

Approximate Site Boundary

JBS&G

Job No: 60756

Client: Richard Crookes Construction

Version: Aerial	Date 5/05/2021
Drawn By: JA	Checked By: MD

Scale 1:2,000

0 25 50

metres

Coord. Sys. GDA 1994 MGA Zone 56

Edmondson Park, NSW

HISTORICAL AERIAL PHOTOGRAPH - AUGUST 2017

AERIAL 2017

File Name: N:\Projects\Richard Crookes\60756 Ed Park Precinct 9\GIS\Maps\Aerials\60756_2017_08_Aerial.mxd
Reference: Nearmap - www.nearmap.com.au (Capture Date: 09/08/2017)

Legend

Approximate Site Boundary

JBS&G

Job No: 60756	
Client: Richard Crookes Construction	
Version: Aerial	Date 5/05/2021
Drawn By: JA	Checked By: MD
Scale 1:2,000	

0 25 50

metres

Coord. Sys. GDA 1994 MGA Zone 56

Edmondson Park, NSW

HISTORICAL AERIAL PHOTOGRAPH - JANUARY 2018

AERIAL 2018

File Name: N:\Projects\Richard Crookes\60756 Ed Park Precinct 9\GIS\Maps\Aerials\60756_2018_01_Aerial.mxd
Reference: Nearmap - www.nearmap.com.au (Capture Date: 21/01/2018)

Legend

Approximate Site Boundary

JBS&G

Job No: 60756

Client: Richard Crookes Construction

Version: Aerial	Date 5/05/2021
Drawn By: JA	Checked By: MD

Scale 1:2,000

0 25 50

metres

Coord. Sys. GDA 1994 MGA Zone 56

Edmondson Park, NSW

HISTORICAL AERIAL PHOTOGRAPH - APRIL 2020

AERIAL 2020

File Name: N:\Projects\Richard Crookes\60756 Ed Park Precinct 9\GIS\Maps\Aerials\60756_2020_04_Aerial.mxd
Reference: Nearmap - www.nearmap.com.au (Capture Date: 15/04/2020)

Legend

Approximate Site Boundary

JBS&G

Job No: 60756	
Client: Richard Crookes Construction	
Version: Aerial	Date 5/05/2021
Drawn By: JA	Checked By: MD
Scale 1:2,000	

0 25 50

metres

Coord. Sys. GDA 1994 MGA Zone 56

Edmondson Park, NSW

HISTORICAL AERIAL PHOTOGRAPH - AUGUST 2020

AERIAL 2020

File Name: N:\Projects\Richard Crookes\60756 Ed Park Precinct 9\GIS\Maps\Aerials\60756_2020_08_Aerial.mxd
Reference: Nearmap - www.nearmap.com.au (Capture Date: 03/08/2020)

Legend

Approximate Site Boundary

JBS&G

Job No: 60756	
Client: Richard Crookes Construction	
Version: Aerial	Date 5/05/2021
Drawn By: JA	Checked By: MD
Scale 1:2,000	

0 25 50

metres

Coord. Sys. GDA 1994 MGA Zone 56

Edmondson Park, NSW

HISTORICAL AERIAL PHOTOGRAPH - OCTOBER 2020

AERIAL 2020

File Name: N:\Projects\Richard Crookes\60756 Ed Park Precinct 9\GIS\Maps\Aerials\60756_2020_10_Aerial.mxd
Reference: Nearmap - www.nearmap.com.au (Capture Date: 01/10/2020)

Legend

Approximate Site Boundary

JBS&G

Job No: 60756	
Client: Richard Crookes Construction	
Version: Aerial	Date 5/05/2021
Drawn By: JA	Checked By: MD
Scale 1:2,000	

0 25 50

metres

Coord. Sys. GDA 1994 MGA Zone 56

Edmondson Park, NSW

HISTORICAL AERIAL PHOTOGRAPH - DECEMBER 2020

AERIAL 2020

File Name: N:\Projects\Richard Crookes\60756 Ed Park Precinct 9\GIS\Maps\Aerials\60756_2020_12_Aerial.mxd
Reference: Nearmap - www.nearmap.com.au (Capture Date: 27/12/2020)

Appendix D Historical Bore Logs

TEST PIT TP01

PROJECT NUMBER 59033	**DRILLING COMPANY** Ken Coles Excavations	**EASTING** 301,602.37
PROJECT NAME Edmondson Park Feb 2021	**DRILLING DATE** 09-Feb-21	**NORTHING** 6,239,625.57
CLIENT Landcom	**DRILL RIG**	**COORD SYS** GDA94_MGA_zone_56
ADDRESS Buchan Ave, Edmondson Park, NSW	**DRILLING METHOD** Test Pit	**COORD SOURCE** GPS
	DIMENSIONS 0.3 x 0.6 m	**LOGGED BY** AS

COMMENTS

Drilling Method	Water (m bgl)	Depth (m bgl)	Graphic Log	Lithological Class	Lithological Description	Moisture	Samples	PID	Additional Observations
Test Pit		0.1		Fill	Fill: Silty CLAY, dark brown, dry, low plasticity, heterogeneous, inclusions of roots and very smal gravels.		TP01_0-0.1	1.2	No odour, staining or asbestos. QA/QC01.
		0.2		CH	CLAY, red/grey mottle, dry, high plasticity, homogeneous, stiff.		TP01_0.1-0.3	1.5	No odour, staining or asbestos.
		0.3							
		0.4							
		0.5							
		0.6							
		0.7							
		0.8							
		0.9							
		1							
		1.1							
		1.2							
		1.3							
		1.4							

Disclaimer This log is intended for environmental not geotechnical purposes.
produced by ESlog.ESdat.net on 08 Apr 2021

TEST PIT TP02

PROJECT NUMBER 59033	**DRILLING COMPANY** Ken Coles Excavations	**EASTING** 301,650.29
PROJECT NAME Edmondson Park Feb 2021	**DRILLING DATE** 09-Feb-21	**NORTHING** 6,239,581.51
CLIENT Landcom	**DRILL RIG**	**COORD SYS** GDA94_MGA_zone_56
ADDRESS Buchan Ave, Edmondson Park, NSW	**DRILLING METHOD** Test Pit	**COORD SOURCE** GPS
	DIMENSIONS 0.3 x 0.6 m	**LOGGED BY** AS

COMMENTS

Drilling Method	Water (m bgl)	Depth (m bgl)	Graphic Log	Lithological Class	Lithological Description	Moisture	Samples	PID	Additional Observations
Test Pit		0.1		Fill	Fill: Silty CLAY, dark brown, dry, medium plasticity, heterogeneous, soft, inclusions of roots.		TP02_0-0.2	2	No odour, staining or asbestos.
		0.2		CH	CLAY, red/grey mottle, dry, high plasticity, homogeneous, firm.		TP02_0.2-0.5	1.7	No odour, staining or asbestos.
		0.3							
		0.4							
		0.5							
		0.6							
		0.7							
		0.8							
		0.9							
		1							
		1.1							
		1.2							
		1.3							
		1.4							

Disclaimer This log is intended for environmental not geotechnical purposes.
produced by ESlog.ESdat.net on 08 Apr 2021

TEST PIT TP03

PROJECT NUMBER 59033	**DRILLING COMPANY** Ken Coles Excavations	**EASTING** 301,693.83
PROJECT NAME Edmondson Park Feb 2021	**DRILLING DATE** 09-Feb-21	**NORTHING** 6,239,562.31
CLIENT Landcom	**DRILL RIG**	**COORD SYS** GDA94_MGA_zone_56
ADDRESS Buchan Ave, Edmondson Park, NSW	**DRILLING METHOD** Test Pit	**COORD SOURCE** GPS
	DIMENSIONS 0.3 x 0.6 m	**LOGGED BY** AS

COMMENTS

Drilling Method	Water (m bgl)	Depth (m bgl)	Graphic Log	Lithological Class	Lithological Description	Moisture	Samples	PID	Additional Observations
Test Pit		0.1		Fill	Fill: Silty CLAY, dark brown, damp, low plasticity, heterogeneous, soft, inclusions of clay clasts, roots and gravels.		TP03_0-0.1	0.9	No odour, staining or asbestos.
		0.2		CH	CLAY, red/grey mottle, dry, high plasticity, homogeneous, stiff.		TP03_0.1-0.3	1.1	No odour, staining or asbestos.
		0.3							
		0.4							
		0.5							
		0.6							
		0.7							
		0.8							
		0.9							
		1							
		1.1							
		1.2							
		1.3							
		1.4							

Disclaimer This log is intended for environmental not geotechnical purposes.
produced by ESlog.ESdat.net on 08 Apr 2021

TEST PIT TP04

PROJECT NUMBER 59033	**DRILLING COMPANY** Ken Coles Excavations	**EASTING** 301,735.18
PROJECT NAME Edmondson Park Feb 2021	**DRILLING DATE** 09-Feb-21	**NORTHING** 6,239,543.45
CLIENT Landcom	**DRILL RIG**	**COORD SYS** GDA94_MGA_zone_56
ADDRESS Buchan Ave, Edmondson Park, NSW	**DRILLING METHOD** Test Pit	**COORD SOURCE** GPS
	DIMENSIONS 0.3 x 0.6 m	**LOGGED BY** AS

COMMENTS

Drilling Method	Water (m bgl)	Depth (m bgl)	Graphic Log	Lithological Class	Lithological Description	Moisture	Samples	PID	Additional Observations
Test Pit		0.1		Fill	Fill: CLAY, dark brown, dry, low plasticity, heterogeneous, stiff, inclusions of shale gravels.		TP04_0-0.1	2.1	No odour, staining or asbestos.
		0.2		CH	CLAY, red/grey, dry, high plasticity, stiff, inclusions of shale gravels.		TP04_0.1-0.3	3.4	No odour, staining or asbestos.
		0.3							
		0.4							
		0.5							
		0.6							
		0.7							
		0.8							
		0.9							
		1							
		1.1							
		1.2							
		1.3							
		1.4							

Disclaimer This log is intended for environmental not geotechnical purposes.
produced by ESlog.ESdat.net on 08 Apr 2021

TEST PIT TP05

PROJECT NUMBER 59033	**DRILLING COMPANY** Ken Coles Excavations	**EASTING** 301,783.79
PROJECT NAME Edmondson Park Feb 2021	**DRILLING DATE** 09-Feb-21	**NORTHING** 6,239,516.36
CLIENT Landcom	**DRILL RIG**	**COORD SYS** GDA94_MGA_zone_56
ADDRESS Buchan Ave, Edmondson Park, NSW	**DRILLING METHOD** Test Pit	**COORD SOURCE** GPS
	DIMENSIONS 0.3 x 0.6 m	**LOGGED BY** AS

COMMENTS

Drilling Method	Water (m bgl)	Depth (m bgl)	Graphic Log	Lithological Class	Lithological Description	Moisture	Samples	PID	Additional Observations
Test Pit		0.1		Fill	Fill: CLAY, dark brown, dry, low plasticity, inclusions of shale gravels, roots and sticks.		TP05_0-0.1	1.1	No odour, staining or asbestos.
		0.2		CH	CLAY, red/grey, dry, high plasticity, stiff.		TP05_0.1-0.3	1.1	No odour, staining or asbestos.
		0.3							
		0.4							
		0.5							
		0.6							
		0.7							
		0.8							
		0.9							
		1							
		1.1							
		1.2							
		1.3							
		1.4							

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TEST PIT TP06

PROJECT NUMBER 59033	**DRILLING COMPANY** Ken Coles Excavations	**EASTING** 301,830.92
PROJECT NAME Edmondson Park Feb 2021	**DRILLING DATE** 09-Feb-21	**NORTHING** 6,239,482.31
CLIENT Landcom	**DRILL RIG**	**COORD SYS** GDA94_MGA_zone_56
ADDRESS Buchan Ave, Edmondson Park, NSW	**DRILLING METHOD** Test Pit	**COORD SOURCE** GPS
	DIMENSIONS 0.3 x 0.6 m	**LOGGED BY** AS

COMMENTS

Drilling Method	Water (m bgl)	Depth (m bgl)	Graphic Log	Lithological Class	Lithological Description	Moisture	Samples	PID	Additional Observations
Test Pit		0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1 1.1 1.2 1.3 1.4		Fill	Fill: CLAY, dark brown, dry, medium plasticity, inclusions of shale gravels, and organic matter.		TP06_0-0.3	2.9	Slight organic odour. No staining or asbestos.
				CH	CLAY, red/grey, high plasticity, inclusions of shale gravels. Additional brown/yellow mottle with depth.		TP06_0.3-0.5	2.2	No odour, staining or asbestos.

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TEST PIT TP07

PROJECT NUMBER 59033	**DRILLING COMPANY** Ken Coles Excavations	**EASTING** 301,799.29
PROJECT NAME Edmondson Park Feb 2021	**DRILLING DATE** 09-Feb-21	**NORTHING** 6,239,456.69
CLIENT Landcom	**DRILL RIG**	**COORD SYS** GDA94_MGA_zone_56
ADDRESS Buchan Ave, Edmondson Park, NSW	**DRILLING METHOD** Test Pit	**COORD SOURCE** GPS
	DIMENSIONS 0.3 x 0.6 m	**LOGGED BY** AS

COMMENTS

Drilling Method	Water (m bgl)	Depth (m bgl)	Graphic Log	Lithological Class	Lithological Description	Moisture	Samples	PID	Additional Observations
Test Pit		0.1		Fill	Fill: CLAY, brown, dry, low plasticity, inclusions of gravels and organic matter.		TP07_0-0.2	0.8	No odour, staining or asbestos.
		0.2		CH	CLAY, deep red, dry, high plasticity, stiff.		TP07_0.2-0.5	1.5	No odour, staining or asbestos.
		0.3							
		0.4							
		0.5							
		0.6							
		0.7							
		0.8							
		0.9							
		1							
		1.1							
		1.2							
		1.3							
		1.4							

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TEST PIT TP08

PROJECT NUMBER 59033	**DRILLING COMPANY** Ken Coles Excavations	**EASTING** 301,747.11
PROJECT NAME Edmondson Park Feb 2021	**DRILLING DATE** 09-Feb-21	**NORTHING** 6,239,483.01
CLIENT Landcom	**DRILL RIG**	**COORD SYS** GDA94_MGA_zone_56
ADDRESS Buchan Ave, Edmondson Park, NSW	**DRILLING METHOD** Test Pit	**COORD SOURCE** GPS
	DIMENSIONS 0.3 x 0.6 m	**LOGGED BY** AS

COMMENTS

Drilling Method	Water (m bgl)	Depth (m bgl)	Graphic Log	Lithological Class	Lithological Description	Moisture	Samples	PID	Additional Observations
Test Pit		0.1		Fill	Fill: CLAY, dark brown, damp, medium plasticity, inclusions of gravel and organic matter.		TP08_0-0.1	1	No odour, staining or asbestos. QA/QC02
		0.2		CH	CLAY, red/grey, dry, high plasticity, stiff.		TP08_0.1-0.3	0.7	No odour, staining or asbestos.
		0.3		Shale	SHALE, weathered, grey.				
		0.4							
		0.5							
		0.6							
		0.7							
		0.8							
		0.9							
		1							
		1.1							
		1.2							
		1.3							
		1.4							

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TEST PIT TP09

PROJECT NUMBER 59033	**DRILLING COMPANY** Ken Coles Excavations	**EASTING** 301,711
PROJECT NAME Edmondson Park Feb 2021	**DRILLING DATE** 09-Feb-21	**NORTHING** 6,239,492.72
CLIENT Landcom	**DRILL RIG**	**COORD SYS** GDA94_MGA_zone_56
ADDRESS Buchan Ave, Edmondson Park, NSW	**DRILLING METHOD** Test Pit	**COORD SOURCE** GPS
	DIMENSIONS 0.3 x 0.6 m	**LOGGED BY** AS

COMMENTS

Drilling Method	Water (m bgl)	Depth (m bgl)	Graphic Log	Lithological Class	Lithological Description	Moisture	Samples	PID	Additional Observations
Test Pit		0.1		Fill	Fill: CLAY, dark brown, dry, low plasticity, inclusions of shale gravels, roots and sticks.		TP09_0-0.1	2	No odour, staining or asbestos.
		0.2		CH	CLAY, red/grey, damp, firm, medium-high plasticity.		TP09_0.1-0.3	2.4	No odour, staining or asbestos.
		0.3							
		0.4							
		0.5							
		0.6							
		0.7							
		0.8							
		0.9							
		1							
		1.1							
		1.2							
		1.3							
		1.4							

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TEST PIT TP10

PROJECT NUMBER 59033	**DRILLING COMPANY** Ken Coles Excavations	**EASTING** 301,669.13
PROJECT NAME Edmondson Park Feb 2021	**DRILLING DATE** 09-Feb-21	**NORTHING** 6,239,517.28
CLIENT Landcom	**DRILL RIG**	**COORD SYS** GDA94_MGA_zone_56
ADDRESS Buchan Ave, Edmondson Park, NSW	**DRILLING METHOD** Test Pit	**COORD SOURCE** GPS
	DIMENSIONS 0.3 x 0.6 m	**LOGGED BY** AS

COMMENTS

Drilling Method	Water (m bgl)	Depth (m bgl)	Graphic Log	Lithological Class	Lithological Description	Moisture	Samples	PID	Additional Observations
Test Pit		0.1		Fill	Fill: CLAY, dark brown, damp, medium plasticity, soft, inclusions of gravel and organic matter.		TP10_0-0.2	1.9	No odour, staining or asbestos.
		0.2		CH	CLAY, red/grey, damp, high plasticity, soft, inclusions of shale gravels.		TP10_0.2-0.5	1.6	No odour, staining or asbestos.
		0.3							
		0.4							
		0.5							
		0.6							
		0.7							
		0.8							
		0.9							
		1							
		1.1							
		1.2							
		1.3							
		1.4							

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TEST PIT TP11

PROJECT NUMBER 59033	**DRILLING COMPANY** Ken Coles Excavations	**EASTING** 301,617.46
PROJECT NAME Edmondson Park Feb 2021	**DRILLING DATE** 09-Feb-21	**NORTHING** 6,239,543.41
CLIENT Landcom	**DRILL RIG**	**COORD SYS** GDA94_MGA_zone_56
ADDRESS Buchan Ave, Edmondson Park, NSW	**DRILLING METHOD** Test Pit	**COORD SOURCE** GPS
	DIMENSIONS 0.3 x 0.6 m	**LOGGED BY** AS

COMMENTS

Drilling Method	Water (m bgl)	Depth (m bgl)	Graphic Log	Lithological Class	Lithological Description	Moisture	Samples	PID	Additional Observations
Test Pit		0.1		Fill	Fill: CLAY, dark brown, damp, medium plasticity, soft, inclusions of gravel and organic matter.		TP11_0-0.2	4.5	Slight organic odour. No staining or asbestos.
		0.2		CH	CLAY, red/grey and orange mottle with depth, high plasticity, soft/firm.		TP11_0.2-0.5	2.8	No odour, staining or asbestos.
		0.3							
		0.4							
		0.5							
		0.6							
		0.7							
		0.8							
		0.9							
		1							
		1.1							
		1.2							
		1.3							
		1.4							

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TEST PIT TP12

PROJECT NUMBER 59033	**DRILLING COMPANY** Ken Coles Excavations	**EASTING** 301,572.3
PROJECT NAME Edmondson Park Feb 2021	**DRILLING DATE** 09-Feb-21	**NORTHING** 6,239,566.67
CLIENT Landcom	**DRILL RIG**	**COORD SYS** GDA94_MGA_zone_56
ADDRESS Buchan Ave, Edmondson Park, NSW	**DRILLING METHOD** Test Pit	**COORD SOURCE** GPS
	DIMENSIONS 0.3 x 0.6 m	**LOGGED BY** AS

COMMENTS

Drilling Method	Water (m bgl)	Depth (m bgl)	Graphic Log	Lithological Class	Lithological Description	Moisture	Samples	PID	Additional Observations
Test Pit		0.1		Fill	Fill: CLAY, dark brown, damp, medium plasticity, inclusions of gravel and organic matter.		TP12_0-0.1	2.3	No odour, staining or asbestos.
		0.2		Fill	Reworked Natural: CLAY, grey/red, damp, high plasticity, firm.		TP12_0.1-0.5	2.2	No odour, staining or asbestos.
		0.5		CH	CLAY, red/grey, dry, high plasticity, stiff.		TP12_0.5-0.8	1.8	No odour, staining or asbestos.
		1.1							

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TEST PIT TP13

PROJECT NUMBER 59033	**DRILLING COMPANY** Ken Coles Excavations	**EASTING** 301,559.72
PROJECT NAME Edmondson Park Feb 2021	**DRILLING DATE** 09-Feb-21	**NORTHING** 6,239,528.85
CLIENT Landcom	**DRILL RIG**	**COORD SYS** GDA94_MGA_zone_56
ADDRESS Buchan Ave, Edmondson Park, NSW	**DRILLING METHOD** Test Pit	**COORD SOURCE** GPS
	DIMENSIONS 0.3 x 0.6 m	**LOGGED BY** AS

COMMENTS

Drilling Method	Water (m bgl)	Depth (m bgl)	Graphic Log	Lithological Class	Lithological Description	Moisture	Samples	PID	Additional Observations
Test Pit		0.1		Fill	Fill: Gravelly CLAY, brown, dry, low plasticity, soft, inclusions of organic matter.		TP13_0-0.2	2	No odour, staining or asbestos.
		0.2		Fill	Reworked Natural: CLAY, grey/red/brown, damp, low/medium plasticity, firm.		TP13_0.2-0.5	2.3	No odour, staining or asbestos.
		0.5		CH	CLAY, red/grey, dry, high plasticity, stiff.		TP13_0.5-0.8	1.9	No odour, staining or asbestos.
		0.6							
		0.7							
		0.8							
		0.9							
		1							
		1.1							
		1.2							
		1.3							
		1.4							

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TEST PIT TP14

PROJECT NUMBER 59033	**DRILLING COMPANY** Ken Coles Excavations	**EASTING** 301,614.35
PROJECT NAME Edmondson Park Feb 2021	**DRILLING DATE** 09-Feb-21	**NORTHING** 6,239,506.67
CLIENT Landcom	**DRILL RIG**	**COORD SYS** GDA94_MGA_zone_56
ADDRESS Buchan Ave, Edmondson Park, NSW	**DRILLING METHOD** Test Pit	**COORD SOURCE** GPS
	DIMENSIONS 0.3 x 0.6 m	**LOGGED BY** AS

COMMENTS

Drilling Method	Water (m bgl)	Depth (m bgl)	Graphic Log	Lithological Class	Lithological Description	Moisture	Samples	PID	Additional Observations
Test Pit		0.1		Fill	Fill: Gravelly CLAY, brown, dry, no plasticity, firm.		TP14_0-0.1	1.6	No odour, staining or asbestos.
		0.2		CH	CLAY, red/grey, dry, high plasticity, stiff.		TP14_0.1-0.3	0.9	No odour, staining or asbestos.
		0.3							
		0.4							
		0.5							
		0.6							
		0.7							
		0.8							
		0.9							
		1							
		1.1							
		1.2							
		1.3							
		1.4							

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TEST PIT TP15

PROJECT NUMBER 59033	**DRILLING COMPANY** Ken Coles Excavations	**EASTING** 301,654.37
PROJECT NAME Edmondson Park Feb 2021	**DRILLING DATE** 09-Feb-21	**NORTHING** 6,239,480.24
CLIENT Landcom	**DRILL RIG**	**COORD SYS** GDA94_MGA_zone_56
ADDRESS Buchan Ave, Edmondson Park, NSW	**DRILLING METHOD** Test Pit	**COORD SOURCE** GPS
	DIMENSIONS 0.3 x 0.6 m	**LOGGED BY** AS

COMMENTS

Drilling Method	Water (m bgl)	Depth (m bgl)	Graphic Log	Lithological Class	Lithological Description	Moisture	Samples	PID	Additional Observations
Test Pit		0.1		Fill	Fill: CLAY, brown, dry, medium plasticity, stiff, inclusions of gravel.		TP15_0-0.1	1.3	No odour, staining or asbestos.
		0.2		CH	CLAY, red/grey, dry, high plasticity, stiff.		TP15_0.1-0.3	0.6	No odour, staining or asbestos.
		0.3							
		0.4							
		0.5							
		0.6							
		0.7							
		0.8							
		0.9							
		1							
		1.1							
		1.2							
		1.3							
		1.4							

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TEST PIT TP16

PROJECT NUMBER 59033	**DRILLING COMPANY** Ken Coles Excavations	**EASTING** 301,693.87
PROJECT NAME Edmondson Park Feb 2021	**DRILLING DATE** 09-Feb-21	**NORTHING** 6,239,450.17
CLIENT Landcom	**DRILL RIG**	**COORD SYS** GDA94_MGA_zone_56
ADDRESS Buchan Ave, Edmondson Park, NSW	**DRILLING METHOD** Test Pit	**COORD SOURCE** GPS
	DIMENSIONS 0.3 x 0.6 m	**LOGGED BY** AS

COMMENTS

Drilling Method	Water (m bgl)	Depth (m bgl)	Graphic Log	Lithological Class	Lithological Description	Moisture	Samples	PID	Additional Observations
Test Pit		0.1		Fill	Fill: CLAY, brown, dry, medium plasticity, stiff, inclusions of gravel.		TP16_0-0.1	0.2	No odour, staining or asbestos.
		0.2		CH	CLAY, red/grey, dry, high plasticity, stiff.		TP16_0.1-0.3	0.6	No odour, staining or asbestos.
		0.3							
		0.4							
		0.5							
		0.6							
		0.7							
		0.8							
		0.9							
		1							
		1.1							
		1.2							
		1.3							
		1.4							

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TEST PIT TP17

PROJECT NUMBER 59033	**DRILLING COMPANY** Ken Coles Excavations	**EASTING** 301,734.14
PROJECT NAME Edmondson Park Feb 2021	**DRILLING DATE** 09-Feb-21	**NORTHING** 6,239,430.59
CLIENT Landcom	**DRILL RIG**	**COORD SYS** GDA94_MGA_zone_56
ADDRESS Buchan Ave, Edmondson Park, NSW	**DRILLING METHOD** Test Pit	**COORD SOURCE** GPS
	DIMENSIONS 0.3 x 0.6 m	**LOGGED BY** AS

COMMENTS

Drilling Method	Water (m bgl)	Depth (m bgl)	Graphic Log	Lithological Class	Lithological Description	Moisture	Samples	PID	Additional Observations
Test Pit		0.1		Fill	Fill: CLAY, brown, dry, medium plasticity, stiff, inclusions of gravel.		TP17_0-0.1	0.7	No odour, staining or asbestos.
		0.2		CH	CLAY, red/grey, dry, high plasticity, stiff.		TP17_0.1-0.3	0.4	No odour, staining or asbestos.
		0.3							
		0.4							
		0.5							
		0.6							
		0.7							
		0.8							
		0.9							
		1							
		1.1							
		1.2							
		1.3							
		1.4							

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TEST PIT TP18

PROJECT NUMBER 59033	**DRILLING COMPANY** Ken Coles Excavations	**EASTING** 301,769.96
PROJECT NAME Edmondson Park Feb 2021	**DRILLING DATE** 09-Feb-21	**NORTHING** 6,239,417.2
CLIENT Landcom	**DRILL RIG**	**COORD SYS** GDA94_MGA_zone_56
ADDRESS Buchan Ave, Edmondson Park, NSW	**DRILLING METHOD** Test Pit	**COORD SOURCE** GPS
	DIMENSIONS 0.3 x 0.6 m	**LOGGED BY** AS

COMMENTS

Drilling Method	Water (m bgl)	Depth (m bgl)	Graphic Log	Lithological Class	Lithological Description	Moisture	Samples	PID	Additional Observations
Test Pit		0.1		Fill	Fill: CLAY, brown, dry, low plasticity, stiff, inclusions of gravel.		TP18_0-0.1	1.8	No odour, staining or asbestos.
		0.2		CH	CLAY, red/grey, dry, high plasticity, stiff.		TP18_0.1-0.3	1.6	No odour, staining or asbestos.
		0.3							
		0.4							
		0.5							
		0.6							
		0.7							
		0.8							
		0.9							
		1							
		1.1							
		1.2							
		1.3							
		1.4							

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TEST PIT TP19

PROJECT NUMBER 59033	**DRILLING COMPANY** Ken Coles Excavations	**EASTING** 301,744.73
PROJECT NAME Edmondson Park Feb 2021	**DRILLING DATE** 09-Feb-21	**NORTHING** 6,239,378.64
CLIENT Landcom	**DRILL RIG**	**COORD SYS** GDA94_MGA_zone_56
ADDRESS Buchan Ave, Edmondson Park, NSW	**DRILLING METHOD** Test Pit	**COORD SOURCE** GPS
	DIMENSIONS 0.3 x 0.6 m	**LOGGED BY** AS

COMMENTS

Drilling Method	Water (m bgl)	Depth (m bgl)	Graphic Log	Lithological Class	Lithological Description	Moisture	Samples	PID	Additional Observations
Test Pit		0.1		Fill	Fill: CLAY, brown, dry, medium plasticity, stiff, inclusions of gravel.		TP19_0-0.1	2.2	No odour, staining or asbestos.
		0.2		CH	CLAY, red/grey, dry, high plasticity, stiff.		TP19_0.1-0.3	2	No odour, staining or asbestos.
		0.3							
		0.4							
		0.5							
		0.6							
		0.7							
		0.8							
		0.9							
		1							
		1.1							
		1.2							
		1.3							
		1.4							

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TEST PIT TP20

PROJECT NUMBER 59033	**DRILLING COMPANY** Ken Coles Excavations	**EASTING** 301,704.92
PROJECT NAME Edmondson Park Feb 2021	**DRILLING DATE** 09-Feb-21	**NORTHING** 6,239,401.65
CLIENT Landcom	**DRILL RIG**	**COORD SYS** GDA94_MGA_zone_56
ADDRESS Buchan Ave, Edmondson Park, NSW	**DRILLING METHOD** Test Pit	**COORD SOURCE** GPS
	DIMENSIONS 0.3 x 0.6 m	**LOGGED BY** AS

COMMENTS

Drilling Method	Water (m bgl)	Depth (m bgl)	Graphic Log	Lithological Class	Lithological Description	Moisture	Samples	PID	Additional Observations
Test Pit		0.1		Fill	Fill: CLAY, brown, dry, low plasticity, stiff, inclusions of gravel.		TP20_0-0.1	0.9	No odour, staining or asbestos.
		0.2		CH	CLAY, red/grey, dry, high plasticity, stiff.		TP20_0.1-0.3	0.9	No odour, staining or asbestos.
		0.3							
		0.4							
		0.5							
		0.6							
		0.7							
		0.8							
		0.9							
		1							
		1.1							
		1.2							
		1.3							
		1.4							

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TEST PIT TP21

PROJECT NUMBER 59033	**DRILLING COMPANY** Ken Coles Excavations	**EASTING** 301,668.33
PROJECT NAME Edmondson Park Feb 2021	**DRILLING DATE** 09-Feb-21	**NORTHING** 6,239,421.64
CLIENT Landcom	**DRILL RIG**	**COORD SYS** GDA94_MGA_zone_56
ADDRESS Buchan Ave, Edmondson Park, NSW	**DRILLING METHOD** Test Pit	**COORD SOURCE** GPS
	DIMENSIONS 0.3 x 0.6 m	**LOGGED BY** AS

COMMENTS

Drilling Method	Water (m bgl)	Depth (m bgl)	Graphic Log	Lithological Class	Lithological Description	Moisture	Samples	PID	Additional Observations
Test Pit		0.1		Fill	Fill: CLAY, grey/brown, dry, low plasticity, stiff, inclusions of gravel.		TP21_0-0.1	0.9	No odour, staining or asbestos.
		0.2		CH	CLAY, red/grey, dry, high plasticity, stiff.		TP21_0.1-0.3	0.7	No odour, staining or asbestos.
		0.3							
		0.4							
		0.5							
		0.6							
		0.7							
		0.8							
		0.9							
		1							
		1.1							
		1.2							
		1.3							
		1.4							

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TEST PIT TP22

PROJECT NUMBER 59033	**DRILLING COMPANY** Ken Coles Excavations	**EASTING** 301,623.75
PROJECT NAME Edmondson Park Feb 2021	**DRILLING DATE** 09-Feb-21	**NORTHING** 6,239,438.56
CLIENT Landcom	**DRILL RIG**	**COORD SYS** GDA94_MGA_zone_56
ADDRESS Buchan Ave, Edmondson Park, NSW	**DRILLING METHOD** Test Pit	**COORD SOURCE** GPS
	DIMENSIONS 0.3 x 0.6 m	**LOGGED BY** AS

COMMENTS

Drilling Method	Water (m bgl)	Depth (m bgl)	Graphic Log	Lithological Class	Lithological Description	Moisture	Samples	PID	Additional Observations
Test Pit		0.1		Fill	Fill: CLAY, red/brown, dry, low plasticity, soft, inclusions of gravel.		TP22_0-0.1	0.5	No odour, staining or asbestos.
		0.2		CH	CLAY, red/grey, dry, high plasticity, firm.		TP22_0.1-0.3	0.2	No odour, staining or asbestos.
		0.3							
		0.4							
		0.5							
		0.6							
		0.7							
		0.8							
		0.9							
		1							
		1.1							
		1.2							
		1.3							
		1.4							

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TEST PIT TP23

PROJECT NUMBER 59033	**DRILLING COMPANY** Ken Coles Excavations	**EASTING** 301,591.92
PROJECT NAME Edmondson Park Feb 2021	**DRILLING DATE** 09-Feb-21	**NORTHING** 6,239,465.41
CLIENT Landcom	**DRILL RIG**	**COORD SYS** GDA94_MGA_zone_56
ADDRESS Buchan Ave, Edmondson Park, NSW	**DRILLING METHOD** Test Pit	**COORD SOURCE** GPS
	DIMENSIONS 0.3 x 0.6 m	**LOGGED BY** AS

COMMENTS

Drilling Method	Water (m bgl)	Depth (m bgl)	Graphic Log	Lithological Class	Lithological Description	Moisture	Samples	PID	Additional Observations
Test Pit		0.1		Fill	Fill: CLAY, red/brown, dry, low plasticity, soft, inclusions of gravel.		TP23_0-0.1	1.8	No odour, staining or asbestos.
		0.2		CH	CLAY, red/grey, dry, low/medium plasticity, firm.		TP23_0.1-0.3	3.6	No odour, staining or asbestos.
		0.3							
		0.4							
		0.5							
		0.6							
		0.7							
		0.8							
		0.9							
		1							
		1.1							
		1.2							
		1.3							
		1.4							

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TEST PIT TP24

PROJECT NUMBER 59033	**DRILLING COMPANY** Ken Coles Excavations	**EASTING** 301,530.82
PROJECT NAME Edmondson Park Feb 2021	**DRILLING DATE** 09-Feb-21	**NORTHING** 6,239,502.84
CLIENT Landcom	**DRILL RIG**	**COORD SYS** GDA94_MGA_zone_56
ADDRESS Buchan Ave, Edmondson Park, NSW	**DRILLING METHOD** Test Pit	**COORD SOURCE** GPS
	DIMENSIONS 0.3 x 0.6 m	**LOGGED BY** AS

COMMENTS

Drilling Method	Water (m bgl)	Depth (m bgl)	Graphic Log	Lithological Class	Lithological Description	Moisture	Samples	PID	Additional Observations
Test Pit		0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1 1.1 1.2 1.3 1.4		CH	CLAY, red/grey, damp, high plasticity, firm.		TP24_0-0.1	4	No odour, staining or asbestos.

TEST PIT TP25

PROJECT NUMBER 59033	**DRILLING COMPANY** Ken Coles Excavations	**EASTING** 301,502.99
PROJECT NAME Edmondson Park Feb 2021	**DRILLING DATE** 09-Feb-21	**NORTHING** 6,239,457.39
CLIENT Landcom	**DRILL RIG**	**COORD SYS** GDA94_MGA_zone_56
ADDRESS Buchan Ave, Edmondson Park, NSW	**DRILLING METHOD** Test Pit	**COORD SOURCE** GPS
	DIMENSIONS 0.3 x 0.6 m	**LOGGED BY** AS

COMMENTS

Drilling Method	Water (m bgl)	Depth (m bgl)	Graphic Log	Lithological Class	Lithological Description	Moisture	Samples	PID	Additional Observations
Test Pit		0.1		Fill	Fill: Gravelly CLAY, red and grey mottle with depth, dry, medium plasticity, soft.		TP25_0-0.1	2.3	No odour, staining or asbestos.
		0.2		CH	CLAY, red/grey, dry, high plasticity, firm.		TP25_0.1-0.3	2.1	No odour, staining or asbestos.
		0.3							
		0.4							
		0.5							
		0.6							
		0.7							
		0.8							
		0.9							
		1							
		1.1							
		1.2							
		1.3							
		1.4							

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TEST PIT TP26

PROJECT NUMBER 59033	**DRILLING COMPANY** Ken Coles Excavations	**EASTING** 301,552.18
PROJECT NAME Edmondson Park Feb 2021	**DRILLING DATE** 09-Feb-21	**NORTHING** 6,239,427.05
CLIENT Landcom	**DRILL RIG**	**COORD SYS** GDA94_MGA_zone_56
ADDRESS Buchan Ave, Edmondson Park, NSW	**DRILLING METHOD** Test Pit	**COORD SOURCE** GPS
	DIMENSIONS 0.3 x 0.6 m	**LOGGED BY** AS

COMMENTS

Drilling Method	Water (m bgl)	Depth (m bgl)	Graphic Log	Lithological Class	Lithological Description	Moisture	Samples	PID	Additional Observations
Test Pit		0.1		Fill	Fill: Gravelly CLAY, brown, dry, low plasticity, soft, inclusions of organic matter.		TP26_0-0.1	2.3	No odour, staining or asbestos.
		0.2		CH	CLAY, red/grey, dry, high plasticity, stiff.		TP26_0.1-0.3	1.9	No odour, staining or asbestos.
		0.3							
		0.4							
		0.5							
		0.6							
		0.7							
		0.8							
		0.9							
		1							
		1.1							
		1.2							
		1.3							
		1.4							

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TEST PIT TP27

PROJECT NUMBER 59033	**DRILLING COMPANY** Ken Coles Excavations	**EASTING** 301,607.81
PROJECT NAME Edmondson Park Feb 2021	**DRILLING DATE** 09-Feb-21	**NORTHING** 6,239,404.79
CLIENT Landcom	**DRILL RIG**	**COORD SYS** GDA94_MGA_zone_56
ADDRESS Buchan Ave, Edmondson Park, NSW	**DRILLING METHOD** Test Pit	**COORD SOURCE** GPS
	DIMENSIONS 0.3 x 0.6 m	**LOGGED BY** AS

COMMENTS

Drilling Method	Water (m bgl)	Depth (m bgl)	Graphic Log	Lithological Class	Lithological Description	Moisture	Samples	PID	Additional Observations
Test Pit		0.1		Fill	Fill: Gravelly CLAY, brown, dry, low plasticity, soft, inclusions of organic matter.		TP27_0-0.1	4.2	No odour, staining or asbestos. QA/QC03
		0.2		CH	CLAY, red/grey, dry, high plasticity, stiff.		TP27_0.1-0.3	3.8	No odour, staining or asbestos.
		0.3							
		0.4							
		0.5							
		0.6							
		0.7							
		0.8							
		0.9							
		1							
		1.1							
		1.2							
		1.3							
		1.4							

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TEST PIT TP28

PROJECT NUMBER 59033	**DRILLING COMPANY** Ken Coles Excavations	**EASTING** 301,644.88
PROJECT NAME Edmondson Park Feb 2021	**DRILLING DATE** 09-Feb-21	**NORTHING** 6,239,390.05
CLIENT Landcom	**DRILL RIG**	**COORD SYS** GDA94_MGA_zone_56
ADDRESS Buchan Ave, Edmondson Park, NSW	**DRILLING METHOD** Test Pit	**COORD SOURCE** GPS
	DIMENSIONS 0.3 x 0.6 m	**LOGGED BY** AS

COMMENTS

Drilling Method	Water (m bgl)	Depth (m bgl)	Graphic Log	Lithological Class	Lithological Description	Moisture	Samples	PID	Additional Observations
Test Pit		0.1		Fill	Fill: CLAY, brown, dry, low plasticity, soft, inclusions of gravel.		TP28_0-0.1	2.1	No odour, staining or asbestos.
		0.2		CH	CLAY, red/grey/orange, dry, high plasticity, stiff.		TP28_0.1-0.3	2.4	No odour, staining or asbestos.
		0.3							
		0.4							
		0.5							
		0.6							
		0.7							
		0.8							
		0.9							
		1							
		1.1							
		1.2							
		1.3							
		1.4							

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TEST PIT TP29

PROJECT NUMBER 59033	**DRILLING COMPANY** Ken Coles Excavations	**EASTING** 301,691.15
PROJECT NAME Edmondson Park Feb 2021	**DRILLING DATE** 09-Feb-21	**NORTHING** 6,239,363.54
CLIENT Landcom	**DRILL RIG**	**COORD SYS** GDA94_MGA_zone_56
ADDRESS Buchan Ave, Edmondson Park, NSW	**DRILLING METHOD** Test Pit	**COORD SOURCE** GPS
	DIMENSIONS 0.3 x 0.6 m	**LOGGED BY** AS

COMMENTS

Drilling Method	Water (m bgl)	Depth (m bgl)	Graphic Log	Lithological Class	Lithological Description	Moisture	Samples	PID	Additional Observations
Test Pit		0.1		Fill	Fill: CLAY, brown, dry, low plasticity, soft, inclusions of gravel and organic matter.		TP29_0-0.1	2	Slight organic odour. No staining or asbestos.
		0.2		CH	CLAY, red/grey, dry, high plasticity, stiff, inclusions of roots.		TP29_0.1-0.3	3.6	Slight organic odour. No staining or asbestos.
		0.3							
		0.4							
		0.5							
		0.6							
		0.7							
		0.8							
		0.9							
		1							
		1.1							
		1.2							
		1.3							
		1.4							

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TEST PIT TP30

PROJECT NUMBER 59033	**DRILLING COMPANY** Ken Coles Excavations	**EASTING** 301,740.32
PROJECT NAME Edmondson Park Feb 2021	**DRILLING DATE** 09-Feb-21	**NORTHING** 6,239,338.72
CLIENT Landcom	**DRILL RIG**	**COORD SYS** GDA94_MGA_zone_56
ADDRESS Buchan Ave, Edmondson Park, NSW	**DRILLING METHOD** Test Pit	**COORD SOURCE** GPS
	DIMENSIONS 0.3 x 0.6 m	**LOGGED BY** AS

COMMENTS

Drilling Method	Water (m bgl)	Depth (m bgl)	Graphic Log	Lithological Class	Lithological Description	Moisture	Samples	PID	Additional Observations
Test Pit		0.1		Fill	Fill: CLAY, brown, dry, low plasticity, soft, inclusions of gravel.		TP30_0-0.1	2	No odour, staining or asbestos. QA/QC04
		0.2		CH	CLAY, red/grey, dry, medium plasticity, stiff.		TP30_0.1-0.3	1.5	No odour, staining or asbestos.
		0.3							
		0.4							
		0.5							
		0.6							
		0.7							
		0.8							
		0.9							
		1							
		1.1							
		1.2							
		1.3							
		1.4							

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GROUNDWATER WELL MW1

PROJECT NUMBER 59033	**DRILLING COMPANY** Matrix Drilling	**EASTING** 301,616.5
PROJECT NAME Edmondson Park Feb 2021	**DRILLING DATE** 08-Feb-21	**NORTHING** 6,239,619.06
CLIENT Landcom	**DRILL RIG**	**ELEVATION** N/A
PERMIT NO. N/A	**DRILLING METHOD** Solid Flight Auger	**COORD SYS** GDA94_MGA_zone_56
ADDRESS Buchan Ave, Edmondson Park, NSW	**TOTAL DEPTH** 15.5 m bgl	**COORD SOURCE** GPS
	DIAMETER 150 mm	**LOGGED BY** AS
COMPLETION	**CASING** Class 18 PVC - 50mm	**SCREEN INTERVAL** 9.5 - 15.5 m bgl
COMMENTS		

Drilling Method	Water (m bgl)	Well Details	Depth (m bgl)	Graphic Log	Lithological Class	Lithological Description	Moisture	Samples	PID	Additional Observations
SFA	▽		1 2 3 4 5 6 7 8 9 10 11 12 13 14 15		Fill CH Shale	Fill: Silty CLAY, brown, dry, no plasticity, heterogeneous, soft, inclusions of gravel, brick and concrete. CLAY, brown, dry, high plasticity, homogeneous, stiff. SHALE, weathered, grey/light brown, dry, no plasticity, soft, inclusions of shale fragments from 3m. Harder shale from 8.8m.				No odour, staining or asbestos. No odour, staining or asbestos. No odour, staining or asbestos. Water strike at 15m.
						Termination Depth at: 15.5 m.				

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GROUNDWATER WELL MW2

PROJECT NUMBER 59033	**DRILLING COMPANY** Matrix Drilling	**EASTING** 301,636.75
PROJECT NAME Edmondson Park Feb 2021	**DRILLING DATE** 08-Feb-21	**NORTHING** 6,239,387.46
CLIENT Landcom	**DRILL RIG**	**ELEVATION** N/A
PERMIT NO. N/A	**DRILLING METHOD** Solid Flight Auger	**COORD SYS** GDA94_MGA_zone_56
ADDRESS Buchan Ave, Edmondson Park, NSW	**TOTAL DEPTH** 15 m bgl	**COORD SOURCE** GPS
	DIAMETER 150 mm	**LOGGED BY** AS
COMPLETION	**CASING** Class 18 PVC - 50mm	**SCREEN INTERVAL** 9 - 15 m bgl
COMMENTS		

Drilling Method	Water (m bgl)	Well Details	Depth (m bgl)	Graphic Log	Lithological Class	Lithological Description	Moisture	Samples	PID	Additional Observations
SFA	▽		0		Fill	Fill: Silty CLAY, brown, dry, no plasticity, heterogeneous, soft, inclusions of gravel, brick and wood chips.				No odour, staining or asbestos.
					CH	CLAY, brown/grey, dry, high plasticity, homogeneous, stiff.				No odour, staining or asbestos.
			1		Shale	SHALE, weathered, grey/light brown, dry, no plasticity, soft, inclusions of shale fragments from 2m. Harder shale from 11m.				No odour, staining or asbestos.
			2							
			3							
			4							
			5							
			6							
			7							
			8							
			9							
			10							
			11							
			12							Water strike at 12.5m.
			13							
			14							
			15			Termination Depth at: 15.0 m.				

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GROUNDWATER WELL MW3

PROJECT NUMBER 59033	**DRILLING COMPANY** Matrix Drilling	**EASTING** 301,763.51
PROJECT NAME Edmondson Park Feb 2021	**DRILLING DATE** 08-Feb-21	**NORTHING** 6,239,384.62
CLIENT Landcom	**DRILL RIG**	**ELEVATION** N/A
PERMIT NO. N/A	**DRILLING METHOD** Solid Flight Auger	**COORD SYS** GDA94_MGA_zone_56
ADDRESS Buchan Ave, Edmondson Park, NSW	**TOTAL DEPTH** 14.8 m bgl	**COORD SOURCE** GPS
	DIAMETER 150 mm	**LOGGED BY** AS
COMPLETION	**CASING** Class 18 PVC - 50mm	**SCREEN INTERVAL** 8.8 - 14.8 m bgl

COMMENTS

Drilling Method	Water (m bgl)	Well Details	Depth (m bgl)	Graphic Log	Lithological Class	Lithological Description	Moisture	Samples	PID	Additional Observations
SFA	▽		1		Fill	Fill: Silty CLAY, brown, dry, no plasticity, heterogeneous, soft, inclusions of gravel and sticks.				No odour, staining or asbestos.
					CH					No odour, staining or asbestos.
					Shale	CLAY, red/grey, dry, high plasticity, homogeneous, stiff.				No odour, staining or asbestos.
			2			SHALE, weathered, grey/light brown, dry, no plasticity, soft, inclusions of shale fragments from 2.5m. Harder shale from 6m.				
			3							
			4							
			5							
			6							
			7							
			8							
			9							
			10							
			11							
			12							
			13							Water strike at 12.5m.
			14							
			15			Termination Depth at: 14.8 m.				

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Borehole ID

BH01

Page 1 of 3

Engineering Log - Non Cored Borehole

Project No.: PSM3750

Client:	SINSW	Commenced:	21/01/2019
Project Name:	Geotechnical Investigation on Landcom 6.0 Ha Land	Completed:	21/01/2019
Hole Location:	Lot 375 Edmondson Park	Logged By:	MB
Hole Position:	301756.0 m E 6239364.0 m N	Checked By:	YB

Drill Model and Mounting:	Hanjin Track Mounted	Inclination:	-90°	RL Surface:	60.00 m		
Hole Diameter:	110 mm	Bearing:		Datum:	AHD	Operator:	B&G Drilling

Drilling Information								Soil Description						Observations
Method	Penetration	Support	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description SOIL NAME: Colour, structure, plasticity, additional	Moisture Condition	Consistency / Relative Density	Hand Penetrometer UCS (kPa) 100 200 300 400 500	Structure and Additional Observations
AD/V		N	Not Observed	CBR 0.00-1.50 m		59.0	1		CL-ML / CI	SILTY CLAY: pale brown and orange, low plasticity, trace sand coarse grained up to 2mm, roots and rootlets observed.		F		0.00: Topsoil
										CLAY: mottled red, orange and grey, low plasticity				0.10: Inferred Natural Soil
				ES 1.00 m PP 1.00 m =300 kPa								F to St	x	
				ES 2.00 m PP 2.00 m =300 kPa		58.0	2		CL	SANDY CLAY: red and grey, low plasticity, sand fine grained.			x	
				Atterberg 2.50 m						Becomes medium to coarse grained at 2.5 m.	D	St		
						57.0	3							
AD/T		N				56.0	4		CL-ML	SILTY CLAY: dark brown, medium plasticity		VSt		3.50: Shale fragments observed
										Becomes pale brown at 4.5 m.				4.00: V-bit refusal
										Continued on cored borehole sheet				4.03: TC-bit refusal

Method
AD/T - Auger drilling TC bit
AD/V - Auger drilling V bit
WB - Washbore
SPT - Standard penetration test
PT - Push tube
AS - Auger Screwing

Penetration
No resistance through to refusal

Water
Inflow
Partial Loss
Complete Loss

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
ES - Environmental Sample
TW - Thin Walled
LB - Large Disturbed Sample

Classification symbols and soil descriptions based on Unified Soil Classification System

Moisture Condition
D - Dry
M - Moist
W - Wet

Consistency/Relative Density
VS - Very soft
S - Soft
F - Firm
St - Stiff
VSt - Very stiff
H - Hard
VL - Very loose
L - Loose
MD - Medium dense
D - Dense
VD - Very dense
Ce - Cemented
C - Compact

See Explanatory Notes for details of abbreviations and basis of descriptions.

PSM 3.00.2 LIB V2.GLB Log IS_AU_NONCORE_BH_NZ_AU PSM3750 GINT LOGS.GPJ <<DrawingFile>> 08/02/2019 15:46 8.30.005 Datgel Lab and In Situ Tool - DGD Lib: PSM 3.00.2 2015-10-23.Prj: PSM 2.01 2015-04-07

Engineering Log - Cored Borehole

Project No.: PSM3750

Client:	SINSW	Commenced:	21/01/2019
Project Name:	Geotechnical Investigation on Landcom 6.0 Ha Land	Completed:	21/01/2019
Hole Location:	Lot 375 Edmondson Park	Logged By:	MB
Hole Position:	301756.0 m E 6239364.0 m N	Checked By:	YB
Drill Model and Mounting:	Hanjin Track Mounted	Inclination: -90°	RL Surface: 60.00 m
Barrel Type and Length:	Triple Tube 100mm	Bearing:	Datum: AHD Operator: B&G Drilling

Drilling Information							Rock Substance				Rock Mass Defects	
Method	Water	TCR (%)	RQD (%)	SAMPLES & FIELD TESTS	RL (m)	Depth (m)	Graphic Log	Material Description ROCK TYPE: Colour, grain size, structure (texture, fabric, mineral composition, hardness, alteration, cementation, etc as applicable)	Weathering EW HW MW SW F	Strength Is(50) ● - Axial ○ - Diametral EL <0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH	Defect Spacing (mm) <20 60 200 600 1000	Defect Descriptions / Comments Description, alpha/beta, infilling or coating, shape, roughness, thickness, other
			90		59.0	1		Continued from non-cored borehole sheet				
					58.0	2						
					57.0	3						
					56.0	4						

Method
AD/T - Auger drilling TC bit
AD/V - Auger drilling V bit
WB - Washbore
HQ3- Wireline core (63.5 mm)
PQ3- Wireline core (85.0 mm)
SPT- Standard penetration test
PT - Push tube

Water
Inflow
Partial Loss
Complete Loss

Graphic Log/Core Loss
Core recovered (hatching indicates material)
No core recovery

Weathering
EW - Extremely Weathered
HW - Highly Weathered
MW - Moderately Weathered
SW - Slightly Weathered
F - Fresh

Strength
EL - Extremely Low
VL - Very Low
L - Low
M - Medium
H - High
VH - Very High
EH - Extremely High

Defect Type
FT - Fault
SS - Shear Surface
SZ - Shear Zone
BP - Bedding parting
SM - Seam
IS - Infilled Seam
JT - Joint
CO - Contact
CZ - Crushed Zone
VN - Vein
FZ - Fracture Zone
BSH - Bedding Shear
DB - Drilling Break

Infilling/Coating
CN - Clean
SN - Stain
VN - Veneer
CO - Coating
RF - Rock fragments
G - Gravel
S - Sand
Z - Silt
CA - Calcite
CL - Clay
FE - Iron
QZ - Quartz
X - Carbonaceous

Roughness
SL - Slickensided
POL - Polished
S - Smooth
RF - Rough
VR - Very Rough

Shape
PR - Planar
CU - Curved
UN - Undulating
ST - Stepped
IR - Irregular

See Explanatory Notes for details of abbreviations and basis of descriptions.

PSM 3.00.2 LIB V2.GLB Log IS_AU_CORE_EH_PSM PSM3750 GINT LOGS.GPJ <<DrawingFile>> 08/02/2019 15:45 8.30.003 Datgel Lab and In Situ Tool - DGD [Lib: PSM 3.00.2 2015-10-23 Pr: PSM 2/1 2015-04-07

Engineering Log - Cored Borehole

Project No.: PSM3750

Client:	SINSW	Commenced:	21/01/2019
Project Name:	Geotechnical Investigation on Landcom 6.0 Ha Land	Completed:	21/01/2019
Hole Location:	Lot 375 Edmondson Park	Logged By:	MB
Hole Position:	301756.0 m E 6239364.0 m N	Checked By:	YB
Drill Model and Mounting:	Hanjin Track Mounted	Inclination: -90°	RL Surface: 60.00 m
Barrel Type and Length:	Triple Tube 100mm	Bearing:	Datum: AHD Operator: B&G Drilling

Drilling Information								Rock Substance			Rock Mass Defects	
Method	Water	TCR (%)	RQD (%)	SAMPLES & FIELD TESTS	RL (m)	Depth (m)	Graphic Log	Material Description ROCK TYPE: Colour, grain size, structure (texture, fabric, mineral composition, hardness, alteration, cementation, etc as applicable)	Weathering EW HW MW SW F	Strength Is(50) ● - Axial ○ - Diametral EL <0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH	Defect Spacing (mm) <20 60 200 600 1000	Defect Descriptions / Comments Description, alpha/beta, infilling or coating, shape, roughness, thickness, other
NMLC	Not Observed	100	90	5.36m Is(50) d=3.92 a=10.64 MPa	54.0	6		SILTSTONE: Orange and brown, varying from extremely weathered rock to hard clay.(continued) Becomes black and grey, fine-grained and well developed.				BP 15° CL VN UN RF BP 5° CL CO UN RF 2 mm BP 0° FE SN CU RF
								Becomes orange and grey, rock fabric visible, developed laminations.				SM 0° CL CU S 20 mm BP 0° CL CO PR RF 2 mm BP 5° CL VN PR RF 1 mm SM 0° CL CO ST RF 10 mm
				6.40m Is(50) d=0.46 a=2.37 MPa	53.0	7						BP 0° CL VN PR RF BP 0° CL VN PR RF BP 2° CN PR RF 6.72: DB 6.84: DB 6.90: DB
		100	97	7.51m Is(50) d=0.05 a=0.65 MPa	52.0	8		Becomes dark grey and grey, rock fabric visible, well developed laminations.				SM 15° CL UN S 10 mm JT 40° CL CO UN RF 5 mm JT 60° CN PR RF BP 0° CL VN CU RF BP 15° CN ST RF 7.50: HOBO water monitoring device installed
				8.45m Is(50) d=0.13 a=0.23 MPa	51.0	9		Hole Terminated at 8.50 m Standpipe installed				

Method
AD/T - Auger drilling TC bit
AD/V - Auger drilling V bit
WB - Washbore
HQ3- Wireline core (63.5 mm)
PQ3- Wireline core (85.0 mm)
SPT- Standard penetration test
PT - Push tube

Water
Inflow
Partial Loss
Complete Loss

Graphic Log/Core Loss
Core recovered (hatching indicates material)
No core recovery

Weathering
EW - Extremely Weathered
HW - Highly Weathered
MW - Moderately Weathered
SW - Slightly Weathered
F - Fresh

Strength
EL - Extremely Low
VL - Very Low
L - Low
M - Medium
H - High
VH - Very High
EH - Extremely High

Defect Type
FT - Fault
SS - Shear Surface
SZ - Shear Zone
BP - Bedding parting
SM - Seam
IS - Infilled Seam
JT - Joint
CO - Contact
CZ - Crushed Zone
VN - Vein
FZ - Fracture Zone
BSH - Bedding Shear
DB - Drilling Break

Infilling/Coating
CN - Clean
SN - Stain
VN - Veneer
CO - Coating
RF - Rock fragments
G - Gravel
S - Sand
Z - Silt
CA - Calcite
CL - Clay
FE - Iron
QZ - Quartz
X - Carbonaceous

Roughness
SL - Slickensided
POL - Polished
S - Smooth
RF - Rough
VR - Very Rough

Shape
PR - Planar
CU - Curved
UN - Undulating
ST - Stepped
IR - Irregular

See Explanatory Notes for details of abbreviations and basis of descriptions.

PSM 3.00.2 LIB V2.GLB Log IS_AU_CORE_EH_PSM_PSM3750 GINT LOGS.GPJ <<DrawingFile>> 08/02/2019 15:45 8.30.003 Datgel Lab and In Situ Tool - DGD | Lib: PSM 3.00.2 2015-10-23 Prj: PSM 2.01 2015-04-07

JOB No.: PSM 3750 BH ID: BH 01

PROJECT: Landcom 6.0 HA Land

LOCATION: Lot 375 Edmondson Park

FROM: 4.9m TO: 8.5m DATE: 21/1/19

APP Corportation	
School Infrastructure NSW	
Lot 375 Edmondson Park, NSW	
CORE PHOTO BH01 - 4.9m to 8.5m	
Pells Sullivan Meynink	PSM3750-006L Attachment A Figure 1

Borehole ID

BH02

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Engineering Log - Non Cored Borehole

Project No.: PSM3750

Client:	SINSW	Commenced:	22/01/2019
Project Name:	Geotechnical Investigation on Landcom 6.0 Ha Land	Completed:	22/01/2019
Hole Location:	Lot 375 Edmondson Park	Logged By:	MB
Hole Position:	301776.0 m E 6239489.0 m N	Checked By:	YB
Drill Model and Mounting:	Hanjin Track Mounted	Inclination: -90°	RL Surface: 57.00 m
Hole Diameter:	110 mm	Bearing:	Datum: AHD

Operator: B&G Drilling

Drilling Information								Soil Description						Observations
Method	Penetration	Support	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description SOIL NAME: Colour, structure, plasticity, additional	Moisture Condition	Consistency / Relative Density	Hand Penetrometer UCS (kPa) 100 200 300 400 500	Structure and Additional Observations
AD/V		N	Not Observed	SPT 1.00 - 1.45 m 4, 7, 10 N = 17 PP 1.00 m =300 kPa		56.0	1		CL	SILTY CLAY: dark brown, low to no plasticity.	M	S		0.00: Topsoil - roots and rootlets observed.
									CL	CLAY: orange, brown and grey, low plasticity.		F to St	x	0.20: Inferred Natural Soil. 1.00: SPT recovered: 0.45 m
				PP 2.00 m =400 kPa		55.0	2		CH	CLAY: red and grey, medium to high plasticity.		VSt	x	1.70: Drill resistance increases. 1.90: V-bit refusal. 2.50: SPT recovered: 0.45 m
AD/T		N		SPT 2.50 - 2.95 m 8, 11, 17 N = 28		54.0	3			SILTSTONE: Pale brown, extremely weathered, extremely low strength.	D			2.70: Extremely weathered shale fragments observed, up to 5mm. 3.00: Inferred Bedrock, strength and weathering inferred from cuttings.
				ES 4.00 m SPT 4.00 - 4.10 m Refusal		53.0	4			Hole Terminated at 4.10 m Refusal				4.00: TC-bit refusal SPT recovered: 0.10m

Method
AD/T - Auger drilling TC bit
AD/V - Auger drilling V bit
WB - Washbore
SPT - Standard penetration test
PT - Push tube
AS - Auger Screwing

Penetration
No resistance through to refusal

Water
Inflow
Partial Loss
Complete Loss

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
ES - Environmental Sample
TW - Thin Walled
LB - Large Disturbed Sample

Classification symbols and soil descriptions based on Unified Soil Classification System

Moisture Condition
D - Dry
M - Moist
W - Wet

Consistency/Relative Density
VS - Very soft
S - Soft
F - Firm
St - Stiff
VSt - Very stiff
H - Hard
VL - Very loose
L - Loose
MD - Medium dense
D - Dense
VD - Very dense
Ce - Cemented
C - Compact

See Explanatory Notes for details of abbreviations and basis of descriptions.

PSM 3.00.2 LIB V2.GLB Log IS_AU_NONCORE_BH_NZ_AU PSM3750 GINT LOGS.GPJ <<DrawingFile>> 08/02/2019 15:46 8.30.005 Datgel Lab and In Situ Tool - DGD | Lib: PSM 3.00.2 2015-10-23 Prj: PSM 2.01 2015-04-07

Borehole ID

BH03

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Engineering Log - Non Cored Borehole

Project No.: PSM3750

Client:	SINSW	Commenced:	21/01/2019
Project Name:	Geotechnical Investigation on Landcom 6.0 Ha Land	Completed:	21/01/2019
Hole Location:	Lot 375 Edmondson Park	Logged By:	MB
Hole Position:	301718.0 m E 6239491.0 m N	Checked By:	YB
Drill Model and Mounting:	Hanjin Track Mounted	Inclination: -90°	RL Surface: 59.00 m
Hole Diameter:	110 mm	Bearing:	Datum: AHD

Operator: B&G Drilling

Drilling Information							Soil Description					Observations
Method	Penetration	Support	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description SOIL NAME: Colour, structure, plasticity, additional	Moisture Condition	Consistency / Relative Density	Hand Penetrometer UCS (kPa) 100 200 300 400 500	Structure and Additional Observations
AD/V		N	Not Observed	CBR 0.00-1.50 m		58.0	1		CL	SILTY CLAY: pale brown, low plasticity, trace sand coarse grained up to 1mm, roots and rootlets observed.		F		0.00: Topsoil
									CL	CLAY: red and grey, low plasticity.		St to VSt		0.10: Inferred Natural Soil.
				PP 1.20 m =350 kPa									x	
AD/T		N		ES 1.50 m Atterberg 1.50-2.00 m					CL	SILTY CLAY: pale brown, medium plasticity, trace gravel sub-rounded to sub-angular up to 5mm.	D			1.50: V-bit refusal.
				ES 2.00 m		57.0	2			Becomes red and very stiff to hard at 2.0 m.		VSt		
						56.0	3			LAMINITE: black, orange and red, extremely low strength, extremely weathered.				3.00: Inferred Bedrock - strength and weathering inferred from cuttings.
										Continued on cored borehole sheet				3.29: TC-bit refusal.
						55.0	4							

Method
AD/T - Auger drilling TC bit
AD/V - Auger drilling V bit
WB - Washbore
SPT - Standard penetration test
PT - Push tube
AS - Auger Screwing

Penetration
No resistance through to refusal

Water
Inflow
Partial Loss
Complete Loss

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
ES - Environmental Sample
TW - Thin Walled
LB - Large Disturbed Sample

Classification symbols and soil descriptions based on Unified Soil Classification System

Moisture Condition
D - Dry
M - Moist
W - Wet

Consistency/Relative Density
VS - Very soft
S - Soft
F - Firm
St - Stiff
VSt - Very stiff
H - Hard
VL - Very loose
L - Loose
MD - Medium dense
D - Dense
VD - Very dense
Ce - Cemented
C - Compact

See Explanatory Notes for details of abbreviations and basis of descriptions.

PSM 3.00.2 LIB V2 GLB Log IS_AU_NONCORE_BH_NZ_AU PSM3750 GINT LOGS.GPJ <<DrawingFile>> 08/02/2019 15:46 8.30.003 Datgel Lab and In Situ Tool - DGD | Lib: PSM 3.00.2 2015-10-23 Prj: PSM 2.01 2015-04-07

Engineering Log - Cored Borehole

Project No.: PSM3750

Client:	SINSW	Commenced:	21/01/2019
Project Name:	Geotechnical Investigation on Landcom 6.0 Ha Land	Completed:	21/01/2019
Hole Location:	Lot 375 Edmondson Park	Logged By:	MB
Hole Position:	301718.0 m E 6239491.0 m N	Checked By:	YB
Drill Model and Mounting:	Hanjin Track Mounted	Inclination: -90°	RL Surface: 59.00 m
Barrel Type and Length:	Triple Tube 100mm	Bearing:	Datum: AHD Operator: B&G Drilling

Drilling Information							Rock Substance				Rock Mass Defects	
Method	Water	TCR (%)	RQD (%)	SAMPLES & FIELD TESTS	RL (m)	Depth (m)	Graphic Log	Material Description ROCK TYPE: Colour, grain size, structure (texture, fabric, mineral composition, hardness, alteration, cementation, etc as applicable)	Weathering EW HW MW SW F	Strength Is(50) ●- Axial ○- Diametral EL <0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH	Defect Spacing (mm) <20 60 200 600 1000	Defect Descriptions / Comments Description, alpha/beta, infilling or coating, shape, roughness, thickness, other
					58.0	1						
					57.0	2						
					56.0	3		Continued from non-cored borehole sheet				
NMLC	Not Observed	100	92	3.65m Is(50) d=0.1 a=1.06 MPa	55.0	4		LAMINITE: Orange, black and grey, parent rock fabric faint, some hard clay.				
								Becoming grey, 70% sandstone and 30% shale, fine to medium grained, rock fabric visible, developed bedding.				BP 1° CL VN UN S BP 5° Fe Clay VN PR RF 1 mm BP 2° CL VN PR RF 1 mm BP 0° CL VN PR RF 1 mm
				4.51m Is(50) d=1.73 a=1.28 MPa				Becoming dark grey and grey 50% sandstone and 50% shale, fine grained, rock fabric visible, developed bedding.				BP 0° CL CO PR RF 2 mm BP 7° CL VN PR RF 1 mm

Method
AD/T - Auger drilling TC bit
AD/V - Auger drilling V bit
WB - Washbore
HQ3- Wireline core (63.5 mm)
PQ3- Wireline core (85.0 mm)
SPT- Standard penetration test
PT - Push tube

Water
Inflow
Partial Loss
Complete Loss

Graphic Log/Core Loss
Core recovered (hatching indicates material)
No core recovery

Weathering
EW - Extremely Weathered
HW - Highly Weathered
MW - Moderately Weathered
SW - Slightly Weathered
F - Fresh

Strength
EL - Extremely Low
VL - Very Low
L - Low
M - Medium
H - High
VH - Very High
EH - Extremely High

Defect Type
FT - Fault
SS - Shear Surface
SZ - Shear Zone
BP - Bedding parting
SM - Seam
IS - Infilled Seam
JT - Joint
CO - Contact
CZ - Crushed Zone
VN - Vein
FZ - Fracture Zone
BSH - Bedding Shear
DB - Drilling Break

Infilling/Coating
CN - Clean
SN - Stain
VN - Veneer
CO - Coating
RF - Rock fragments
G - Gravel
S - Sand
Z - Silt
CA - Calcite
CL - Clay
FE - Iron
QZ - Quartz
X - Carbonaceous

Roughness
SL - Slickensided
POL - Polished
S - Smooth
RF - Rough
VR - Very Rough

Shape
PR - Planar
CU - Curved
UN - Undulating
ST - Stepped
IR - Irregular

See Explanatory Notes for details of abbreviations and basis of descriptions.

PSM 3.00.2 LIB V2.GLB Log IS_AU_CORE_EH_PSM PSM3750 GINT LOGS.GPJ <<DrawingFile>> 08/02/2019 15:45 8.30.003 Datgel Lab and In Situ Tool - DGD [Lib: PSM 3.00.2 2015-10-23 Prj: PSM 2.01 2015-04-07

Engineering Log - Cored Borehole

Project No.: PSM3750

Client:	SINSW	Commenced:	21/01/2019
Project Name:	Geotechnical Investigation on Landcom 6.0 Ha Land	Completed:	21/01/2019
Hole Location:	Lot 375 Edmondson Park	Logged By:	MB
Hole Position:	301718.0 m E 6239491.0 m N	Checked By:	YB
Drill Model and Mounting:	Hanjin Track Mounted	Inclination: -90°	RL Surface: 59.00 m
Barrel Type and Length:	Triple Tube 100mm	Bearing:	Datum: AHD Operator: B&G Drilling

Drilling Information								Rock Substance				Rock Mass Defects	
Method	Water	TCR (%)	RQD (%)	SAMPLES & FIELD TESTS	RL (m)	Depth (m)	Graphic Log	Material Description ROCK TYPE: Colour, grain size, structure (texture, fabric, mineral composition, hardness, alteration, cementation, etc as applicable)	Weathering EW HW MW SW F	Strength Is(50) ● - Axial ○ - Diametral EL <0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH	Defect Spacing (mm) <20 60 200 600 1000	Defect Descriptions / Comments Description, alpha/beta, infilling or coating, shape, roughness, thickness, other
NMLC	Not Observed	100	92					LAMINITE: dark grey and grey 50% sandstone and 50% shale, fine grained, rock fabric visible, developed bedding.				BP 10° CL VN ST RF BP 2° CL VN ST RF	
				5.53m Is(50) d=2.25 a=1.83 MPa	53.0	6						BP 2° CN UN RF BP 5° CN CU RF	
		100	97	6.41m Is(50) d=1.67 a=0.82 MPa				Becoming 70% sandstone and 30% shale, fine to medium grained, rock fabric visible, well developed bedding.				BP 0° CL VN ST RF 1 mm BP 0° CN PR RF BP 2° CN PR RF BP 5° CN UN RF	
				7.29m Is(50) d=8.59 a=2.75 MPa	52.0	7						BP 2° CN CU RF	
					51.0	8		Hole Terminated at 7.40 m Standpipe installed					
					50.0	9							

Method
AD/T - Auger drilling TC bit
AD/V - Auger drilling V bit
WB - Washbore
HQ3- Wireline core (63.5 mm)
PQ3- Wireline core (85.0 mm)
SPT- Standard penetration test
PT - Push tube

Water
Inflow
Partial Loss
Complete Loss

Graphic Log/Core Loss
Core recovered (hatching indicates material)
No core recovery

See Explanatory Notes for details of abbreviations and basis of descriptions.

Weathering
EW - Extremely Weathered
HW - Highly Weathered
MW - Moderately Weathered
SW - Slightly Weathered
F - Fresh

Strength
EL - Extremely Low
VL - Very Low
L - Low
M - Medium
H - High
VH - Very High
EH - Extremely High

Defect Type
FT - Fault
SS - Shear Surface
SZ - Shear Zone
BP - Bedding parting
SM - Seam
IS - Infilled Seam
JT - Joint
CO - Contact
CZ - Crushed Zone
VN - Vein
FZ - Fracture Zone
BSH - Bedding Shear
DB - Drilling Break

Infilling/Coating
CN - Clean
SN - Stain
VN - Veneer
CO - Coating
RF - Rock fragments
G - Gravel
S - Sand
Z - Silt
CA - Calcite
CL - Clay
FE - Iron
QZ - Quartz
X - Carbonaceous

Roughness
SL - Slickensided
POL - Polished
S - Smooth
RF - Rough
VR - Very Rough

Shape
PR - Planar
CU - Curved
UN - Undulating
ST - Stepped
IR - Irregular

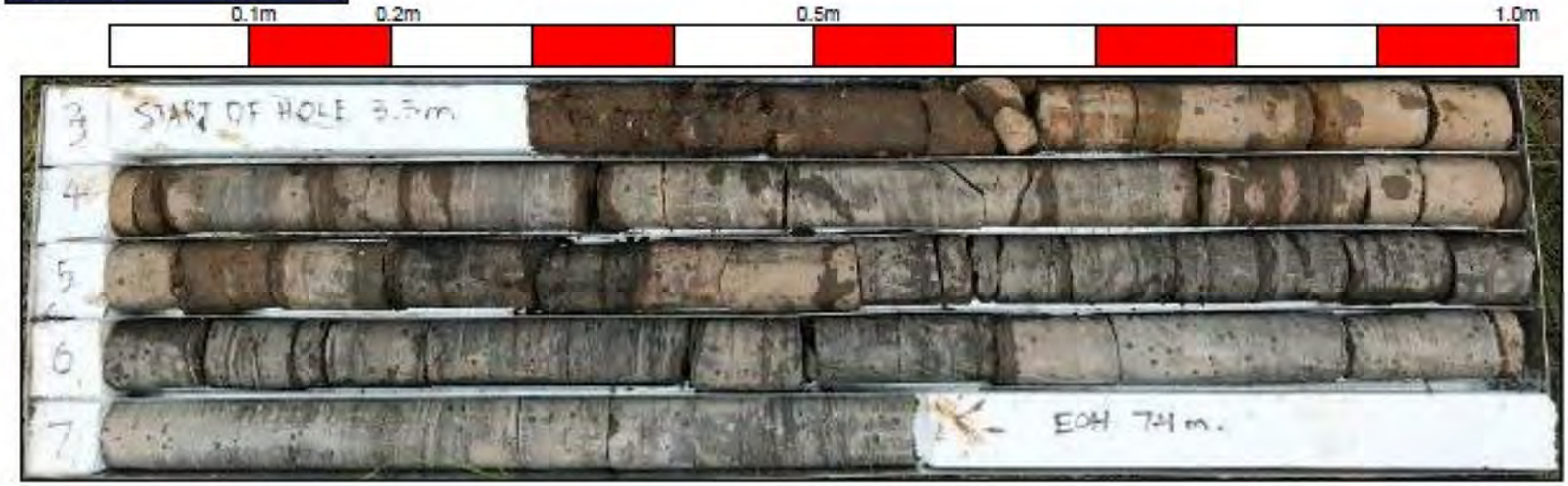
PSM 3.00.2 LIB V2.GLB Log IS_AU_CORE_EH_PSM_PSM3750 GINT LOGS.GPJ <<DrawingFile>> 08/02/2019 15:45 8.30.003 Datgel Lab and In Situ Tool - DGD [Lib: PSM 3.00.2 2015-10-23 Prj: PSM 2.01 2015-04-07

JOB No.: PSM 3750 BH ID: BH 03

PROJECT: Landcom 6.0 HA Land

LOCATION: Lot 375 Edmondson Park

FROM: 3.3m TO: 7.4m DATE: 21/1/19



Pells Sullivan Meynink

APP Corportation

School Infrastructure NSW

Lot 375 Edmondson Park, NSW

CORE PHOTO BH03 - 3.3m to 7.4m

PSM3750-006L Attachment A Figure 1

PSM

Borehole ID

BH04

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Engineering Log - Non Cored Borehole

Project No.: PSM3750

Client:	SINSW	Commenced:	22/01/2019
Project Name:	Geotechnical Investigation on Landcom 6.0 Ha Land	Completed:	22/01/2019
Hole Location:	Lot 375 Edmondson Park	Logged By:	MB
Hole Position:	301622.0 m E 6239539.0 m N	Checked By:	YB
Drill Model and Mounting:	Hanjin Track Mounted	Inclination: -90°	RL Surface: 60.50 m
Hole Diameter:	110 mm	Bearing:	Datum: AHD

Operator: B&G Drilling

Drilling Information								Soil Description					Observations
Method	Penetration	Support	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description SOIL NAME: Colour, structure, plasticity, additional	Moisture Condition	Consistency / Relative Density	Hand Penetrometer UCS (kPa) 100 200 300 400 500	Structure and Additional Observations
AD/V		N							CL	CLAY: pale brown and orange, low plasticity, roots and rootlets observed.		St		0.00: Topsoil
AD/T		N	Not Observed	Atterberg 0.20-0.50 m ES 0.50 m SPT 1.00 - 1.45 m 4, 11, 14 N = 25 SPT 2.50 - 2.90 m 13, 19, Refusal		59.5 58.5 57.5	1 2 3		CL	CLAY: pale brown, medium to high plasticity.	D	VSt		0.30: V-bit refusal. 1.00: SPT recovered: 0.45 m 2.00: Inferred Bedrock, strength and weathering inferred from cuttings. 2.50: SPT recovered: 0.40 m
						56.5	4			SILTSTONE: Grey and orange, extremely low strength, extremely weathered. Hole Terminated at 3.40 m Refusal				3.40: TC-bit refusal

Method
AD/T - Auger drilling TC bit
AD/V - Auger drilling V bit
WB - Washbore
SPT - Standard penetration test
PT - Push tube
AS - Auger Screwing

Penetration
No resistance through to refusal

Water
Inflow
Partial Loss
Complete Loss

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
ES - Environmental Sample
TW - Thin Walled
LB - Large Disturbed Sample

Classification symbols and soil descriptions based on Unified Soil Classification System

Moisture Condition
D - Dry
M - Moist
W - Wet

Consistency/Relative Density
VS - Very soft
S - Soft
F - Firm
St - Stiff
VSt - Very stiff
H - Hard
VL - Very loose
L - Loose
MD - Medium dense
D - Dense
VD - Very dense
Ce - Cemented
C - Compact

See Explanatory Notes for details of abbreviations and basis of descriptions.

PSM 3.00.2 LIB V2.GLB Log IS_AU_NONCORE_BH_NZ_AU PSM3750 GINT LOGS.GPJ <<DrawingFile>> 08/02/2019 15:46 8.30.003 Datgel Lab and In Situ Tool - DGD | Lib: PSM 3.00.2 2015-10-23.Prj: PSM 2.01 2015-04-07

PSM

Borehole ID

BH05

Page 1 of 1

Engineering Log - Non Cored Borehole

Project No.: PSM3750

Client:	SINSW	Commenced:	22/01/2019
Project Name:	Geotechnical Investigation on Landcom 6.0 Ha Land	Completed:	22/01/2019
Hole Location:	Lot 375 Edmondson Park	Logged By:	MB
Hole Position:	301677.0 m E 6239566.0 m N	Checked By:	YB
Drill Model and Mounting:	Hanjin Track Mounted	Inclination: -90°	RL Surface: 60.50 m
Hole Diameter:	110 mm	Bearing:	Datum: AHD

Operator: B&G Drilling

Drilling Information								Soil Description						Observations
Method	Penetration	Support	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description SOIL NAME: Colour, structure, plasticity, additional	Moisture Condition	Consistency / Relative Density	Hand Penetrometer UCS (kPa) 100 200 300 400 500	Structure and Additional Observations
AD/V		N	Not Observed	CBR 0.00-1.50 m					CL	SILTY CLAY: pale brown, low plasticity, roots and rootlets observed.	D to M	St		0.00: Topsoil 0.10: Inferred Natural Soil.
									CL	CLAY: grey and red, low plasticity.				
				SPT 1.00 - 1.45 m 6, 8, 17 N = 25		59.5	1					VSt		1.00: SPT recovered: 0.45 m
				ES 1.50 m					CI-CH	CLAY: pale brown and grey, medium to high plasticity.	D			
						58.5	2					H		2.20: V-bit refusal.
AD/T		N		SPT 2.50 - 2.75 m 5, Refusal										2.50: SPT recovered: 0.25 m
										SILTSTONE: Grey and orange, extremely low strength, extremely weathered				2.70: Inferred Bedrock, strength and weathering inferred from drill cuttings.
				ES 3.00 m		57.5	3			Hole Terminated at 3.00 m Refusal				3.00: TC-bit refusal.
						56.5	4							

Method
AD/T - Auger drilling TC bit
AD/V - Auger drilling V bit
WB - Washbore
SPT - Standard penetration test
PT - Push tube
AS - Auger Screwing

Penetration
No resistance through to refusal

Water
Inflow
Partial Loss
Complete Loss

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
ES - Environmental Sample
TW - Thin Walled
LB - Large Disturbed Sample

Classification symbols and soil descriptions based on Unified Soil Classification System

Moisture Condition
D - Dry
M - Moist
W - Wet

Consistency/Relative Density
VS - Very soft
S - Soft
F - Firm
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H - Hard
VL - Very loose
L - Loose
MD - Medium dense
D - Dense
VD - Very dense
Ce - Cemented
C - Compact

See Explanatory Notes for details of abbreviations and basis of descriptions.

PSM 3.00.2 LIB V2 GLB Log IS_AU_NONCORE_BH_NZ_AU PSM3750 GINT LOGS.GPJ <<DrawingFile>> 08/02/2019 15:46 8.30.003 Datgel Lab and In Situ Tool - DGD | Lib PSM 3.00.2 2015-10-23 Prj PSM 2.01 2015-04-07

Appendix E Summary of Historical Site Investigations

Table 5 - Laboratory Testing Results

Sample ID	pH	Electrical Conductivity [µS/cm]	Moisture Content [%]	Resistivity at 25 °C [ohm.cm]	Chloride By Discrete Analyser [mg/kg]	Soluble Sulfate by ICPAES [mg/kg]	Exchangeable Cations [meq/100g]					ESP [%]
							Ca	Mg	K	Na	CEC	
BH05-1.5m	5.5	216	9.3	4630	230	150	<0.1	7.2	0.3	3.0	10.5	28.6
BH05-3.0m	5.8	300	8.0	3330	280	230	0.1	7.4	0.5	3.2	11.2	28.8
BH03-2.0m	5.8	142	5.8	7040	160	30	<0.1	3.9	0.2	1.8	6.0	30.7
BH04-0.5m	5.5	94	12.1	10600	80	80	0.8	4.6	0.2	1.0	6.6	15.0
BH01-2.0m	5.2	553	11.8	1810	660	180	<0.1	7.9	0.2	4.0	12.2	33.4
BH03-1.5m	5.8	145	6.3	6900	120	90	<0.1	4.6	0.3	1.8	6.8	26.7
BH02-4.0m	7.1	82	14.4	12200	70	20	0.8	5.6	0.4	3.6	10.3	34.4
BH01-1.0m	4.9	526	13.7	1900	410	290	<0.1	4.7	0.1	1.9	6.8	28.4

8 Evaluation of Investigation Results

8.1 Evaluation of Munitions Investigation Results

8.1.1 Grenade and Mortar Impacts

During previous investigation stages at the site, no live UXO was found. Consistent with the known site history, the items found were practice/ inert infantry weapons. The Auditor considers the likelihood for live UXO to be present on site to be very low. While these practice items do not present an explosive hazard, their discovery on site would be alarming to any future workers or occupants at the site.

During the munitions investigations, significant grenade or mortar impacts were located outside the initial "expected" zones of impact, which were primarily the main grenade range and also the dams. Consideration must therefore be given to the adequacy of overall site investigative coverage to identify these "unexpected impacts". The unexpected impacts were primarily identified during the Stage 2A validation exercises which focused on cells of high metallic density as determined by digital metal detector. Following completion of those works, Milsearch found that (2003, page 16) "*it cannot be stated with certainty that all areas of indicated higher metallic density have been checked"* and recommended additional work in the form of remedial searches in order to provide confidence that *"the vast majority of potential UXO hazard has been addressed on the site*".

Further investigations undertaken at the site in 2005 included clearance of 763 locations and pathways between. During this process, only two "unexpected impacts" were found by BACTEC, indicating that their occurrence is becoming less common, providing a greater assurance of having identified "unexpected impacts".

However, the ongoing identification of "unexpected impacts", the scale of the site and the various limitations on the investigations undertaken to date (i.e. areas excluded from all stages of investigation included: areas of protected vegetation, areas of blackberry infestations, and areas where geophysics found metallic anomalies) indicate that the possibility of further "unexpected impacts" being present on site is likely. Further remediation works were therefore required and proposed by Golder. Subsequent remediation undertaken by G-tek and BACTEC is discussed in SAR Section 9.

8.1.2 SAA

The average SAA densities estimated for the site were approximately 700/ha in high intensity usage training areas and approximately 250/ha in remaining areas of the site. The proportional occurrence of live blank SAA was estimated at between 2 and 10%.

According to Milsearch, while live blank SAA constitutes a lesser hazard than live ball ammunition, blanks can still cause significant injury, particularly eye damage, if detonated through tampering. Brass blank ammunition is understood to be particularly dangerous. While presenting no explosive hazard, the discovery of expended blank SAA could be alarming to site workers or occupants.

Golder (2005a) reported that similar projects have typically had a zero tolerance threshold

criteria for SAA within residential developments. The Auditor has previously commented that a threshold concentration of 250 SAA/ha is not considered appropriate.

Further remediation works were evidently required with respect to SAA and proposed by Golder. Subsequent remediation undertaken by G-tek and BACTEC is discussed in SAR Section 9.

8.2 Evaluation of Soil Analytical Results

Approximately 479 soil investigation locations were undertaken by Golder (2005a) in RZNRA, including test pits, hand auger holes and drilled boreholes. Locations were spaced on a grid (32 m), with additional targeted locations for features such as drainage lines, stockpiles and areas of contaminant observations. Soil sampling locations are shown on Attachment 4, Appendix A.

The boundaries of the RZNRA have changed slightly since the time of the investigations, with loss of land along the southern boundary due to excision of the rail corridor. The following evaluation is based on the previous site areas and therefore includes some data that is no longer relevant.

The results of the investigations in RZNRA are summarised in Table 8.1. The results have been assessed against the proposed land use criteria (Section 7). Soil analytical results for the remaining areas of the greater site (CZSRA and RRZW) are provided in Interim Advice #3, included as Appendix F.

Table 8.1: Summary of Soil Analytical Results (mg/kg)

Analyte	n	Detections	Maximum	n > EPA (1994)	n > SIL Column 1 (DEC 2006)	n > SIL Column 5 (DEC 2006)
pH	6	Min-5.1	6.2	-	-	-
Arsenic	641	563	28	-	0	1
Cadmium	641	0	<0.5	-	0	0
Total Chromium	641	641	42	-	0	641 [1]
Chromium VI	6	0	<1	-	0	0
Copper	641	640	55	-	0	0
Lead	641	641	210	0	0	0
Mercury (inorganic)	641	74	0.14	-	0	0
Nickel	641	641	40	-	0	0
Zinc	641	641	810	-	0	3
TPH (C_6-C_9)	105	0	<20	0	-	-
TPH (C_{10}-C_{36})	105	2	800	0	-	-
BTEX	105	0	<0.5	0	-	-
Phenols	6	0	<0.5	-	0	-
VCH	5	0	<0.5	-	-	-

Table 8.1: Summary of Soil Analytical Results (mg/kg)

Analyte	n	Detections	Maximum	n > EPA (1994)	n > SIL Column 1 (DEC 2006)	n > SIL Column 5 (DEC 2006)
Total PAHs	105	1	0.1	-	0	-
Benzo(a)pyrene	105	0	<0.1	-	0	-
OCP/ OPP	83	0	<0.1	-	0	-
PCBs	83	0	<0.1	-	0	-
Explosives	101	0	<1	-	-	-
Asbestos	125	1	-	-	-	-

n number of samples
- No criteria available/used
1 Chromium VI criterion used
VCH Volatile Chlorinated Hydrocarbons
OCP Organophosphorous Pesticides
PCB Polychlorinated Biphenyls

No samples from the RZNRA exceeded human health guidelines (SIL Column 1).

A limited number of metals detections exceeded the phytotoxicity guidelines (SIL Column 5), as follows:

- Arsenic was detected in one sample (BH249/3, 0.6-1.05 m) at 28 mg/kg compared to the guideline of 20 mg/kg. This was a sample of deeper natural material from a borehole in the centre of the area.
- Zinc was detected in three samples exceeding the guideline of 200 mg/kg with concentrations of 470, 720 and 810 mg/kg. These samples were of natural soil from the surface or near surface from locations near a building footing (HA140/1) and in the grenade range (TP469/1 and TP471/2).

The above detections are unlikely to affect vegetation growth at the site due to their very infrequent occurrence.

- All 641 samples analysed for total chromium exceeded the guideline of 1 mg/kg for Chromium VI. However, these results were well below the Chromium III guideline of 400 mg/kg, with a maximum of 42 mg/kg. Chromium VI analyses was performed on six samples containing relatively high total chromium concentrations and chromium VI was not detected. Further, there is nothing in the site history to indicate the chromium VI form would be present, therefore these detections are not considered to represent a risk to vegetation at the site.

One PAH compound was detected in one sample at a concentration equivalent to the detection limit and well below the human health guidelines (SIL Column 1) of 20 mg/kg.

Heavy end TPH in the C_{15} to C_{36} range was detected in two samples at 260 and 800 mg/kg, compared to the EPA guideline of 1,000 mg/kg. Both samples were of surface soil and had

no other contaminant detections. One was from a borehole near the track in the north west (BH2/1) and the other from the central east of the zone (TP285/1). The source of these detections is not known, but may be due to road runoff of vehicle contaminants in the case of BH2.

The above minor organic detections do not present a risk to human health or indicate the presence of widespread contamination.

No other organic compounds were detected, including TPH C_6-C_9, BTEX, phenols, VCH, OCP, OPP, PCB and explosives.

There was one detection of chrysotile asbestos in soil from a stockpile (TPSP6/1). A further detection of Synthetic Mineral Fibre (SMF) was noted by the laboratory in TP9/1, along the northern boundary, however this was not reported by Golder.

Golder (2005a) identified 17 stockpiles on the greater site, five of which were located on RZNRA, as shown on Attachment 5, Appendix A. A large number of stockpiles were clustered in the north west corner of the greater site, identified by Golder as the 'waste disposal west' area (located in RRZW and CZSRA).

Stockpiled soils were observed to consist of silty/ gravelly clays. Numerous wastes including building rubble and asbestos were also associated with stockpiles. The only contaminant detection made in stockpile samples was the detection of chrysotile asbestos in surface soil from TPSP6, located on the northern boundary of the site in RZNRA. This was the only detection of asbestos in soil at the site outside the asbestos impact area identified in CZSRA.

Stop butt material containing lead particulate (5-10 mm in size) was spread about the range (CZSRA) and built into roads (RZNRA, CZSRA and RRZW) in the 1970s. The extent of the lead particulate was delineated during investigations by Milsearch and Golder. Within RZNRA, lead particulate impact was associated with an access road along the northern boundary (Attachment 7, Appendix A).

In the Auditor's opinion, the soil analytical results are consistent with the site history and field observations. Minimal contaminant detections were made in the general site areas, with only limited detections exceeding human health guidelines made in known areas of contamination. The Auditor is satisfied that the general site areas are free of contamination and that significant contamination detections are restricted to areas of known contamination where remedial action has been undertaken (refer Section 9).

8.3 Evaluation of Groundwater Analytical Results

Golder (2005a) collected groundwater samples from seven wells and three trenches on the greater site in February and March 2005 (three wells were dry). Two of these wells (BH2 and BH291, BH249 was dry) are located on RZNRA. Groundwater samples were analysed for a variety of contaminants including heavy metals, TPH, BTEX, PAH, OCP, OPP, PCB, explosives, phenols and VHCs.

The analytical results for true groundwater are tabulated below in Table 8.2 (results for perched trench water are excluded). Results from field testing for temperature, pH, electrical conductivity (EC) and Total Dissolved Solids (TDS) are also included in these tables. Laboratory testing was conducted for pH and EC and results were similar to the field measurements.

Groundwater well locations are shown on Attachment 6, Appendix A.

Table 8.2: Evaluation of Groundwater Well Analytical Results – Summary Table

Analyte	Units	n	Detections	Minimum	Maximum	Max Well	n >ANZECC Fresh (2000)
Temperature	°C	7	7	21.0	23.8	BH558	-
pH	-	7	7	6.8	7.2	BH675	0
EC	µV	7	7	9,210	14,270	BH291	-
TDS	mS	7	7	4.53	7.18	BH291	-
Arsenic	mg/L	7	7	0.004	0.12	BH2	**1** [1]
Cadmium	mg/L	7	0	-	<0.0002	-	0
Total Chromium	mg/L	7	7	0.007	0.014	BH608	**7** [2]
Copper	mg/L	7	5	<0.001	0.004	BH608	**3**
Lead	mg/L	7	7	0.002	0.012	BH675	**6**
Mercury (inorganic)	mg/L	7	0	<0.0001	0.0001	BH291 (Dup)	**1** [3]
Nickel	mg/L	7	7	0.002	0.022	BH675	**4**
Zinc	mg/L	7	3	<0.001	0.07	BH291 (Dup)	**2**
TPH (C_6-C_9)	mg/L	7	0	-	<0.04	-	-
TPH (C_{10}-C_{36})	mg/L	7	0	-	<0.5	-	-
BTEX	mg/L	7	0	-	<0.001	-	0
Phenols	µg/L	7	0	-	<0.5	-	0
VHC	µg/L	7	0	-	<5	-	0
PAHs	µg/L	7	0	-	<0.5	-	0 [4]
OCP/ OPP	µg/L	7	0	<0.01	<0.2	-	0 [5]
PCBs	µg/L	7	0	-	<0.1	-	-
Explosives	mg/L	7	0	-	<0.005	-	-

n number of samples
- No criteria available/used
1 Arsenic III criteria
2 Chromium III criteria
3 Detection limit (0.0001 mg/L) for primary samples is above guideline (0.00006 mg/L)
4 Detection limits for some PAHs (anthracene, benzo(a)pyrene) are above guidelines
5 Detection limits for some OCP/OPP (Aldrin, Dieldrin, Chlorpyrifos) are above guidelines

Groundwater was found to be approximately neutral and saline.

Heavy metals, except cadmium, were detected at concentrations exceeding the guidelines in at least one groundwater well at the site. Heavy metal exceedances were distributed across all wells at the site. Exceedances were detected in both upgradient and downgradient wells. It is possible that the presence of heavy metals in groundwater is due to those metals naturally occurring within the rock aquifer. Elevated metals concentrations are commonly detected in groundwater within Wianamatta Shale.

There is one area of the site where there is an apparent correlation between heavy metal detections and contaminant sources. The highest metals concentrations were commonly detected in wells BH608 and BH675 which are in the vicinity of the small arms range, disposal trenches and nearby Dam 3 (on CZSRA), where the majority of soil metals exceedances were detected. One of the two zinc exceedances for the site was also detected in well BH608, in the small arms range. It is possible that these activities have locally increased the heavy metal loading in groundwater, but this increase is not considered to be substantially more than the concentrations which appear to be naturally occurring at the site.

No organic compounds were detected in any of the groundwater well samples from the site, including TPH, BTEX, PAH, phenols, VHC, OCP, OPP, PCB and explosives.

In the Auditor's opinion, the groundwater analytical results are consistent with the site history of the greater site and field observations. There is evidence of only minor contamination of groundwater by heavy metals in the vicinity of the small arms range (located within CZSRA). The majority of heavy metals exceedances detected at the site and within the greater site are considered to be representative of background conditions within the shale bedrock. The Auditor is satisfied that groundwater at the RZNRA site and within the greater site is free of levels of contamination that would negatively impact on the proposed development or the surrounding environment.

Appendix F NSW EPA Public Registers Search Results

Search results

Your search for:Suburb: Edmondson Park

Search Again
Refine Search

did not find any records in our database.

If a site does not appear on the record it may still be affected by contamination. For example:

- Contamination may be present but the site has not been regulated by the EPA under the Contaminated Land Management Act 1997 or the Environmentally Hazardous Chemicals Act 1985.
- The EPA may be regulating contamination at the site through a licence or notice under the Protection of the Environment Operations Act 1997 (POEO Act).
- Contamination at the site may be being managed under the planning process.

Search TIP

To search for a specific site, search by LGA (local government area) and carefully review all sites listed.

... more search tips

More information about particular sites may be available from:

- The POEO public register
- The appropriate planning authority: for example, on a planning certificate issued by the local council under section 149 of the Environmental Planning and Assessment Act.

See What's in the record and What's not in the record.

If you want to know whether a specific site has been the subject of notices issued by the EPA under the CLM Act, we suggest that you search by Local Government Area only and carefully review the sites that are listed.
This public record provides information about sites regulated by the EPA under the Contaminated Land Management Act 1997, including sites currently and previously regulated under the Environmentally Hazardous Chemicals Act 1985. Your inquiry using the above search criteria has not matched any record of current or former regulation. You should consider searching again using different criteria. The fact that a site does not appear on the record does not necessarily mean that it is not affected by contamination. The site may have been notified to the EPA but not yet assessed, or contamination may be present but the site is not yet being regulated by the EPA. Further information about particular sites may be available from the appropriate planning authority, for example, on a planning certificate issued by the local council under section 149 of the Environmental Planning and Assessment Act. In addition the EPA may be regulating contamination at the site through a licence under the Protection of the Environment Operations Act 1997. You may wish to search the POEO public register.POEO public register

3 May 2021

Search results

Your search for: **General Search** with the following criteria

Suburb - Edmondson Park

returned 0 result

Search Again

Search results

Your search for: **General Search** with the following criteria

Suburb - Bardia

returned 4 results

Export to excel

1 of 1 Pages

Search Again

Number	Name	Location	Type	Status	Issued date
1560052	THI BICH QUYEN KIM	48 Mount Olympus Street, BARDIA, NSW 2565	s.91 Clean Up Notice	Issued	19 Dec 2017
1561026	THI BICH QUYEN KIM	48 Mount Olympus Street, BARDIA, NSW 2565	s.110 Variation of Clean Up Notice	Issued	18 Jul 2018
1571578	THI BICH QUYEN KIM	48 Mount Olympus Street, BARDIA, NSW 2565	s.110 Variation of Clean Up Notice	Issued	29 Oct 2018
1575794	THI BICH QUYEN KIM	48 Mount Olympus Street, BARDIA, NSW 2565	s.110 Variation of Clean Up Notice	Issued	11 Feb 2019

03 May 2021

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Rev No.	Author	Reviewer	Approved for Issue		
		Name	Name	Signature	Date
A	Michelle Delandro	Seth Molinari	Draft for Client Comment	-	13/05/2021
0	Michelle Delandro	Joanne Rosner	Joanne Rosner		21/05/2021

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Site Audit Report - Residential Zone North of Rail Alignment, Zouch Road, Edmondson Park NSW

Prepared for:
Landcom

Prepared by:
ENVIRON Australia Pty Ltd

Date:
October 2013

Project Number:
AS120163B

Audit Number:
GN263-1

ENVIRON

ENVIRON

8 October 2013

Our Ref: AS120163B

UrbanGrowth NSW
Level 14, 60 Station Street
Parramatta NSW 2150
Attn: David Schofield

Dear David,

Re: Site Audit Report - Residential Zone North of Rail Alignment, Zouch Road, Edmondson Park NSW

I have pleasure in submitting the Site Audit Report for the subject site. The Site Audit Statement, produced in accordance with the NSW Contaminated Land Management Act 1997 follows this letter. The Audit was commissioned by Landcom, now trading as UrbanGrowth NSW, to assess the suitability of the site for its intended use (residential, open space and commercial).

This Site Audit Report is not currently required by regulation or legislation and is therefore a non-statutory audit.

Thank you for giving me the opportunity to conduct this Audit. Please call me on 9954 8100 if you have any questions.

Yours faithfully,
ENVIRON Australia Pty Ltd

Graeme Nyland

Graeme Nyland
EPA Accredited Site Auditor 9808

ENVIRON Australia Pty Ltd, Level 3, 100 Pacific Highway, PO Box 560, North Sydney, NSW 2060, Australia
Tel: +61 2 9954 8100 Fax: +61 2 9954 8150

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www.environcorp.com

NSW Site Auditor Scheme
SITE AUDIT STATEMENT

A site audit statement summarises the findings of a site audit. For full details of the site auditor's findings, evaluations and conclusions, refer to the associated site audit report.

This form was approved under the* Contaminated Land Management Act 1997 *on 31st October 2012. For more information about completing this form, go to Part IV.

PART I: Site audit identification

Site audit statement no. GN 263-1

This site audit is a ~~**statutory audit/**~~**non-statutory audit*** within the meaning of the *Contaminated Land Management Act 1997*.

Site auditor details (as accredited under the *Contaminated Land Management Act 1997*)

Name:	Graeme Nyland	Company:	ENVIRON Australia Pty Ltd
Address:	Level 3, 100 Pacific Highway (PO Box 560)		
	North Sydney NSW	Postcode:	2060
Phone:	02 9954 8100	Fax:	02 9954 8150

Site details

Address: Residential Zone North of Rail Alignment, access off Zouch Road, Edmondson Park, NSW

Postcode: 2174

Property description *(attach a list if several properties are included in the site audit)*

Part Lot 7 and part Lot 8, DP 1127652 (refer attachment at end of Part I of this statement)

Local Government Area: Liverpool City Council

Area of site (e.g. hectares): 43 ha

Current zoning: B4 Mixed Use, RE1 Public Recreation and R1 General Residential

To the best of my knowledge, the site ~~**is/**~~**is not*** the subject of a declaration, order, agreement or notice under the *Contaminated Land Management Act 1997* or the *Environmentally Hazardous Chemicals Act 1985*.

Declaration/Order/Agreement/Proposal/Notice* no(s): N/A

Strike out as appropriate

Site audit commissioned by

Name: Donna Savage Company: UrbanGrowth NSW (trading name of Landcom)

Address: Level 14, 60 Station Street, Parramatta, NSW

Postcode: 2150

Phone: 9841 8680 Fax: 9841 8666

Name and phone number of contact person (if different from above)

David Schofield – 9841 8751

Purpose of site audit

☒ A. To determine land use suitability *(please specify intended use[s])*

...residential, open space and commercial

~~**OR**~~

~~☐ B(i) To determine the nature and extent of contamination, and/or~~

~~☐ B(ii) To determine the appropriateness of an **investigation/remedial action/management plan***, and/or~~

~~☐ B(iii) To determine if the land can be made suitable for a particular use or uses by implementation of a specified **remedial action plan/management plan*** *(please specify intended use[s])*~~

~~……~~

Information sources for site audit

Consultancy(ies) which conducted the site investigation(s) and/or remediation

- Milsearch Pty Ltd (Milsearch)
- Parsons Brinkerhoff Australia Pty Ltd (PB)
- Golder Associates Pty Ltd (Golder)
- BACTEC SE Asia Pty Ltd (BACTEC)
- JBS Environmental Pty Ltd (JBS)
- G-tek Australia Pty Limited (G-tek)
- Pacific Environmental Services Pty Ltd (Pacific Environmental)
- JBS&G (NSW & WA) Pty Ltd (formerly JBS)

Title(s) of report(s) reviewed:

- Report “Stage 1 Preliminary Contamination Investigation. Zouch Road Ingleburn 92 Ha Site”. September 2000 by Milsearch.
- Report “Final Stage 2 Munitions Contamination Investigations. Landcom 92 Ha Site, Zouch Road, Ingleburn (Former Army Infantry Centre). 21 January – 6 April 2002”. Footer date 30 June 2002 (and earlier draft) by Milsearch.
- Report “Stage 2 Munitions Contamination Investigations, Additional Investigations. Landcom 92 Ha Site, Zouch Road, Ingleburn (Former Army Infantry Centre)”, 14-16

Strike out as appropriate

January & 9 February 2003, 30 April-2 May 2003, 21-22 May 2003. Footer date 10 June 2003 by Milsearch.

- Report “SAQP, Detailed Site Assessment, Zouch Road, Ingleburn”. May 2004 (and drafts dated March and April 2004) by PB.
- Report “Final Report, UXO Investigation Ex-Infantry Training Area, Zouch Road, Edmondson Park, NSW”. February 2005 by BACTEC.
- Report “Detailed Contamination Site Investigation, Landcom Project No: 12619, Zouch Road, Edmondson Park, NSW”. August 2005 (and draft dated May 2005) by Golder.
- Report “Remediation Action Plan, Landcom Project No: 12619, Zouch Road, Edmondson Park, NSW”. December 2005 (and draft dated October 2005) by Golder.
- Report “Environmental Management Plan (EMP), Proposed Remediation Works, Regional Park Zone, Part Lot 7 and 8 in DP1127653, Edmondson Park, NSW”, included as Appendix E of RAP. 10 December 2010 (and draft 26 August 2010) by Golder.
- Report “Remediation Action Plan, Landcom Project 12619 – Zouch Road, Edmondson Park, NSW”. 11 February 2011 (and drafts dated 26 August and 10 December 2010) by Golder.
- Report “Final Report, UXO Remediation of the SW Rail Link Alignment, Former Defence Training Area – Ingleburn”. July 2011 by BACTEC.
- Report “Validation Sampling, Analysis and Quality Plan, Landcom Project 12619, Zouch Road, Edmondson Park, NSW”. 3 February 2012 by JBS.
- Letter Report “Environmental & Occupational Health Management Plan for Asbestos Management at Zouch Road Edmondson Park Former Bardia Barracks Redevelopment Site for TRN Group”. February 2012 by Pacific Environmental.
- Letter Report “Stockpile Characterisation Advice, Landcom Project 12619 Zouch Road, Edmondson Park”. 5 April 2012 (and draft dated 23 March 2012) by JBS.
- Letter Report “Pre-remediation Groundwater Monitoring Event Results, Landcom Project 12619 Zouch Road, Edmondson Park”. 13 April 2012 by JBS.
- Letter Report “Explosive Ordnance Clearance Certificate in Respect of UXO Clearance of the Former Defence Training Area, Ingleburn, NSW, SW Rail Link Corridor for John Holland Group”. 17 September 2012 by BACTEC.
- Letter Report “Post-remediation Groundwater Monitoring Event Results, Landcom Project 12619 Zouch Road, Edmondson Park”. 25 February 2013 by JBS.
- Report “Data Quality Indicator Compliance Assessment, Validation Assessment Works, Landcom Project 12619, Zouch Road, Edmondson Park, NSW”. 28 February 2013 by JBS.
- Report “Urban Growth, Public Open Space, Site Environmental Management Plan, Residential Zone North of Rail Alignment, Zouch Road, Edmondson Park, NSW (Rev 0)”. 2 September 2013 (and Rev B dated 28 August 2013) by JBS&G.
- Report “Post Activity Report – Unexploded Ordnance Search and Clearance, Edmondson Park, NSW (Version 1.2)”. 3 September 2013 (and version 1.1 dated 24 January 2013) by G-tek.
- Report “Validation Report – RZNRA, Landcom, Zouch Rd, Edmondson Park, NSW (Rev 0)”. 24 September 2013 (and Rev A dated March 2013) by JBS.

Other information reviewed (including previous site audit reports and statements relating to the site)

N/A

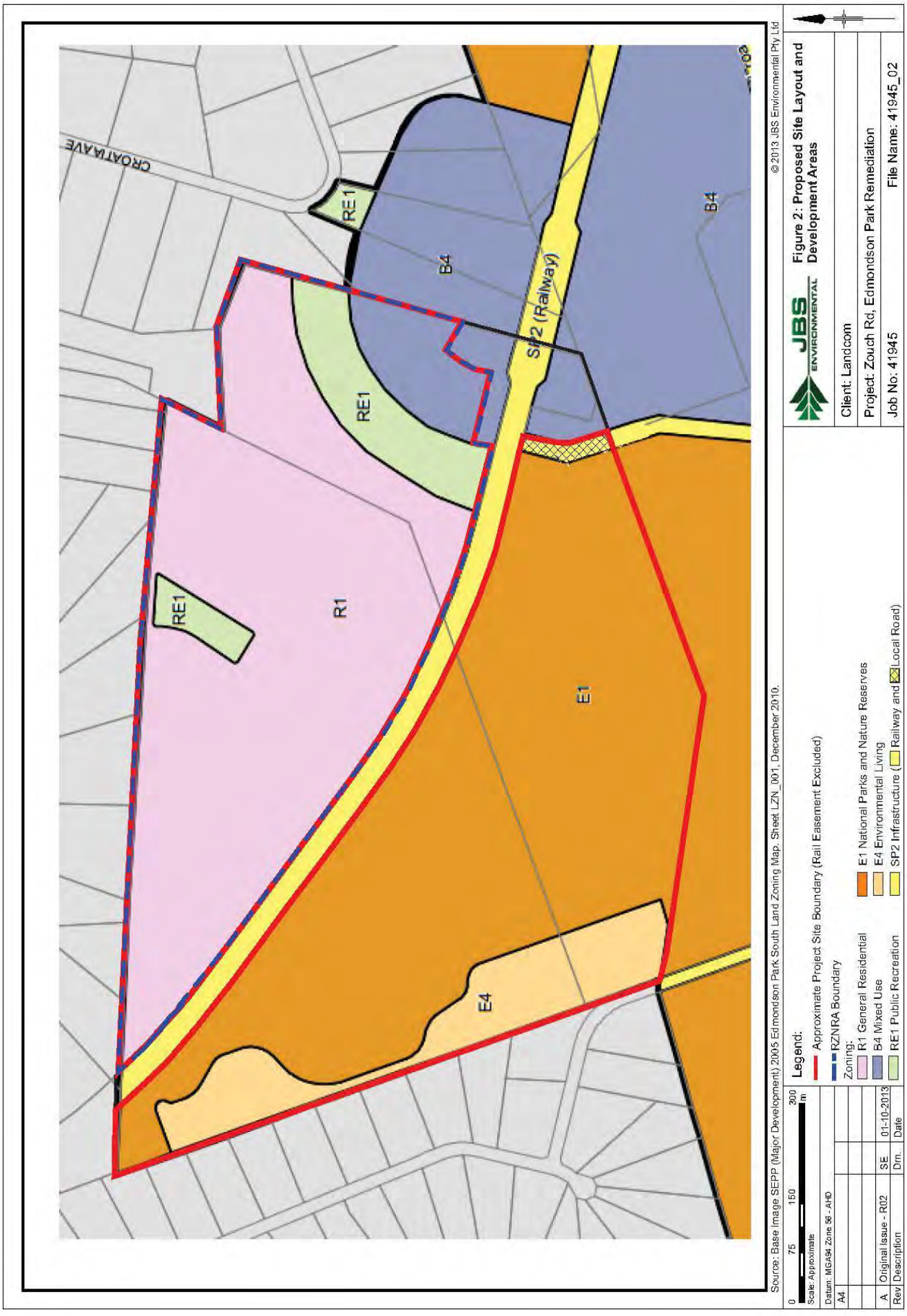
Site audit report

Strike out as appropriate

Title:… Site Audit Report – Residential Zone North of Rail Alignment, Zouch Road, Edmondson Park NSW

Report no. GN 263-1 (ENVIRON Ref: AS120163B) Date: October 2013

Strike out as appropriate



Strike out as appropriate

PART II: Auditor's findings

Please complete either Section A or Section B, **not** both. *(Strike out the irrelevant section.)*

Use Section A where site investigation and/or remediation has been completed and a conclusion can be drawn on the suitability of land use(s).

Use Section B where the audit is to determine the nature and extent of contamination and/or the appropriateness of an investigation or remedial action or management plan and/or whether the site can be made suitable for a specified land use or uses subject to the successful implementation of a remedial action or management plan.

Section A

☒ **I certify that, in my opinion, the site is SUITABLE for the following use(s)** *(tick all appropriate uses and strike out those not applicable)*:

- ~~☐ Residential, including substantial vegetable garden and poultry~~
- ~~☐ Residential, including substantial vegetable garden, excluding poultry~~
- ☒ Residential with accessible soil, including garden (minimal home-grown produce contributing less than 10% fruit and vegetable intake), excluding poultry
- ☒ Day care centre, preschool, primary school
- ☒ Residential with minimal opportunity for soil access, including units
- ☒ Secondary school
- ☒ Park, recreational open space, playing field
- ☒ Commercial/industrial
- ~~☐ Other *(please specify)* ……~~

subject to compliance with the following environmental management plan *(insert title, date and author of plan)* **in light of contamination remaining on the site: …**

"Urban Growth, Public Open Space, Site Environmental Management Plan, Residential Zone North of Rail Alignment, Zouch Road, Edmondson Park, NSW". 2 September 2013, JBS&G (NSW & WA) Pty Ltd

~~**OR**~~

~~☐ **I certify that, in my opinion, the site is NOT SUITABLE for any use due to the risk of harm from contamination.**~~

Overall comments…

The site is a portion of a greater area formerly used by Department of Defence as a training facility. Investigation of the greater site area identified military objects (concertina wire, weapons pits, etc.), waste material on the ground surface and buried in pits and trenches, unexploded ordnance (UXO), exploded ordnance waste (EOW) and small arms ammunition (SAA) from military training exercises, and lead impacted material used to form tracks.

Remediation of the site was undertaken to remove waste material, UXO, EOW and SAA, and lead impacted material. Waste material, UXO, EOW and SAA was generally disposed off-site.

Asbestos containing material, contaminated stockpiled material and lead impacted material were placed in an encapsulation area located within the greater site area.

Vegetation was not removed from proposed open space areas of the site, so clearance for munitions was limited to visual inspection (a metal detector was not used) in these areas. Residual UXO and SAA may therefore remain below the ground surface in open space areas of the site. Open space areas of the site are to be managed with an Environmental Management Plan. The major features of the management plan are:

- Induction and/or training of site workers.
- Public awareness of potential for UXO and SAA.
- Maintenance to minimise the potential for erosion or ground cover disturbance.
- Management measures in the event disturbance of groundcover or the subsurface profile is required.
- Procedures to follow in the event UXO or SAA identified.

Groundwater on the site and in the greater site area was assessed prior to and following remediation. Metals concentrations in groundwater exceeded ecological criteria, however were considered indicative of background conditions associated with Wianamatta Group shales. Groundwater is therefore not considered to present a significant risk to human and ecological receptors.

Due to the scale of the site and limitations of investigative coverage, there is the potential for contamination or aesthetic issues to remain (e.g. unidentified pits, trenches, etc.). The risk is considered to be low due to the investigation and remediation undertaken, however it is recommended as good practice to implement an unexpected finds protocol (UFP) during development.

Section B

Purpose of the plan[1] which is the subject of the audit …

I certify that, in my opinion:

- ❑ **the nature and extent of the contamination HAS/HAS NOT* been appropriately determined**

AND/OR

- ❑ **the investigation/remedial action plan/management plan* IS/IS NOT* appropriate for the purpose stated above**

AND/OR

- ❑ **the site CAN BE MADE SUITABLE for the following uses** *(tick all appropriate uses and strike out those not applicable)*:
  - ❑ Residential, including substantial vegetable garden and poultry
  - ❑ Residential, including substantial vegetable garden, excluding poultry
  - ❑ Residential with accessible soil, including garden (minimal home-grown produce contributing less than 10% fruit and vegetable intake), excluding poultry
  - ❑ Day care centre, preschool, primary school
  - ❑ Residential with minimal opportunity for soil access, including units
  - ❑ Secondary school
  - ❑ Park, recreational open space, playing field
  - ❑ Commercial/industrial
  - ❑ Other *(please specify)* ……

if the site is remediated/managed* in accordance with the following remedial action plan/management plan* *(insert title, date and author of plan)*

…

subject to compliance with the following condition(s):

…

[1] For simplicity, this statement uses the term 'plan' to refer to both plans and reports.

**** Strike out as appropriate***

~~Overall comments~~

PART III: Auditor's declaration

I am accredited as a site auditor by the NSW Environment Protection Authority under the *Contaminated Land Management Act 1997* (Accreditation No. 9808).

I certify that:

- I have completed the site audit free of any conflicts of interest as defined in the *Contaminated Land Management Act 1997,* and
- with due regard to relevant laws and guidelines, I have examined and am familiar with the reports and information referred to in Part I of this site audit, and
- on the basis of inquiries I have made of those individuals immediately responsible for making those reports and obtaining the information referred to in this statement, those reports and that information are, to the best of my knowledge, true, accurate and complete, and
- this statement is, to the best of my knowledge, true, accurate and complete.

I am aware that there are penalties under the *Contaminated Land Management Act 1997* for wilfully making false or misleading statements.

Signed... Date... 8/10/2013

PART IV: Explanatory notes

To be complete, a site audit statement form must be issued with all four parts.

How to complete this form

Part I identifies the auditor, the site, the purpose of the audit and the information used by the auditor in making the site audit findings.

Part II contains the auditor's opinion of the suitability of the site for specified uses or of the appropriateness of an investigation, or remedial action or management plan which may enable a particular use. It sets out succinct and definitive information to assist decision-making about the use(s) of the site or a plan or proposal to manage or remediate the site.

The auditor is to complete either Section A or Section B of Part II, **not** both.

In **Section A** the auditor may conclude that the land is *suitable* for a specified use(s) OR *not suitable* for any beneficial use due to the risk of harm from contamination.

By certifying that the site is *suitable*, an auditor declares that, at the time of completion of the site audit, no further remediation or investigation of the site was needed to render the site fit for the specified use(s). Any **condition** imposed should be limited to implementation of an environmental management plan to help ensure the site remains safe for the specified use(s). The plan should be legally enforceable: for example a requirement of a notice under the *Contaminated Land Management Act 1997* (CLM Act) or a development consent condition issued by a planning authority. There should also be appropriate public notification of the plan, e.g. on a certificate issued under s.149 of the *Environmental Planning and Assessment Act 1979*.

Auditors may also include **comments** which are key observations in light of the audit which are not directly related to the suitability of the site for the use(s). These observations may cover aspects relating to the broader environmental context to aid decision-making in relation to the site.

In **Section B** the auditor draws conclusions on the nature and extent of contamination, and/or suitability of plans relating to the investigation, remediation or management of the land, and/or whether land can be made suitable for a particular land use or uses upon implementation of a remedial action or management plan.

By certifying that a site *can be made suitable* for a use or uses if remediated or managed in accordance with a specified plan, the auditor declares that, at the time the audit was completed, there was sufficient information satisfying guidelines made or approved under the CLM Act to determine that implementation of the plan was feasible and would enable the specified use(s) of the site in the future.

For a site that *can be made suitable*, any **conditions** specified by the auditor in Section B should be limited to minor modifications or additions to the specified plan. However, if the auditor considers that further audits of the site (e.g. to validate remediation) are required, the auditor must note this as a condition in the site audit statement.

Auditors may also include **comments** which are observations in light of the audit which provide a more complete understanding of the environmental context to aid decision-making in relation to the site.

In **Part III** the auditor certifies his/her standing as an accredited auditor under the CLM Act and makes other relevant declarations.

Where to send completed forms

In addition to furnishing a copy of the audit statement to the person(s) who commissioned the site audit, statutory site audit statements must be sent to:

EPA (NSW)
Contaminated Sites Section
PO Box A290, SYDNEY SOUTH NSW 1232
nswauditors@epa.nsw.gov.au

AND

the **local council** for the land which is the subject of the audit.

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List of Abbreviations

ACM	Asbestos Containing Material
AHD	Australian Height Datum
ANZECC	Australian and New Zealand Environment and Conservation Council
AOC	Areas of Concern
BACTEC	BACTEC SE Asia Pty Ltd
BTEX	Benzene, Toluene, Ethylbenzene & Xylenes (Monocyclic Aromatic Hydrocarbons)
CLM Act	NSW Contaminated Land Management Act 1997
COC	Chain of Custody
Council	Liverpool City Council
CT	Certificate of Title
CZSRA	Conservation Zone South of Rail Alignment
DA	Development Application
DP	Deposited Plan
DQI	Data Quality Indicator
DQO	Data Quality Objective
EC	Electrical Conductivity
EIL	Ecological Investigation Limit
EMP	Environmental Management Plan
Envirolab	Envirolab Services Pty Ltd
EOW	Explosive ordnance waste
EPA	Environment Protection Authority (NSW)
EPL	Environmental Protection Licence
ESA	Environmental Site Assessment report
GME	Groundwater Monitoring Event
Golder	Golder Associated Pty Ltd
G-tek	G-tek Australia Pty Ltd
HIL	Health Investigation Level
ha	Hectare
JBS	JBS Environmental Pty Ltd, now JBS&G (NSW & WA) Pty Ltd
km	Kilometres
m	Metres
MAH	Monocyclic Aromatic Hydrocarbons
Mercury	Inorganic mercury unless noted otherwise
Metals	As: Arsenic, Cd: Cadmium, Cr: Chromium, Cu: Copper, Ni: Nickel, Pb: Lead, Zn: Zinc, Hg: Mercury
mg/kg	Milligrams per Kilogram
mg/L	Milligrams per Litre
mbgl	Metres below ground level
Milsearch	Milsearch Pty Ltd
µg/L	Micrograms per Litre
NATA	National Association of Testing Authorities
NC	Not Calculated
ND	Not Detected
NEHF	National Environmental Health Forum
NEPM	National Environment Protection Measure
NHMRC	National Health and Medical Research Council
n	Number of Samples
OCPs	Organochlorine Pesticides
OEH	Office of Environment and Heritage
OH&S	Occupational Health & Safety
OPPs	Organophosphorus Pesticides
Pacific Environmental	Pacific Environmental Services Pty Ltd
PAHs	Polycyclic Aromatic Hydrocarbons
PB	Parsons Brinkerhoff Australia Pty Ltd

PCBs	Polychlorinated Biphenyls
pH	a measure of acidity, hydrogen ion activity
PID	Photoionisation Detector
Pickford & Rhyder	Pickford & Rhyder Consulting Pty Ltd
ppm	Parts Per Million
PQL	Practical Quantitation Limit
QA/QC	Quality Assurance/Quality Control
RAP	Remediation Action Plan
RPD	Relative Percent Difference
RRZW	Rural Residential Zone West
RZNRA	Residential Zone North of Rail Alignment
SAA	Small Arms Ammunition
SAQP	Sampling Analysis and Quality Plan
SAR	Site Audit Report
SAS	Site Audit Statement
SGS	SGS Australia Pty Ltd
SILs	Soil Investigation Levels
SMF	Synthetic Mineral Fibre
SMP	Site Management Plan
SWL	Standing Water Level
TDS	Total Dissolved Solids
TPHs	Total Petroleum Hydrocarbons
TV	Trigger Value
UFP	Unexpected Finds Protocol
UXO	Unexploded Ordnance
VCH	Volatile Chlorinated Hydrocarbons
XRF	X-ray Fluorescence Analyser
-	On tables is "not calculated", "no criteria" or "not applicable"

1 Introduction

A site contamination audit has been conducted in relation to a portion of a site at Zouch Road, Edmondson Park, NSW, formerly occupied by the Department of Defence. The greater site area is known as the Landcom Project 12619 site, referred to herein as "the greater site". The audit relates to the portion known as the Residential Zone North of Rail Alignment ("RZNRA"), shown on Attachment 1, Appendix A.

The audit was commissioned by Landcom (now trading as UrbanGrowth NSW) to assess the suitability of the greater site for its intended use, including residential and conservation. The audit is not currently required by regulation or legislation and is therefore a non-statutory audit. The audit was conducted to provide an independent review by an EPA Accredited Auditor of whether the land is suitable for any specified use or range of uses i.e. a "Site Audit" as defined in Section 4 (1) (b) (iii) of the NSW *Contaminated Land Management Act 1997* (the CLM Act).

1.1 Background to the Audit and Previous Interim Advice

Site assessment and remediation have been conducted in stages, and largely with reference to the greater site area. Initial investigations conducted by Milsearch Pty Ltd (2000 to 2003) focused on the military history of the site and the potential for contamination by munitions. Parsons Brinkerhoff Australia Pty Ltd (2004) then prepared a Sampling, Analysis and Quality Plan (SAQP) for Detailed Site Assessment, which covered munitions issues as well as soil and groundwater contamination issues. Golder Associates Pty Ltd (2005) undertook a Detailed Contamination Site Investigation of the site and prepared a Remediation Action Plan (RAP). The munitions aspects of the 2005 assessment, which included remediation works in some areas, were conducted by BACTEC SE Asia Pty Ltd.

Golder Associates Pty Ltd (2011) prepared a revised RAP for the site based on a revised development plan. A draft Site Management Plan (SMP) was also prepared at this time. Implementation of the RAP was subsequently supervised by JBS Environmental Pty Ltd (2012-2013) and the remediation performed has been documented in a series of validation reports covering the following site areas (refer Attachment 1, Appendix A):

1. Approximately 8.3 hectares (ha) of rural residential zone located along the western boundary of the site, known as Rural Residential Zone West (RRZW).

2. Approximately 43 ha of development primarily north of the rail corridor, including residential use, a school, public open space and mixed use development in a town centre, known as Residential Zone North of Rail Alignment (RZNRA).

3. Approximately 36 ha of conservation zone south of the rail corridor, to be part of the Edmondson Regional Park, known as Conservation Zone South of Rail Alignment (CZSRA).

A single data quality compliance report was prepared by JBS (2013b) covering all three site areas since the remediation and validation tasks were completed as one site. The munitions aspects of the remediation, which included unexploded ordnance (UXO) search and clearance activities, were conducted by G-tek Australia Pty Limited. A small portion of

RZNRA used during construction of the adjacent rail corridor was remediated by BACTEC in May and July 2011 and September 2012 on behalf of Transport for NSW.

The audit commenced in 2003 and was conducted in stages. Advice has previously been provided by the Auditor relating to the greater site area, as follows:

- Stage 1 – Initial Advice, 7 February 2003 (included as Appendix D).
- Interim Advice #2, 8 July 2003 relating mainly to review of munitions investigations (included as Appendix E).
- Various comments on the Sampling Analysis and Quality Plan, 21 April to 19 May 2004.
- Interim Advice #3, 8 September 2005, relating to review of detailed soil and groundwater investigation (included as Appendix F).
- Interim Advice #4, 30 January 2006, relating to review of the original RAP (Golder 2005) (included as Appendix G).
- Interim Advice #5, 24 February 2011, relating to review of the revised RAP (Golder, 2011) and associated issues (included as Appendix H).

The site area divisions and proposed land uses have changed slightly over the course of the audit. Most notably the greater site no longer includes the rail corridor area which was acquired by Transport Construction Authority (now Transport for NSW). This Audit relates to works performed at the RZNRA area.

1.2 Scope of the Audit

Details of the audit are:

Requested by:	Donna Savage on behalf of Landcom
Request/Commencement Date:	24 January 2003
Auditor:	Graeme Nyland
Accreditation No.:	9808

The scope of the audit included:

- Review of the following reports:
  - Report “Stage 1 Preliminary Contamination Investigation. Zouch Road Ingleburn 92 Ha Site”. September 2000, by Milsearch Pty Ltd (Milsearch) for Landcom.
  - Report “Final Stage 2 Munitions Contamination Investigations. Landcom 92 Ha Site, Zouch Road, Ingleburn (Former Army Infantry Centre). 21 January – 6 April 2002”. Footer date 30 June 2002 (and earlier draft) by Milsearch.
  - Report “Stage 2 Munitions Contamination Investigations, Additional Investigations. Landcom 92 Ha Site, Zouch Road, Ingleburn (Former Army

Infantry Centre)", 14-16 January & 9 February 2003, 30 April-2 May 2003, 21-22 May 2003. Footer date 10 June 2003 by Milsearch.

- Report "SAQP, Detailed Site Assessment, Zouch Road, Ingleburn". May 2004 (and drafts dated March and April 2004) by Parsons Brinkerhoff Australia Pty Ltd (PB).
- Report "Detailed Contamination Site Investigation, Landcom Project No: 12619, Zouch Road, Edmondson Park, NSW". August 2005(a) (and draft dated May 2005) by Golder Associated Pty Ltd (Golder). Including the following as an appendix:
    - Report "Final Report, UXO Investigation Ex-Infantry Training Area, Zouch Road, Edmondson Park, NSW". February 2005 by BACTEC SE Asia Pty Ltd (BACTEC).
- Report "Remediation Action Plan, Landcom Project No: 12619, Zouch Road, Edmondson Park, NSW". December 2005(b) (and draft dated October 2005) by Golder.
- Report "Environmental Management Plan (EMP), Proposed Remediation Works, Regional Park Zone, Part Lot 7 and 8 in DP1127653, Edmondson Park, NSW", included as Appendix E of RAP. 10 December 2010 (and draft 26 August 2010) by Golder.
- Report "Remediation Action Plan, Landcom Project 12619 – Zouch Road, Edmondson Park, NSW". 11 February 2011 (and drafts dated 26 August and 10 December 2010) by Golder.
- Report "Final Report, UXO Remediation of the SW Rail Link Alignment, Former Defence Training Area – Ingleburn". July 2011 by BACTEC.
- Report "Validation Sampling, Analysis and Quality Plan, Landcom Project 12619, Zouch Road, Edmondson Park, NSW". 3 February 2012(a) by JBS Environmental Pty Ltd (JBS).
- Letter Report "Explosive Ordnance Clearance Certificate in Respect of UXO Clearance of the Former Defence Training Area, Ingleburn, NSW, SW Rail Link Corridor for John Holland Group". 17 September 2012 by BACTEC.
- Report "Data Quality Indicator Compliance Assessment, Validation Assessment Works, Landcom Project 12619, Zouch Road, Edmondson Park, NSW". 28 February 2013(b) by JBS.
- Report "Post Activity Report – Unexploded Ordnance Search and Clearance, Edmondson Park, NSW (Version 1.1)". 3 September 2013 (and version 1.1 dated 24 January 2013) by G-tek Australia Pty Limited (G-tek).

  - Report “Validation Report – RZNRA, Landcom, Zouch Rd, Edmondson Park, NSW (Rev 0)”. 24 September 2013(c) (and Rev A dated March 2013) by JBS. Including the following as appendices:
    - Letter Report “Environmental & Occupational Health Management Plan for Asbestos Management at Zouch Road Edmondson Park Former Bardia Barracks Redevelopment Site for TRN Group”. February 2012 by Pacific Environmental Services Pty Ltd (Pacific Environmental).
    - Letter Report “Stockpile Characterisation Advice, Landcom Project 12619 Zouch Road, Edmondson Park”. 5 April 2012(b) (and draft dated 23 March 2012) by JBS.
    - Letter Report “Pre-remediation Groundwater Monitoring Event Results, Landcom Project 12619 Zouch Road, Edmondson Park”. 13 April 2012(c) by JBS.
    - Letter Report “Post-remediation Groundwater Monitoring Event Results, Landcom Project 12619 Zouch Road, Edmondson Park”. 25 February 2013(a) by JBS.
  - Report “Urban Growth, Public Open Space, Site Environmental Management Plan, Residential Zone North of Rail Alignment, Zouch Road, Edmondson Park, NSW (Rev 0)”. 2 September 2013(d) (and Rev B dated 28 August 2013) by JBS&G (NSW & WA) Pty Ltd (formerly JBS).

- Site visits by the Auditor or his representative on 31 January 2003, 1 March 2005, 8 April 2010, 15 May, 19 June, 19 July and 8 November 2012 and 27 September 2013.
- Discussions with the client (Landcom) and with consultants (Milsearch, PB, Golder and JBS) who undertook the investigations and remediation.

2 Site Details

2.1 Location

The site locality is shown on Attachment 2, Appendix A.

The site details are as follows:

Street address:	off Zouch Road, Edmondson Park, NSW 2171.
Identifier:	Part Lot 7 and part Lot 8, DP 1127652 (formerly part Lot 1 DP 807460 and part Lot 2 DP 907461) (see Attachment 2, Appendix A).
Local Government:	Liverpool City Council
Owner:	Landcom (NSW Government), now trading as UrbanGrowth NSW
Site Area:	Approximately 43 ha for RZNRA site which is part of the greater Landcom project 12619 site (with total area of 87.3 ha)

A survey plan of the site has not been provided.

2.2 Zoning

JBS (2013c) report that the zoning of the site is B4 Mixed use, RE1 Public Recreation and R1 General Residential.

According to the Stage 1 Milsearch report, the previous site zoning was 5(a) Military.

2.3 Adjacent Uses

The site is located within an area of residential and semi-rural use.

Adjacent site uses are as follows based on information provided in the JBS Validation Report for the RZNRA site:

- North and East – rural residential properties, which generally comprise residences with surrounding landscaped areas, recreational facilities (tennis courts and swimming pools), market gardens and grazing land.
- West and South – A works site associated with the proposed south-west railway line extension. Beyond the rail corridor is the proposed conservation zone of the greater site (12619 Project site), comprising areas of open scrub and tall closed forest.

None of the surrounding land uses outside the greater site boundary were identified as having the potential to cause significant contamination at the site.

2.4 Site Condition

2.4.1 Pre-remediation

The JBS (2013c) validation report for RZNRA noted the following site conditions prior to remediation activities at this site:

- The site was fenced along the eastern and northern boundaries. The southern boundary adjoining the rail corridor was marked with survey pegs and fencing in some areas.
- An unsealed track extended along the northern boundary.
- Moderate vegetative cover was present in the west, east and portions of the centre of the site. A portion of the vegetation in the east of the site is a riparian zone (Maxwell's Creek) protected under the Edmondson Park Precinct Conservation Agreement. The remainder of the site generally comprised grassed open space and scattered trees. A dam was located in the eastern portion of the site, associated with a natural drainage depression.
- Site features related to the former military use of the site included pits, trenches, barbed wire fencing, concertina wire, concrete slabs (former structures/building foundations) and small arms ammunition (SAA) debris. Former grenade ranges and additional areas were identified in the east of the site (REM1 to REM5).
- Waste material was identified in an open trench adjacent to the northern boundary. Waste materials included scrap metal, wire, building waste and general waste. Two stockpiles of soil (SP5 and SP6) were observed near the trench. Waste material was observed at a number of other locations on the site.
- Small stockpiles vegetated with grass at a number of locations on the site.

The site conditions pre-remediation are shown in Attachment 3, Appendix A. Additional information on site conditions at the greater site is included in Appendix F.

2.4.2 Post-remediation

JBS (2013c) noted the following site conditions upon completion of the remediation activities at this site:

- Trees were removed from the site, with the exception of proposed open space areas in the east and centre north of the site.
- The previously identified stockpiled waste materials, remnant lead particulate, SAA/UXO, and other items associated with historical army use have been removed.
- Stockpiled soil identified as suitable for reuse on the site was either backfilled into excavations or spread over the surrounding ground surface.

The Auditor's observations on 27 September 2013 were consistent with those reported by JBS.

2.5 Proposed Development

According to the RAP (Golder, 2011) for the greater site, key features of the proposed development include:

- Approximately 6.4 ha of rail corridor crossing the site from the south-east corner to north-west corner.
- Approximately 37.4 ha of conservation zone south of the rail corridor, to be part of the Edmondson Regional Park.

- Approximately 43 ha of development (the site) primarily north of the rail corridor, including residential use, a school, public open space and mixed use development in a town centre. The public open space in the east of the site is a riparian zone (Maxwell's Creek) protected under the Edmondson Park Precinct Conservation Agreement.
- Approximately 6.7 ha of rural residential zone located along the western boundary.

The proposed site layout is shown in Attachment 1, Appendix A.

For the purposes of this audit, the 'residential with gardens and accessible soil' land use scenario has been assumed as the most sensitive proposed land use.

3 Site History

Milsearch (2000) provided a site history of the greater site based on aerial photographs, site inspection, interviews with serving and former soldiers who trained at Ingleburn camp, literature searches and Defence 1996 Unexploded Ordnance Assessments for Ingleburn Military Camp. Golder (2005a) also undertook additional site history investigations comprising review of historical aerial photographs, historical title information and Section 149 Certificates from Liverpool City Council.

The Auditor has summarised the site history of the greater site, of which the RZNRA site comprises the north eastern portion, provided by Milsearch and Golder in Table 3.1.

Table 3.1: Site History

Date	Activity
1819	Original land grant, private ownership, farming usage likely.
1939	Defence hired 'vacant land' near Ingleburn Camp as a 'manoeuvre area'. Usage by Defence continued through the WW2 period.
1953	Purchased by Commonwealth of Australia. Land within the wider Ingleburn area was acquired by the Army and used to establish camps and to conduct training for wartime expansion. Site was used primarily for infantry training purposes. First features developed at the site were a small arms firing range, golf course, grenade throwing bay and impact zone and cricket pitch. The grenade range was located in the centre of the site (on RZNRA site) and was used for live grenade throwing practices and possibly also mortar practice bombs for up to 30 years. The firing range, located in the south west of the site (on CZSRA), was also used for up to 30 years.
Between 1956 and 1961	Golf course is disused. Dams 1 to 3 are present. The dams may have been used for disposal of unwanted munitions.
Between 1970 and 1978	Small arms firing range has been reconfigured to fire in the opposite direction. The original stop butt material, which contained lead particulate, was spread about the range and built into roads at the site in the 1970s. Vegetation cover at the site is increasing from this time.
Between 1978 and 1986	Three disposal trenches have been excavated, located in high ground to the north east of the firing range (on CZSRA). The pits were reportedly filled by the former disposal practices of the 'Boards of Survey' of 'burn, bash and bury'. This area would contain general stores materials which were damaged or surplus to requirements.
1989	Purchased by NSW Land and Housing Corporation (Landcom). Usage by Defence ceased.

Table 3.1: Site History	
Date	**Activity**
Between 2005 and 2009	Various site investigations undertaken.
2012	Remediation activities.

In the Auditor's opinion, the site history review has adequately identified the major potential contamination issues on the RZNRA site, which include UXO/SAA and waste in stockpiles and buried in pits or trenches. Some uncertainty remains with respect to the potential for:

- Additional waste disposal trenches.
- Additional areas of lead particulate.
- The location of slit trenches that may have been backfilled.
- Unexpended (live) blank SAA possibly disposed during tactical training exercises.

In the Auditor's opinion, the site history provides an adequate indication of past activities. The Auditor is satisfied that the past uses that have significant potential to contaminate the site have been identified.

4 Contaminants Of Concern

Milsearch (2000) provided a list of the contaminants of concern and potentially contaminating activities for the greater site. The Auditor has summarised these in Table 4.1, with additional information from the reviewed reports, site history and site condition.

Table 4.1: Contaminants of Concern

Area	Activity	Potential Contaminants
Grenade range (RZNRA)	Live grenade throwing practices and possibly also mortar practice bombs	UXO and grenade explosion residues
Firing range stop butts (CZSRA) Roadways where reengineered stop butt material was placed (RZNRA, CZSRA, RRZW) Dam 3 (runoff)	Small arms firing range	Lead particulate and other heavy metals
Dams 1, 2 and 3	Possible munitions disposal	UXO
3 burial trenches, NE of small arms firing range (CZSRA) Possible additional unknown locations	Waste disposal in trenches	Unknown, could include heavy metals, petroleum hydrocarbons, pesticides, asbestos, household chemicals
Extreme north west corner of the site (RRZW and CZSRA) 100 m north east of the entrance gate South of small arms firing range 5 piles north of small arms firing range 2 piles on crest of hill north of small arms firing range Potential locations across entire site	Waste disposal in piles, including building rubble	Unknown, could include heavy metals, petroleum hydrocarbons, pesticides, asbestos, household chemicals
Known slit trench locations Underground command posts Possible additional unknown locations	In-ground structures used for infantry minor tactical training	Physical objects such as star pickets and corrugated iron Unknown, possibly heavy metals (significant contamination would not be expected with this type of material, removal would be desirable for aesthetic purposes)
Entire site, especially near slit trenches	Infantry minor tactical training	Expended SAA, small percentage live (unexpended) SAA
Entire site	Pest and weed control	Pesticides, herbicides, arsenic, mercury
All waterways on site	Runoff of contaminants	Lead particulate primarily Pesticides, herbicides, arsenic,

Table 4.1: Contaminants of Concern		
Area	**Activity**	**Potential Contaminants**
		mercury
Former building (RZNRA)	Building products and treatments	Pesticides, asbestos, lead
Coal stockpile (CZSRA)	Storage and distribution of coal	Coal dust Possibly polycyclic aromatic hydrocarbons (PAH), phenols
Numerous locations	Practice obstacles	Barbed wire physical hazard
Numerous locations	Car body disposal and burning	PAH, heavy metals, petroleum hydrocarbons
Numerous locations	Car body disposal, surface dumping and practice obstacles	Physical objects including cars and barbed wire Unknown, possibly PAH, heavy metals, petroleum hydrocarbons (significant contamination would not be expected with these types of surface dumpings, removal would be desirable for aesthetic purposes)

This table (prepared by the Auditor) was adopted by PB for the SAQP and was subsequently also adopted by Golder as the basis for their investigation.

An additional issue identified by Golder during their investigations was an asbestos impact area that overlaps the small arms range, where fragmented pieces of bonded asbestos sheeting were scattered across the ground surface (not on RZNRA).

According to Milsearch, while live blank SAA ammunition constitutes a lesser hazard than live ball ammunition, blanks can still cause significant injury, particularly eye damage, if detonated through tampering.

Although the waste types likely to be encountered in the burial trenches or surface dumpings are likely to vary, the classes of contaminants of concern likely to be associated with waste disposal are well known, and are listed in Table 4.1, above.

The Auditor considers that the analyte list used by JBS adequately reflects the site history and condition.

5 Stratigraphy and Hydrogeology

In 2005 Golder investigated the subsurface conditions of the greater site by the following:

- 628 test pits to between 0.3 and 4.3 m below ground level (bgl) (generally less than 1 mbgl)
- 112 hand auger locations to between 0.5 and 1 mbgl
- 10 drilled boreholes to between 8 and 16.3 mbgl
- 13 test pits into stockpiled material to between 0.6 and 1.8 mbgl

The Auditor has compiled the following summary of the site stratigraphy and hydrogeology following review of the Golder (2005a) and recent JBS (2013c) report.

5.1 Stratigraphy

The regional geology comprises Bringelly Shale of the Wianamatta Group which comprises shale, carbonaceous claystone, claystone, laminate, fine to medium grained lithic sandstone, rare coal and tuff.

The sub-surface profile of the greater site is summarised in Table 5.1.

Table 5.1: Stratigraphy

Depth (mbgl)	Subsurface Profile
To between 0.05 and 0.5	Topsoil: clayey silt/ silt, brown, dry to moist, trace fine gravel.
To between 0.1 and 3.4	Fill: general fill is silty/ gravelly clay, low to medium plasticity, brown, red and grey. Occurs in general stockpiles, small arms range, disposal trenches and northwest disposal area. **Small arms range** – silty clay, red grey, fine to medium ironstone gravels, pieces of lead particulate (within CZSRA site). **Disposal trenches** – trench contents comprised: bonded asbestos sheeting, building waste (bricks, pipes, concrete blocks, guttering, downpipes), household waste (fridges, water heaters, metal cabinets) and foul water in the pits. Pits terminated in clay (within CZSRA site). **Northwest disposal area** – silty/ gravelly clay, concrete blocks, bricks, timber, general building waste (within RRZW and CZSRA site).
Between topsoil/ fill and bedrock	Residual: silty clay, medium to high plasticity, moist, some fine to medium ironstone gravels.
From between 0.2 and 3.2	Bedrock: shale, weathered, grey brown. A weathered, sandy shale outcrop was observed in the south west corner of the greater site.

mbgl – metres below ground level

5.2 Hydrogeology

Limited groundwater investigations have been undertaken at the greater site. Ten deep boreholes were drilled and wells were installed in the seven locations that encountered groundwater during site investigations by Golder (2005a). Three monitoring wells are located on the RZNRA site. Groundwater was present at between 2.5 and 14.6 mbgl, generally occurring within the shale. The equivalent reduced levels for groundwater at the greater site were 46.2 to 54.8 mAHD.

Pre-remediation sampling of the two existing monitoring wells on the RZNRA site (BH2 and BH291) by JBS in February 2012 recorded groundwater present at depths of 2.6 to 3.9 mbgl (46.7 to 50.4 mAHD).

Golder expected perched groundwater to occur within alluvial deposits near main drainage lines and dams, flowing in the direction of the ground slope. The regional groundwater flow direction was inferred as likely to flow in an east to north-easterly direction towards the Georges River.

The measured groundwater levels indicate that true groundwater flows in two directions: away from the ridgeline in the centre of the site to the northwest; and southeast directions. The inferred groundwater contours are shown in ENVIRON's Interim Advice #3 as Attachment 3 (Appendix F).

The nearest registered bores in the area (search date 2005) were located approximately 1.5 km from the greater site.

5.3 Auditor's Opinion

The Auditor considers the site investigations undertaken across the greater site provide an acceptable description of the geology and hydrogeology of the greater site.

6 Evaluation of Quality Assurance and Quality Control

6.1 Munitions

Data Quality Objectives in relation to the remediation and validation of munitions contamination, including UXO, were not specifically addressed by G-tek (2013) and BACTEC (2011 and 2012). The Auditor has assessed QA/QC by considering the adequacy of the validation undertaken and the qualifications of personnel involved. The remediation undertaken is discussed in Section 9 and was found to be reliable for the purposes of the audit.

Quality control and calibration requirements for UXO remediation works were specified by G-tek in their report. Key elements of QA/QC were as follows:

- Searches comprised both a visual search and metal detector search in residential areas of the site. Open space areas were remediated by visual search only.
- A repeat search of a representative 10% area of each 1 ha (100x100 m) search cell.
- The detection equipment was calibrated daily and passed on all occasions.

Quality control and calibration requirements for UXO remediation works were specified by BACTEC (2011). Searches comprised both a visual search and metal detector search. The detection equipment was calibrated daily. Field records were not provided, however BACTEC report that calibration passed on all occasions.

Assessment of QA/QC for previous remediation performed by BACTEC (2005) was undertaken in Interim Advice #3 (Appendix F).

6.2 Soil and Groundwater

The Auditor has assessed the overall quality of the remediation and validation data by review of the information presented in the referenced reports, supplemented by field observations. Validation sampling was generally undertaken in accordance with the RAP. The Auditor's assessment follows in Tables 6.1 and 6.2.

Assessment of QA/QC data from previous investigations of the site was undertaken in Interim Advice #3 (Appendix F).

Table 6.1: QA/QC – Sampling and Analysis Methodology Assessment

Sampling and Analysis Plan and Sampling Methodology	Auditor's Opinion
Data Quality Objectives (DQO) JBS defined specific DQOs in accordance with the seven step process outlined in DEC (2006).	These were considered appropriate for the remediation conducted.
Sampling pattern and locations *Soil:* Validation locations were targeted to identified areas of concern, including: stockpiles; stockpile footprints; lead particulate excavation; and asbestos. *Groundwater:* Monitoring wells were installed by Golder (2005a) during previous investigation of the site. The wells	The soil validation locations adequately target the areas of concern and unexpected finds. Groundwater monitoring well locations provide an adequate coverage of the greater site.

Table 6.1: QA/QC – Sampling and Analysis Methodology Assessment	
Sampling and Analysis Plan and Sampling Methodology	**Auditor's Opinion**
were placed in judgemental locations to give coverage of the greater site. Three wells were located on RZNRA (BH2, BH249 and BH291).	
Sampling density *Soil:* Stockpile characterisation samples were collected at a density of one per 2-70m^3, depending on stockpile volume. One sample was collected from the footprint of stockpile SP6. The surface area of the footprint was not provided. Validation samples from the northern access track were collected on an approximate 10 m grid. Three samples were collected from the footprint of unexpected find UF04 (150 m^2). *Groundwater*: A total of 10 groundwater wells were installed at the greater site, however, three of these wells were dry upon completion and could not be sampled. Three other wells were extended deeper, in consultation with the Auditor, to ensure groundwater was encountered in key locations.	The sampling density was adequate to validate remediation of the site. The Auditor is satisfied with the adopted groundwater investigation density and analytical program.
Sample depths Samples from stockpiles were collected from 0.2 m below the stockpile surface. Soil samples from stockpile footprints and the lead particulate excavation were collected from the surface of the exposed face to a depth of approximately 0.05 m.	This sampling strategy was appropriate and adequate.
Well construction A total of ten groundwater wells were installed at the greater site, seven to 8 mbgl and three to around 15 mbgl. Three of the shallow wells were dry upon completion. Remaining wells contained sufficient water to sample. For all of these wells, the top of water table occurs within the screened interval. Wells were constructed of Class 18 50 mm uPVC pipe. A 1.5 mm graded sand filter pack was used with a bentonite seal of at least 1 m.	The well construction was acceptable.
Sample collection method *Soil*: Samples were collected from stockpiles by shovel, hand trowel, hand auger or excavator bucket. Samples from stockpile footprints and lead particulate excavation were collected by hand trowel or excavator bucket. *Groundwater*: Wells were purged and sampled using low flow Micropurge pump system. Wells purged dry were sampled using disposable bailers.	The sample collection method was found to be acceptable given the key contaminants at the site are not volatile organics.
Decontamination procedures *Soil:* Sampling equipment (trowel, shovel and hand auger) was scrubbed with a wire brush, cleaned with a solution of Decon 90 detergent and rinsed with water.	Considered acceptable

Table 6.1: QA/QC – Sampling and Analysis Methodology Assessment	
Sampling and Analysis Plan and Sampling Methodology	**Auditor's Opinion**
Decontamination of the excavator bucket was not specified, however samples were collected from the centre of the bucket ensuring that no part of the sample had contacted the sides of the bucket. *Groundwater*: The pump head, flow cell and interface probe were decontaminated following sampling at each location with a Decon 90 detergent solution and a water rinse.	
Sample handling and containers Soil samples were placed in glass jars with Teflon lined lids provided by the laboratory. Samples for asbestos analyses were placed in plastic bags. Groundwater samples were placed into prepared and preserved sampling bottles provided by the laboratory. Soil and groundwater samples were chilled during storage and subsequent transport to the labs. Groundwater samples to be analysed for heavy metals were field filtered.	Considered acceptable
Chain of Custody (COC) Completed chain of custody forms were provided in the validation report.	Considered acceptable
Detailed description of field screening protocols Soil samples from the lead particulate excavation were field screened for lead using a hand held X-ray fluorescence analyser (XRF). A detailed description of the procedure was not provided. Groundwater field parameters were measured during well purging using a flow cell. Field screening for volatiles using a PID was not proposed in the RAP and was not undertaken during remediation and validation of the site.	Considered acceptable. Volatile organics are not key contaminants of concern. The absence of PID field screening is therefore acceptable. XRF data was used to screen samples selected for laboratory analyses. The laboratory analytical results were less than the adopted criteria and the area is considered to be adequately remediated and validated.
Calibration of field equipment Calibration records for the XRF were provided. Groundwater meters were reported to have been calibrated prior to the start of each day. Field sheets were provided, however there were some issues with the documentation. Pre-remediation calibration appears to have only been completed for pH (7) and oxygen. A post-remediation calibration record is provided, however readings were not supplied.	Groundwater meter calibration records were incomplete. The data is considered acceptable given that the field parameters were consistent between the monitoring rounds.
Sampling logs XRF field screening records were provided for the validation of the lead particulate excavation, indicating sample location, depth, lithology, lead particulate observations and lead	Considered acceptable

Table 6.1: QA/QC – Sampling and Analysis Methodology Assessment	
Sampling and Analysis Plan and Sampling Methodology	**Auditor's Opinion**
concentrations. Field records were provided for the validation of the footprint of SP6 and UF04, indicating depth, sample locations, soil description and observations. Field records for stockpile characterisation samples included depth, sample locations, soil description and observations. Groundwater field sampling records were provided.	

Table 6.2: QA/QC – Field and Lab Quality Assurance and Quality Control	
Field and Lab QA/QC	**Auditor's Opinion**
Field quality control samples Field quality control samples collected during validation sampling and groundwater monitoring included trip blanks, trip spikes, rinsate blanks, intra-laboratory duplicates and inter-laboratory duplicates.	Considered acceptable
Field quality control results *Soil validation* The results from field quality control samples were within appropriate limits. *Groundwater monitoring* A low zinc concentration (0.003 mg/L) was detected in a rinsate blank collected from the decontaminated pump head during pre-remediation groundwater monitoring. Elevated RPDs were reported for zinc and nickel concentrations in intra-laboratory and inter-laboratory duplicates during pre-remediation groundwater monitoring. The highest concentrations in each instance were in the primary sample. Results from remaining field quality control samples were within appropriate limits.	Considered acceptable
NATA registered laboratory and NATA endorsed methods The primary laboratory utilised for the project was Envirolab Service Pty Ltd (Envirolab). The Envirolab certificates were NATA stamped. The secondary laboratory utilised for inter-laboratory duplicates analyses was SGS Australia Pty Ltd (SGS). The SGS certificates were NATA stamped. Inter-laboratory duplicate analyses for asbestos was undertaken by Pickford & Rhyder Consulting Pty Ltd (Pickford & Rhyder). The Pickford & Rhyder certificates were NATA stamped.	Considered acceptable

Table 6.2: QA/QC – Field and Lab Quality Assurance and Quality Control	
Field and Lab QA/QC	**Auditor's Opinion**
Analytical methods Analytical methods were included in the laboratory test certificates. Envirolab and SGS provided brief method summaries of in-house NATA accredited methods used. Asbestos identification was conducted by Envirolab and Pickford & Rhyder using stereomicroscopy and polarised light microscopy with dispersion staining by method AS4964-2004 "Method for the Qualitative Identification of Asbestos Bulk Samples".	Considered acceptable The analytical methods are considered acceptable for the purposes of the site audit, noting that the AS4964-2004 is currently the only available method in Australia for analysing asbestos. DOH (2009) and enHealth (2005) state that "*until an alternative analytical technique is developed and validated the AS4964-2004 is recommended for use*".
Holding times Review of the COCs and laboratory certificates indicate that the holding times had been met.	Considered acceptable
Practical Quantitation Limits (PQLs) PQLs were less than the threshold criteria for the contaminants of concern in soil. The asbestos limit of detection for asbestos in soil was 0.1 g/kg. Not all PQLs for the groundwater assessment were sufficiently low, with the PQL for cadmium (0.1 µg/L) above the trigger value (0.06 µg/L).	*Soil (except asbestos):* Overall the soil PQLs are acceptable. *Asbestos*: In the absence of any other validated analytical method, the detection limit for asbestos is considered acceptable. A positive result would be considered to exceed the "no asbestos detected in soil" criteria, providing this is applied within a weight of evidence approach to assess the significance of the exceedance, accounting for the history of the site and frequency of the occurrence. *Groundwater*: The PQL was only marginally elevated above the trigger values and in the context of the results reported the discrepancy does not materially affect the outcome of the audit.
Laboratory quality control samples Laboratory quality control samples including laboratory control samples, matrix spikes, surrogate spikes, blanks, internal standards and duplicates were undertaken by the laboratories. No quality control samples were analysed by Pickford & Rhyder or Envirolab for asbestos analyses. Samples were analysed in accordance with Australian Standard 4964-2004. The standard requires trace analysis by polarised light microscopy to be undertaken on duplicates of each sample.	Considered acceptable
Laboratory quality control results The results from laboratory quality control samples were	Considered acceptable

Table 6.2: QA/QC – Field and Lab Quality Assurance and Quality Control	
Field and Lab QA/QC	**Auditor's Opinion**
within appropriate limits.	
Data Quality Indicators (DQI) and Data Evaluation (completeness, comparability, representativeness, precision, accuracy) JBS (2013c) concluded that "*…the results of the field and laboratory QA/QC program indicate the collected data meets the DQI project requirements and as such the validation data is considered reliable for the purposes of making decisions with respect to the suitability of the land for proposed residential uses*".	An assessment of the data quality with respect to the five category areas has been undertaken by the Auditor and is summarised below.

In considering the data as a whole the Auditor concludes that:

- The data is likely to be representative of the conditions in remediated areas.
- The data is adequately complete.
- There is a high degree of confidence that data is comparable for each sampling and analytical event.
- The primary and secondary laboratories provided sufficient information to conclude that data is of sufficient precision.
- The data is likely to be accurate.

7 Environmental Quality Criteria

The investigations and validation were completed prior to the recent revision of the National Environment Protection Council (NEPC), National Environmental Protection (Assessment of Site Contamination) Measure (NEPM) (1999, Amended 2013), therefore this document was not referenced for the audit.

7.1 Munitions

There are currently no EPA endorsed environmental quality criteria for UXO or SAA (live or blank). A detailed discussion of munitions criteria adopted for the site was provided in Interim Advice #3 (Appendix F). In general, a zero tolerance threshold has been adopted for grenade and mortar impact areas and blank SAA in proposed residential areas, practically achieved through implementation of 100% search and remediation coverage. A lower tolerance threshold was adopted in the proposed open space area (Attachment 1, Appendix A), with the exception of grenade and mortar impact areas that intersected these portions.

7.2 Soil

The Auditor has assessed the soil data provided by JBS in reference to Soil Investigation Levels for Urban Redevelopment Sites in NSW (SIL) in DEC (2006) *Guidelines for the NSW Site Auditor Scheme (2nd edition)*:

- SIL Column 1 – 'residential with gardens and accessible soil';
- SIL Column 3 – 'parks, recreational open space'; and
- SIL Column 5 – 'provisional phytotoxicity-based investigation levels'.

EPA (1994) *Guidelines for Assessing Service Station Sites* have also been referred to for assessing total petroleum hydrocarbons (TPH) and benzene, toluene, ethylbenzene and xylene (BTEX) results. These guidelines relate to sensitive land uses and are therefore appropriate for the site.

The Auditor has considered the need for remediation based on the 'aesthetic' contamination as outlined in the NEPM (1999) Schedule B(1) *Guideline on the Investigation Levels for Soil and Groundwater* that states that "*there are no numeric Aesthetic Guidelines but the fundamental principle is that the soils should not be discoloured, malodorous (including when dug over or wet) nor of abnormal consistency. The natural state of the soil should be considered"*.

There are no national or EPA approved guidelines for asbestos in soil relating to human health. DEC (2006) state that Auditors must exercise their professional judgement when assessing whether a site is suitable for a specific use. The DEC (now EPA) states that the position of the Health Department is that there should be no asbestos in surface soil.

JBS proposed to use the PQL as a screening value where no criteria was available (e.g. asbestos), above which results would be considered in greater detail.

7.3 Groundwater

The Auditor has assessed the groundwater data in reference to ANZECC (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* for fresh waters. Trigger

values (TVs) provided are concentrations that, if exceeded, indicate a potential environmental problem and 'trigger' further investigation. The freshwater 95% level of protection have been adopted for the current review. Some have been modified based on bioaccumulation or acute-toxicity or potential toxicity to particular species.

There are no reliable Australian criteria for TPH in groundwater. The current NSW EPA position is that there should be no free phase product in groundwater, and that the aromatic components of dissolved-phase TPH in groundwater should be assessed using the ANZECC (2000) TVs where available. These guidelines include criteria for some BTEX compounds and for some PAHs.

8 Evaluation of Investigation Results

8.1 Evaluation of Munitions Investigation Results

8.1.1 Grenade and Mortar Impacts

During previous investigation stages at the site, no live UXO was found. Consistent with the known site history, the items found were practice/ inert infantry weapons. The Auditor considers the likelihood for live UXO to be present on site to be very low. While these practice items do not present an explosive hazard, their discovery on site would be alarming to any future workers or occupants at the site.

During the munitions investigations, significant grenade or mortar impacts were located outside the initial "expected" zones of impact, which were primarily the main grenade range and also the dams. Consideration must therefore be given to the adequacy of overall site investigative coverage to identify these "unexpected impacts". The unexpected impacts were primarily identified during the Stage 2A validation exercises which focused on cells of high metallic density as determined by digital metal detector. Following completion of those works, Milsearch found that (2003, page 16) "*it cannot be stated with certainty that all areas of indicated higher metallic density have been checked"* and recommended additional work in the form of remedial searches in order to provide confidence that *"the vast majority of potential UXO hazard has been addressed on the site*".

Further investigations undertaken at the site in 2005 included clearance of 763 locations and pathways between. During this process, only two "unexpected impacts" were found by BACTEC, indicating that their occurrence is becoming less common, providing a greater assurance of having identified "unexpected impacts".

However, the ongoing identification of "unexpected impacts", the scale of the site and the various limitations on the investigations undertaken to date (i.e. areas excluded from all stages of investigation included: areas of protected vegetation, areas of blackberry infestations, and areas where geophysics found metallic anomalies) indicate that the possibility of further "unexpected impacts" being present on site is likely. Further remediation works were therefore required and proposed by Golder. Subsequent remediation undertaken by G-tek and BACTEC is discussed in SAR Section 9.

8.1.2 SAA

The average SAA densities estimated for the site were approximately 700/ha in high intensity usage training areas and approximately 250/ha in remaining areas of the site. The proportional occurrence of live blank SAA was estimated at between 2 and 10%.

According to Milsearch, while live blank SAA constitutes a lesser hazard than live ball ammunition, blanks can still cause significant injury, particularly eye damage, if detonated through tampering. Brass blank ammunition is understood to be particularly dangerous. While presenting no explosive hazard, the discovery of expended blank SAA could be alarming to site workers or occupants.

Golder (2005a) reported that similar projects have typically had a zero tolerance threshold

criteria for SAA within residential developments. The Auditor has previously commented that a threshold concentration of 250 SAA/ha is not considered appropriate.

Further remediation works were evidently required with respect to SAA and proposed by Golder. Subsequent remediation undertaken by G-tek and BACTEC is discussed in SAR Section 9.

8.2 Evaluation of Soil Analytical Results

Approximately 479 soil investigation locations were undertaken by Golder (2005a) in RZNRA, including test pits, hand auger holes and drilled boreholes. Locations were spaced on a grid (32 m), with additional targeted locations for features such as drainage lines, stockpiles and areas of contaminant observations. Soil sampling locations are shown on Attachment 4, Appendix A.

The boundaries of the RZNRA have changed slightly since the time of the investigations, with loss of land along the southern boundary due to excision of the rail corridor. The following evaluation is based on the previous site areas and therefore includes some data that is no longer relevant.

The results of the investigations in RZNRA are summarised in Table 8.1. The results have been assessed against the proposed land use criteria (Section 7). Soil analytical results for the remaining areas of the greater site (CZSRA and RRZW) are provided in Interim Advice #3, included as Appendix F.

Table 8.1: Summary of Soil Analytical Results (mg/kg)

Analyte	n	Detections	Maximum	n > EPA (1994)	n > SIL Column 1 (DEC 2006)	n > SIL Column 5 (DEC 2006)
pH	6	Min-5.1	6.2	-	-	-
Arsenic	641	563	28	-	0	1
Cadmium	641	0	<0.5	-	0	0
Total Chromium	641	641	42	-	0	641 [1]
Chromium VI	6	0	<1	-	0	0
Copper	641	640	55	-	0	0
Lead	641	641	210	0	0	0
Mercury (inorganic)	641	74	0.14	-	0	0
Nickel	641	641	40	-	0	0
Zinc	641	641	810	-	0	3
TPH (C_6-C_9)	105	0	<20	0	-	-
TPH (C_{10}-C_{36})	105	2	800	0	-	-
BTEX	105	0	<0.5	0	-	-
Phenols	6	0	<0.5	-	0	-
VCH	5	0	<0.5	-	-	-

Table 8.1: Summary of Soil Analytical Results (mg/kg)

Analyte	n	Detections	Maximum	n > EPA (1994)	n > SIL Column 1 (DEC 2006)	n > SIL Column 5 (DEC 2006)
Total PAHs	105	1	0.1	-	0	-
Benzo(a)pyrene	105	0	<0.1	-	0	-
OCP/ OPP	83	0	<0.1	-	0	-
PCBs	83	0	<0.1	-	0	-
Explosives	101	0	<1	-	-	-
Asbestos	125	1	-	-	-	-

n number of samples
- No criteria available/used
1 Chromium VI criterion used
VCH Volatile Chlorinated Hydrocarbons
OCP Organophosphorous Pesticides
PCB Polychlorinated Biphenyls

No samples from the RZNRA exceeded human health guidelines (SIL Column 1).

A limited number of metals detections exceeded the phytotoxicity guidelines (SIL Column 5), as follows:

- Arsenic was detected in one sample (BH249/3, 0.6-1.05 m) at 28 mg/kg compared to the guideline of 20 mg/kg. This was a sample of deeper natural material from a borehole in the centre of the area.
- Zinc was detected in three samples exceeding the guideline of 200 mg/kg with concentrations of 470, 720 and 810 mg/kg. These samples were of natural soil from the surface or near surface from locations near a building footing (HA140/1) and in the grenade range (TP469/1 and TP471/2).

The above detections are unlikely to affect vegetation growth at the site due to their very infrequent occurrence.

- All 641 samples analysed for total chromium exceeded the guideline of 1 mg/kg for Chromium VI. However, these results were well below the Chromium III guideline of 400 mg/kg, with a maximum of 42 mg/kg. Chromium VI analyses was performed on six samples containing relatively high total chromium concentrations and chromium VI was not detected. Further, there is nothing in the site history to indicate the chromium VI form would be present, therefore these detections are not considered to represent a risk to vegetation at the site.

One PAH compound was detected in one sample at a concentration equivalent to the detection limit and well below the human health guidelines (SIL Column 1) of 20 mg/kg.

Heavy end TPH in the C_{15} to C_{36} range was detected in two samples at 260 and 800 mg/kg, compared to the EPA guideline of 1,000 mg/kg. Both samples were of surface soil and had

no other contaminant detections. One was from a borehole near the track in the north west (BH2/1) and the other from the central east of the zone (TP285/1). The source of these detections is not known, but may be due to road runoff of vehicle contaminants in the case of BH2.

The above minor organic detections do not present a risk to human health or indicate the presence of widespread contamination.

No other organic compounds were detected, including TPH C_6-C_9, BTEX, phenols, VCH, OCP, OPP, PCB and explosives.

There was one detection of chrysotile asbestos in soil from a stockpile (TPSP6/1). A further detection of Synthetic Mineral Fibre (SMF) was noted by the laboratory in TP9/1, along the northern boundary, however this was not reported by Golder.

Golder (2005a) identified 17 stockpiles on the greater site, five of which were located on RZNRA, as shown on Attachment 5, Appendix A. A large number of stockpiles were clustered in the north west corner of the greater site, identified by Golder as the 'waste disposal west' area (located in RRZW and CZSRA).

Stockpiled soils were observed to consist of silty/ gravelly clays. Numerous wastes including building rubble and asbestos were also associated with stockpiles. The only contaminant detection made in stockpile samples was the detection of chrysotile asbestos in surface soil from TPSP6, located on the northern boundary of the site in RZNRA. This was the only detection of asbestos in soil at the site outside the asbestos impact area identified in CZSRA.

Stop butt material containing lead particulate (5-10 mm in size) was spread about the range (CZSRA) and built into roads (RZNRA, CZSRA and RRZW) in the 1970s. The extent of the lead particulate was delineated during investigations by Milsearch and Golder. Within RZNRA, lead particulate impact was associated with an access road along the northern boundary (Attachment 7, Appendix A).

In the Auditor's opinion, the soil analytical results are consistent with the site history and field observations. Minimal contaminant detections were made in the general site areas, with only limited detections exceeding human health guidelines made in known areas of contamination. The Auditor is satisfied that the general site areas are free of contamination and that significant contamination detections are restricted to areas of known contamination where remedial action has been undertaken (refer Section 9).

8.3 Evaluation of Groundwater Analytical Results

Golder (2005a) collected groundwater samples from seven wells and three trenches on the greater site in February and March 2005 (three wells were dry). Two of these wells (BH2 and BH291, BH249 was dry) are located on RZNRA. Groundwater samples were analysed for a variety of contaminants including heavy metals, TPH, BTEX, PAH, OCP, OPP, PCB, explosives, phenols and VHCs.

The analytical results for true groundwater are tabulated below in Table 8.2 (results for perched trench water are excluded). Results from field testing for temperature, pH, electrical conductivity (EC) and Total Dissolved Solids (TDS) are also included in these tables. Laboratory testing was conducted for pH and EC and results were similar to the field measurements.

Groundwater well locations are shown on Attachment 6, Appendix A.

Table 8.2: Evaluation of Groundwater Well Analytical Results – Summary Table

Analyte	Units	n	Detections	Minimum	Maximum	Max Well	n >ANZECC Fresh (2000)
Temperature	°C	7	7	21.0	23.8	BH558	-
pH	-	7	7	6.8	7.2	BH675	0
EC	µV	7	7	9,210	14,270	BH291	-
TDS	mS	7	7	4.53	7.18	BH291	-
Arsenic	mg/L	7	7	0.004	0.12	BH2	**1** [1]
Cadmium	mg/L	7	0	-	<0.0002	-	0
Total Chromium	mg/L	7	7	0.007	0.014	BH608	**7** [2]
Copper	mg/L	7	5	<0.001	0.004	BH608	**3**
Lead	mg/L	7	7	0.002	0.012	BH675	**6**
Mercury (inorganic)	mg/L	7	0	<0.0001	0.0001	BH291 (Dup)	**1** [3]
Nickel	mg/L	7	7	0.002	0.022	BH675	**4**
Zinc	mg/L	7	3	<0.001	0.07	BH291 (Dup)	**2**
TPH (C_6-C_9)	mg/L	7	0	-	<0.04	-	-
TPH (C_{10}-C_{36})	mg/L	7	0	-	<0.5	-	-
BTEX	mg/L	7	0	-	<0.001	-	0
Phenols	µg/L	7	0	-	<0.5	-	0
VHC	µg/L	7	0	-	<5	-	0
PAHs	µg/L	7	0	-	<0.5	-	0 [4]
OCP/ OPP	µg/L	7	0	<0.01	<0.2	-	0 [5]
PCBs	µg/L	7	0	-	<0.1	-	-
Explosives	mg/L	7	0	-	<0.005	-	-

n number of samples
- No criteria available/used
1 Arsenic III criteria
2 Chromium III criteria
3 Detection limit (0.0001 mg/L) for primary samples is above guideline (0.00006 mg/L)
4 Detection limits for some PAHs (anthracene, benzo(a)pyrene) are above guidelines
5 Detection limits for some OCP/OPP (Aldrin, Dieldrin, Chlorpyrifos) are above guidelines

Groundwater was found to be approximately neutral and saline.

Heavy metals, except cadmium, were detected at concentrations exceeding the guidelines in at least one groundwater well at the site. Heavy metal exceedances were distributed across all wells at the site. Exceedances were detected in both upgradient and downgradient wells. It is possible that the presence of heavy metals in groundwater is due to those metals naturally occurring within the rock aquifer. Elevated metals concentrations are commonly detected in groundwater within Wianamatta Shale.

There is one area of the site where there is an apparent correlation between heavy metal detections and contaminant sources. The highest metals concentrations were commonly detected in wells BH608 and BH675 which are in the vicinity of the small arms range, disposal trenches and nearby Dam 3 (on CZSRA), where the majority of soil metals exceedances were detected. One of the two zinc exceedances for the site was also detected in well BH608, in the small arms range. It is possible that these activities have locally increased the heavy metal loading in groundwater, but this increase is not considered to be substantially more than the concentrations which appear to be naturally occurring at the site.

No organic compounds were detected in any of the groundwater well samples from the site, including TPH, BTEX, PAH, phenols, VHC, OCP, OPP, PCB and explosives.

In the Auditor's opinion, the groundwater analytical results are consistent with the site history of the greater site and field observations. There is evidence of only minor contamination of groundwater by heavy metals in the vicinity of the small arms range (located within CZSRA). The majority of heavy metals exceedances detected at the site and within the greater site are considered to be representative of background conditions within the shale bedrock. The Auditor is satisfied that groundwater at the RZNRA site and within the greater site is free of levels of contamination that would negatively impact on the proposed development or the surrounding environment.

9 Evaluation of Remediation

9.1 Previous Remediation Activities

Remediation of seven areas (REM1-REM7 in Attachment 5, Appendix A) across the greater site was previously undertaken with respect to munitions, as detailed in Interim Advice #3 (September 2005, Appendix F). Based on the works undertaken, BACTEC (2005) provided certification that the seven remediation areas are free of UXO.

During the course of munitions investigations across the greater site, SAA/ weapons fragments were collected and documented. Golder reported that the collected training ordnance, such as 81 mm mortars and anti tank mines, were disposed off-site by Department of Defence personnel. Golder (letter, 9 December 2010) advised that remaining items, such as SAA and grenade base plugs which were stockpiled on site for later disposal, were disposed in 2006.

9.2 Summary of Remediation and Validation

Golder (2005a) identified seven areas across the greater site requiring remediation, defined as 'Areas of Concern' (AOC). The AOCs are summarised in Table 9.1 and are shown in Attachment 3, Appendix A.

Table 9.1: Summary of Areas Requiring Remediation

Area of Concern	Description/ Location	Comments
AOC 1	Military associated objects: Concertina wire; weapons pits; former structure/ slabs; general rubbish; scrap metal; asbestos piping Located in all areas of the site	Removal of all stockpiles is also required, particularly in the northwest corner of the site where numerous stockpiles are concentrated.
AOC 2	SAA in proposed residential zones (RZNRA and RRZW)	Could be present in all areas not subject to searching to date (i.e., not at grid locations or within remediation zones). Anticipated to be higher in concentration in previously identified areas of high metallic concentration.
AOC 3	SAA in proposed conservation zone (CZSRA)	Could be present in all areas not subject to searching to date (i.e., not at grid locations or within remediation zones). Anticipated to be higher in concentration in previously identified areas of high metallic concentration.
AOC 4	Lead impacted material – small arms range and northern tracks (RZNRA, CZSRA and RRZW)	Remediation of south western track area not required based on laboratory analysis.
AOC 5	Area of asbestos sheeting fragments (CZSRA and RZNRA)	
AOC 6	PAH impact at TP599 (CZSRA)	The Auditor notes that the lateral extent and

Table 9.1: Summary of Areas Requiring Remediation		
Area of Concern	**Description/ Location**	**Comments**
		immediate source of impact has not been determined.
AOC 7	Waste disposal pits (CZSRA)	Excavation is considered necessary because of unknown contents and contaminated water.

Golder issued a RAP in December 2005 and a revised RAP in February 2011, which were reviewed by the Auditor in Interim Advice #4 and Interim Advice #5, respectively. The proposed remediation included a combination of SAA/UXO removal, waste removal, reuse or removal of stockpiles, and placement of ACM and lead contaminated material in a containment area located within CZSRA. Details of the containment cell construction are provided in the CZSRA Site Audit Report.

The 2011 RAP includes more detail on the containment “cap” design for materials proposed to be buried onsite and validation sampling requirements. The preferred remediation method defined by Golder was considered by the Auditor to be generally appropriate and generally consistent with that previously proposed and reviewed in Interim Advice #4.

JBS undertook remediation and validation of AOC and additional unexpected finds in February to September 2012. G-tek were engaged to undertaken UXO remediation works across the majority of RZNRA, which were completed between May and November 2012. A small portion of RZNRA used during construction of the adjacent rail corridor was remediated by BACTEC in May and July 2011 and September 2012.

A summary of the remediation and validation undertaken on the site is provided in Table 9.2. The remediation areas for the site are shown in Attachment 5, Appendix A. In the Auditor’s opinion, remediation works undertaken were appropriate and generally in accordance with the RAP.

A summary of the validation sampling undertaken for the remediation works in RZNRA is provided in Table 9.3. Characterisation and validation sample plans for the AOC are shown in Attachments 7 and 8, Appendix A.

Further discussion of groundwater is provided in Section 9.3.

Table 9.2: Summary of Remediation and Validation

Area of Concern	Description/ Location	Remediation Performed		Validation Performed	Auditor Comments
AOC 1	**Military associated objects:** Concertina wire; weapons pits; former structures/ slabs; general rubbish; scrap metal; asbestos piping Located in all areas of the site.	Objects collected and disposed off-site, with the exception of asbestos piping which was placed in the encapsulation area within CZSRA. Excavations were backfilled where required with stockpiled soil from SP5 and SP14.		Visual inspection of former footprints to confirm the absence of potential contamination. Removal of material from weapons pits visually validated by Pacific Environmental. Visual inspection for asbestos pipe removal. A clearance certificate was provided by Pacific Environmental for asbestos pipe removal.	RAP required validation sampling of excavation faces on a 10 m grid for laboratory analyses for asbestos. Removal of asbestos pipes did not require excavation, so sampling of walls was not required. Remediation was undertaken in accordance with the RAP.
	Stockpiled materials: Five stockpiles identified on RZNRA during previous investigations (SP4, SP5, SP6, SP14 and SP15). Golder consider these to be clean fill with the exception of SP6 (contains asbestos fibre detection). Additional nine stockpiles (UFSP01, UFSPO2, UFSOP04-UFSP10) identified on RZNRA following vegetation clearance (Attachment 7, Appendix A).	SP6, UFSP04, UFSP05, UFSP06, UFSP07 and UFSP10	SP6 excavated and disposed offsite. Remaining stockpiles placed in containment cell on CZSRA.	Characterisation samples collected from additional nine stockpiles and previously identified stockpiles remaining onsite (one per stockpile). Stockpiles were visually inspected following vegetation removal and during excavation. Visual inspection of SP6 footprint and collection of one validation sample for laboratory analyses for metals, TPH, BTEX, PAHs and asbestos. A clearance certificate was provided by Pacific Environmental for SP6 removal. Validation of stockpile footprints of	Validation sampling of stockpile footprints was not undertaken for additional stockpiles placed in the containment cell (UFSP04, UFSP05, UFSP06, UFSP07 and UFSP10). The RAP required validation samples be collected at a density of one per 100 m^2 and analysed for metals, TPH, BTEX, PAHs and asbestos if evidence of contamination (olfactory or visual impact). Characterisation samples from the stockpiles did not identify significant contamination so
		Remaining stockpiles including SP4, SP5, SP14, SP15, UFSP01, UFSP02, UFSP08 and UFSP09 on RZNRA.	SP5 and SP14 used as backfill in weapons pits. Remaining stockpiles spread on the ground surface.		

Table 9.2: Summary of Remediation and Validation				
Area of Concern	**Description/ Location**	**Remediation Performed**	**Validation Performed**	**Auditor Comments**
			material considered suitable for beneficial reuse on the site was not required. The stockpiles were visually inspected during reuse/spreading.	the absence of footprint validation samples is not considered significant. Remediation was undertaken in accordance with the RAP.
AOC 2	UXO/ SAA in proposed residential zones (Attachment 10, Appendix A)	Blackberry bushes removed (approximately 1.3 ha) and vegetation reduced to 0.1 m outside proposed open space areas. In residential areas, 100% UXO/ SAA shallow detector search using a Minelab F3 metal detector equipment fitted with Black Cap (minimum 300 mm penetration depth). Searching of 1 ha (100x100 m) cells/blocks subdivided further into four 50 m by 50 m sections and then into 1 m wide lanes marked by surveyors string. Searched by two-man teams using a 1 m line spacing. Open Space areas of the site not cleared of vegetation (4.37 ha) were visually searched for UXO/SAA. Searching of 50 m by 50 m sections by walking transects with a 0.5 m spacing. Contractor endorsed by Department of Defence via the Defence UXO Panel. Documentation/ removal of contacts by digging and separation. Contacts removed comprised one live 36M grenade, one practice 81mm mortar, twelve practice 36M	Repeat search of a representative 10% area of each 1 ha (100x100 m) search cell by G-tek. If validation failed (i.e., a contact is found), the entire cell area (1 ha) would be searched again. The definition of “contact” for the purposes of initiating a re-search is “*a metallic object of military firearm origin, greater than 25 mm in length*”.	Technical specifications of the metal detector provided to the Auditor indicate that the depth range is 0.2-1.0 m, depending on the weight of the metal object. G-tek noted that vegetation may have limited the successful identification of finds in open space areas of the site where vegetation was not removed. An EMP has been prepared for open space areas of the site. Remediation was undertaken in general accordance with the RAP. Departures from the RAP are considered to have been adequately addressed.

Table 9.2: Summary of Remediation and Validation

Area of Concern	Description/ Location	Remediation Performed	Validation Performed	Auditor Comments
		grenades and 2100 live SAA and pyrotechnics. Significant quantities of SAA explosive ordnance waste were also located and removed. Off-site disposal at approved landfill of free from explosive (FFE) materials and scrap metal. Live materials (e.g. grenades) returned to Department of Defence for destruction and disposal.		
AOC 4	Lead impacted material – northern tracks in RZNRA (Attachment 7, Appendix A)	Lead contaminated fill material excavated from the access road to depth of approximately 0.3 to 0.5 m. Excavated material placed in a containment cell within CZSRA. The cell was to include a 0.6 m thick cap of clay and topsoil with a marker layer. It was designed to preclude access to the impacted material and minimise surface water infiltration. Management of the containment cell would be required via a SMP.	Visual inspection for lead particulate in excavation areas. Field survey using an XRF. Validation sampling of excavation faces on a 10 m grid for laboratory analyses for lead.	Works performed in accordance with the RAP. The cell construction and management is addressed in the CZSRA site audit.
AOC5	ACM observed as pipes stockpiled in the eastern portion of the site discussed in AOC1 above.	-	-	-
-	Unexpected finds protocol implemented during vegetation	Fill material containing ACM was excavated and placed in the containment cell on	Visual validation of fill material removal. Three validation samples	Works performed in accordance with the RAP

Table 9.2: Summary of Remediation and Validation				
Area of Concern	**Description/ Location**	**Remediation Performed**	**Validation Performed**	**Auditor Comments**
	removal and excavation of other areas of contamination identified approximately 5 m^3 of fill material containing ACM (UF04) (Attachment 7, Appendix A). Unexpected stockpile finds are discussed in AOC1 above.	CZSRA.	collected from excavation faces. A clearance certificate was provided by Pacific Environmental for UF04 removal.	

Table 9.3: Summary of Validation Testing and Results					
Area of Concern	**Validation Item**	**Sampling Undertaken**	**Analytes**	**Results**	**Auditor Comments**
AOC1	ACM pipe removal	Visual inspection undertaken	-	Analytical results not available. Visual inspection of stockpile footprint by JBS following removal confirmed ACM pipework has been removed.	Validation of ACM pipe removal was not undertaken in accordance with the RAP, which required validation sampling of excavation faces on a 10 m grid for laboratory analyses for asbestos. Visual validation is considered to be adequate to demonstrate removal of ACM pipework.
	Stockpiles for beneficial reuse (SP4, SP5, SP14,	One per stockpile Visual inspection	Metals TPH	TPH, BTEX and OCP < PQL Total PAH (0.46 mg/kg) detected	Stockpile volumes ranged 2-70 m^3. The sampling density is considered

Table 9.3: Summary of Validation Testing and Results

Area of Concern	Validation Item	Sampling Undertaken	Analytes	Results	Auditor Comments
	SP15) Additional stockpile characterisation (UFSP01, UFSP02, UFSP04-UFSP10)		BTEX PAHs OCP PCB Asbestos	in one sample < SIL 1 (20 mg/kg) Asbestos not detected Metals < SIL 1 Zinc detected in one sample (240 mg/kg) > SIL 5 (200 mg/kg) Visual inspection of stockpiles identified anthropogenic material in UFSP04, UFSP05, UFSP06, UFSP07 and UFSP10 (hence disposed to containment cell). Visual inspection of stockpiles for reuse did not identify aesthetic concerns including discoloured, stained or odorous soil or the presence of ACM.	adequate. Validation was undertaken in accordance with the RAP. Validation of stockpiles for beneficial reuse is considered to have been adequate.
	SP6 footprint	One sample from stockpile footprint Visual inspection	Metals TPH BTEX PAHs Asbestos	TPH, BTEX and PAH < PQL Asbestos not detected Metals < SIL 1 and 5 Visual inspection of the footprint on a 1 m grid confirmed the absence of ACM fragments and other foreign matter.	Validation was in accordance with RAP. Validation of SP6 removal was adequate.
AOC2	UXO/ SAA removal	Repeat search of a representative 10% area of each 1 ha (100x100 m)	-	Search logs provided by G-tek (2013) indicate that QC searches passed on all occasions.	Repeat searches adequate to demonstrate that remediation of UXO/SAA was adequate.

Table 9.3: Summary of Validation Testing and Results

Area of Concern	Validation Item	Sampling Undertaken	Analytes	Results	Auditor Comments
		search cell by G-tek.			Open space areas where instrument clearance was not undertaken due to vegetation cover will require an EMP (SAR Section 12).
AOC4	Lead in northern access track	10 m grid of lateral and vertical extent of the excavation. Resulting in 90 samples from excavation walls and 65 samples from excavation base (Attachment 8, Appendix A). Visual inspection	Lead	Lead < SIL 1 and 5 Visual inspection of the ground surface at the excavation margins indicated that lead particulate was not present.	Validation was consistent with RAP and has adequately demonstrated removal of lead contamination from the northern access track.
UF04	ACM in fill material	Three validation samples (V1-V3) collected from excavation faces. Visual inspection	Asbestos	No asbestos detections Visual inspection of the excavation and surrounding ground surface did not identify ACM.	Validation was consistent with the RAP. The unexpected ACM find was adequately validated.

9.3 Groundwater

Groundwater remediation was not required by the RAP. Groundwater was assessed at the site before and after remediation to ensure no impacts occurred as a result of the remedial works. A total of ten monitoring wells were installed across the greater site in February 2005. Three of these (BH2, BH249 and BH291) were located with the RZNRA area, however BH249 was found to be dry (Attachment 6, Appendix A).

9.3.1 Pre-Remediation Groundwater Monitoring

Groundwater monitoring was undertaken prior to remediation of the site in February 2012 (JBS, 2012c). BH2 was resampled in March 2012 following removal of approximately 1 m of sediment from the well. The well was allowed to stand for a period of 6 days prior to sampling. Samples were analysed for metals, PAHs, TPH and BTEX.

Sampling of surface water (PSW1) identified in the vicinity of BH2 following a period of rainfall was also undertaken (Attachment 9, Appendix A). JBS identified the water as a potential contaminant source as a result of construction activities. The sample was analysed for metals, TPH and BTEX.

Groundwater and surface water results from the greater site are summarised in Table 9.4.

Table 9.4: Pre-Remediation Groundwater Analytical Results – Summary Table

Analyte	Units	n	Detections	Minimum	Maximum	Max Well	n >ANZECC Fresh (2000)
Temperature	°C	6	6	19.2	22.3	BH2	-
pH	-	6	6	5.27	6.56	BH558	**5**
EC	µV	6	6	646	14,040	BH291	-
Arsenic	mg/L	5	2	<0.001	0.017	BH2	0
Cadmium	mg/L	5	1	<0.0001	0.001	PSW1	0 [1]
Total Chromium	mg/L	5	0	-	<0.001	-	0
Copper	mg/L	5	3	<0.001	0.014	BH2	**2**
Lead	mg/L	5	3	<0.001	0.011	BH2	**2**
Mercury (inorganic)	mg/L	5	0	-	<0.00005	-	0
Nickel	mg/L	5	5	0.005	0.073	BH608	**4**
Zinc	mg/L	5	5	0.02	0.14	BH2	**5**
TPH (C_6-C_9)	mg/L	6	0	-	<0.01	-	-
TPH (C_{10}-C_{36})	mg/L	5	1	<250	1,039	PSW1	-
BTEX	mg/L	6	0	-	<0.001	-	0
PAHs	µg/L	4	0	-	<0.1	-	0

n number of samples
- No criteria available/used
1 Detection limit (0.0001 mg/L) for primary samples is above guideline (0.00006 mg/L)

Concentrations of arsenic, copper, lead, nickel and zinc exceeded the guidelines in wells distributed across the site. Exceedances were detected in both upgradient and downgradient wells. The metals concentrations were generally consistent with the results of previous monitoring (Golder, 2005) summarised in SAR Section 8.3.

TPH C_{10}-C_{36} concentrations were detected above the PQL in BH2 (first sampling event) and in surface water collected from a depression nearby (PSW1). TPH concentrations were less than the PQL in BH2 during the second sampling event.

JBS report that earthworks undertaken in the rail corridor resulted in the removal of the ponded surface water.

9.3.2 Post-Remediation Groundwater Monitoring

Groundwater monitoring was undertaken following remediation of the site in October 2012 (JBS, 2013a). Only three monitoring wells were sampled (BH2, BH291 and BH558) due to removal of other wells during remediation. Samples were analysed for metals, PAHs, TPH and BTEX.

Groundwater and surface water results from the greater site are summarised in Table 9.5.

Table 9.5: Post-Remediation Groundwater Analytical Results – Summary Table

Analyte	Units	n	Detections	Minimum	Maximum	Max Well	n >ANZECC Fresh (2000)
Temperature	°C	3	3	18.1	19.6	BH2	-
pH	-	3	3	6.53	6.81	BH558	0
EC	µV	3	3	9,950	10,890	BH558	-
Arsenic	mg/L	3	2	<0.001	0.012	BH2	0
Cadmium	mg/L	3	1	<0.0001	0.0001	BH558	0 [1]
Total Chromium	mg/L	3	0	-	<0.001	-	0
Copper	mg/L	3	1	<0.001	0.002	BH558	**1**
Lead	mg/L	3	0	-	<0.001	-	0
Mercury (inorganic)	mg/L	3	0	-	<0.00005	-	0
Nickel	mg/L	3	3	0.005	0.035	BH291	**1**
Zinc	mg/L	3	3	0.009	0.07	BH291	**3**
TPH (C_6-C_9)	mg/L	3	0	-	<0.01	-	-
TPH (C_{10}-C_{36})	mg/L	3	0	-	<250	-	-
BTEX	mg/L	3	0	-	<0.001	-	0
PAHs	µg/L	3	0	-	<0.1	-	0

n number of samples
- No criteria available/used
1 Detection limit (0.0001 mg/L) for primary samples is above guideline (0.00006 mg/L)

Concentrations of copper, nickel and zinc exceeded the guidelines in wells distributed across the site. The metals concentrations were generally consistent with the results of previous monitoring by Golder (2005) and JBS (2012c).

TPH, BTEX and PAH concentrations were less than the PQL.

JBS note that the heavy metal concentrations encountered during pre- and post-remediation sampling are considered typical of conditions in Wianamatta Group shales and generally consistent with those previously encountered within the greater site in 2005.

JBS concluded that *"there are no unacceptable risks associated with migration of site contamination via groundwater as a result of site conditions prior to or following site remediation works"*.

9.4 Conclusion

The Auditor concludes that removal of stockpiles, waste material, UXO/SAA, lead particulate and asbestos items has been adequately validated. An EMP is required for open space areas of the site where clearance of UXO/ SAA was by visual inspection (SAR Section 12).

In the Auditor's opinion, the groundwater investigations undertaken were appropriate and in accordance with the RAP. The Auditor considers there to be no evidence of significant anthropogenic contamination associated with site activities or remediation.

10 Contamination Migration Potential

Following successful remediation of contamination sources on the site, validation (visual and analytical) has demonstrated that no significant levels of contaminants are present. Groundwater monitoring undertaken prior to and following remediation did not identify significant groundwater impacts. There is therefore little or no potential for migration of contamination from the site or vertically to groundwater.

11 Assessment of Risk

Based on assessment of results against relevant guidelines and consideration of the overall investigation and remediation, it is the Auditor's opinion that:

- Areas of the site proposed for residential use would present a low risk to human health.
- There is a risk that UXO/SAA is present below the ground surface in proposed open space areas of the site due to clearance by visual inspection. An EMP has been prepared to managed open space areas of the site (SAR Section 12).
- Metals concentrations in groundwater exceeding ecological criteria are considered to be indicative of background conditions associated with Wianamatta Group shales. Groundwater is therefore not considered to present a significant risk to human and ecological receptors.
- Due to the scale of the site and limitations of investigative coverage, there is the potential for contamination or aesthetic issues to remain (e.g. unidentified pits, trenches, etc.). The risk is considered to be low due to the investigation and remediation undertaken, however it is recommended as good practice to implement an unexpected finds protocol (UFP) during development.

12 Ongoing Site Management

JBS propose the ongoing management of remnant contamination in the portions of the site where clearance of UXO/SAA was limited to visual inspections through the following document, which is attached in Appendix I:

- 'Urban Growth, Public Open Space, Site Environmental Management Plan, Residential Zone North of Rail Alignment, Zouch Road, Edmondson Park, NSW' dated 2 September 2013 by JBS&G (NSW & WA) Pty Ltd.

Table 12.1 presents an assessment of the EMP.

Table 12.1: Assessment of the EMP

Item	Comments
Site Specific stand alone document	The EMP is standalone and provides an appropriate level of site specific information.
Plan Objectives	The objective of the EMP is to provide *"…procedures, controls and monitoring activities that will be implemented in an ongoing manner during development and use of the proposed open space areas of the site to minimise the potential for unacceptable site exposure risks to current and future site users, occupants of surrounding properties and to the surrounding environment".* The Auditor considers the objective of the EMP to be relevant.
When does the EMP apply?	The EMP will apply indefinitely. The EMP applies during activities which could involve disturbance or penetration of the existing ground surface. Examples of such activities are provided in the EMP (e.g. vehicle/plant movement, infrastructure installation, vegetation placement or removal, etc.).
Contamination Issues	The EMP provides adequate information regarding the potential for residual buried UXO and SAA within public open space areas. Examples of UXO, SAA and explosive ordnance waste (EOW) are provided as an appendix to the EMP.
Management Measures	Key management controls required in the EMP are: • Induction/training of site workers regarding UXO. • Public awareness of potential for UXO/SAA onsite. • Maintenance to minimise the potential for erosion or ground cover disturbance. • Management measures to be implemented in the event that disturbance of groundcover or the subsurface profile is required. • Procedures to follow in the event UXO, SAA or EOW identified.
Responsibilities	The EMP outlines the responsibilities the site owner, site workers and Liverpool City Council. The EMP is intended to be implemented by the current site owner and any future owners or managers of the site. The responsibilities of the site owner include:

Table 12.1: Assessment of the EMP	
Item	**Comments**
	• Inform the relevant planning and regulatory authorities of the existence of the EMP. • Provide the EMP to the managers of the site. • Ensure site personnel conducting intrusive works are provided a copy of the EMP and inducted into the EMP. • Ensure the requirements of the EMP are implemented. • Provide management services to address any UXO finds or other materials. • Inform the police of the discovery of any suspected UXO and manage appropriate actions to ensure removal of the UXO. • Maintain records and co-ordinate inspections to ensure the requirements of the EMP are demonstrated. The responsibilities of site workers include: • Conducting intrusive works in accordance with the requirements of the EMP and other statutory requirements. • Ensure persons engaged on the site are inducted into the EMP and are aware of their responsibilities in relation to potential UXO/SAA. • Implement temporary management requirements in the event of a UXO find and report the occurrence to the land owner or site manager. The responsibilities of Council include public notification of the existence of the EMP on property records (i.e. s.149 certificate) and enforcement of the EMP as a condition in any future development consent that may involve disturbance of soil at the site.
Revision of the EMP	Revision of the EMP may be required to reflect corrective actions and changes in legislation, site activities, and site conditions. Revision of the EMP is recommended to be undertaken by an appropriately qualified and experienced environmental consultant. The revised EMP should be distributed to all stakeholders.
Occupational Health and Safety (OH&S)	The EMP includes management measures to be undertaken in the event that intrusive works are required. These include preparation of a risk assessment and management strategy by a qualified and experienced UXO consultant. It is anticipated that this would include OH&S requirements for the planned work.
Public notification mechanisms to ensure potential purchasers or other interested parties are aware of the restrictions i.e. Section 149 or placing a covenant on the title of land under the CLM Act to	The audit is non-statutory. The SAR/SAS will be provided to Council so that it can be recorded on the Section 149 certificate. To make the EMP more accessible, it will be included as an Appendix to the SAR.

Table 12.1: Assessment of the EMP	
Item	**Comments**
require maintenance of remediation under the Act.	
Will be or can reasonably be made to be legally enforceable?	Landcom is responsible for implementing the EMP until such time that the land is transferred to Council. Landcom will be responsible for ensuring that the EMP is provided to Liverpool Council for inclusion on the Section 149 certificate for the site.
Are the Council in agreement with the EMP?	JBS advise that Council agreement with the EMP would be dealt with at a contractual level at the time of transfer.

The appropriate conditions for the implementation of a Environmental Management Plan stated under Section 3.4.6 of DEC (2006) *Contaminated Sites: Guidelines for the NSW Site Auditor Scheme (2nd Ed.)* have been met, namely:

- The EMP has been reviewed by the Auditor.
- The provisions of the EMP can be made to be legally enforceable (i.e. Development Consent conditions) in site redevelopment.
- There will be appropriate public notification of restrictions applying to the site through a notification on the Section 149 Certificate for the site.
- The remnant contamination is not considered to pose an unacceptable risk to onsite or offsite environments.

Based on the above, the Auditor considers that the EMP will provide an adequate framework for the management of the remnant contamination at the site.

13 Compliance with Regulatory Guidelines and Directions

Guidelines currently approved by the EPA under section 105 of the NSW *Contaminated Land Management Act 1997* are listed in Appendix C. The Auditor has used these guidelines.

The investigation was generally conducted in accordance with SEPP 55 Planning Guidelines and reported in accordance with the EPA (1997) *Guidelines for Consultants Reporting on Contaminated Sites*. The checklist included in that document has been referred to in conducting the Audit. The EPA's *Checklist for Site Auditors using the EPA Guidelines for the NSW Site Auditor Scheme 1998 (December 1999)* has also been referred to.

Waste materials were disposed of at a number of waste disposal or recycling/processing facilities. All except the scrap metal facility held Environmental Protection Licences (EPLs) although copies of the EPLs were not provided by JBS. Waste disposal dockets for the waste materials were included in the JBS Validation Report (2013c).

A total of approximately 898 tonnes of waste material was disposed off-site from the greater site. Approximately 61 tonnes of asbestos waste, comprising SP6, was disposed to Sita Australia Pty Ltd at Kemps Creek. The remainder comprised concrete, scrap metal, tyres, and mixed construction and demolition waste from across the greater site. Remaining asbestos waste was placed in the containment cell on CZSRA.

Golder does not state whether well licences were obtained from NSW Office of Water.

Asbestos clearance certification prepared by Pacific Environmental was provided for SP6, ACM pipe and UF04. Details of asbestos licences held by contractors involved in asbestos handling and transport were provided to the Auditor for review.

UXO Works Area Release was provided for RZNRA by G-tek, dated 4 December 2012. A small portion of the residential area in the south east of the site was cleared by BACTEC, who provided Explosive Ordnance Clearance Certificated dated 28 July 2011. Qualifications of personnel involved in UXO clearance were provided.

14 Conclusions and Recommendations

G-tek (2013) concluded that "*from an UXO perspective, it is considered that the site is safe for the conduct of required use as a residential subdivision*". JBS (2013c) considers that *"…the RZNRA site is suitable for the proposed residential use with accessible soils subject to implementation of an environmental management plan for those portions of the RZNRA site where UXO/SAA clearance was limited to a visual inspection"*. Based on the information presented in Milsearch, BACTEC, PB, Golder, G-tek, JBS and Pacific Environmental reports and observations made on site, and following the Decision Process for Assessing Urban Redevelopment Sites in DEC (2006) *Guidelines for the NSW Site Auditor Scheme (2nd Edition)*, the Auditor concludes that the site is suitable for the purposes of 'residential with gardens and accessible soil' and other less sensitive uses including schools, open space and commercial, subject to compliance with the following environmental management plan relevant to the proposed open space areas within RZNRA:

- 'Urban Growth, Public Open Space, Site Environmental Management Plan, Residential Zone North of Rail Alignment, Zouch Road, Edmondson Park, NSW' dated 2 September 2013 by JBS&G (NSW & WA) Pty Ltd.

It is recommended as good practice that an UFP be prepared and implemented during development of the site.

15 Other Relevant Information

This Audit was conducted on the behalf of Landcom for the purpose of assessing whether the land is suitable for the proposed uses i.e. a “Site Audit” as defined in Section 4 (1) (b) (iii) of the CLM Act.

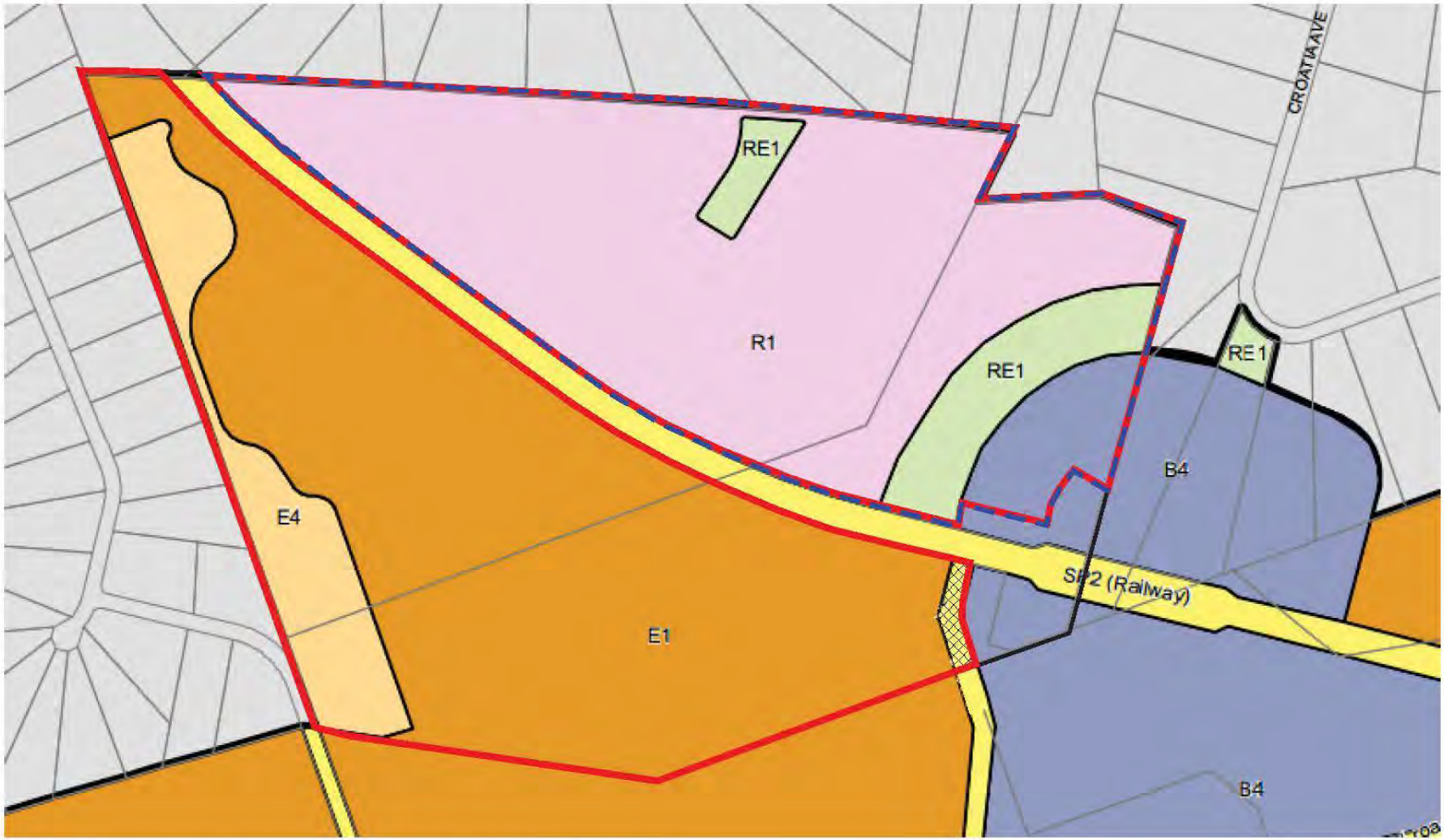
This summary report may not be suitable for other uses. Milsearch, BACTEC, PB, Golder, G-tek, JBS and Pacific Environmental included limitations in their report. The audit must also be subject to those limitations. The Auditor has prepared this document in good faith, but is unable to provide certification outside of areas over which he had some control or is reasonably able to check.

The Auditor has relied on the documents referenced in Section 1 of the Site Audit Report in preparing his opinion. If the Auditor is unable to rely on any of those documents, the conclusions of the audit could change.

It is not possible in a Site Audit Report to present all data which could be of interest to all readers of this report. Readers are referred to the referenced reports for further data. Users of this document should satisfy themselves concerning its application to, and where necessary seek expert advice in respect to, their situation.

Appendix A: Attachments

Attachment 1: Site Layout and Proposed Development
Attachment 2: Lot Boundaries
Attachment 3: Pre-remediation Site Layout
Attachment 4: Previous Investigation Locations
Attachment 5: Site Features
Attachment 6: Groundwater Monitoring Well Locations
Attachment 7: Additional Stockpiles and Unexpected Find
Attachment 8: Lead Particulate Validation Sample Locations
Attachment 9: Surface Water Sample Locations
Attachment 10: UXO Remediation Grid



Source: Base Image SEPP (Major Development) 2005 Edmondson Park South Land Zoning Map. Sheet LZN_001, December 2010.

© 2013 JBS Environmental Pty Ltd

0 75 150 300 m

Scale: Approximate

Datum: MGA94 Zone 56 - AHD

Rev	Description	Drn.	Date
A4			
A	Original Issue - R02	SE	01-10-2013

Legend:

- Approximate Project Site Boundary (Rail Easement Excluded)
- RZNRA Boundary

Zoning:

- R1 General Residential
- B4 Mixed Use
- RE1 Public Recreation
- E1 National Parks and Nature Reserves
- E4 Environmental Living
- SP2 Infrastructure (Railway and Local Road)

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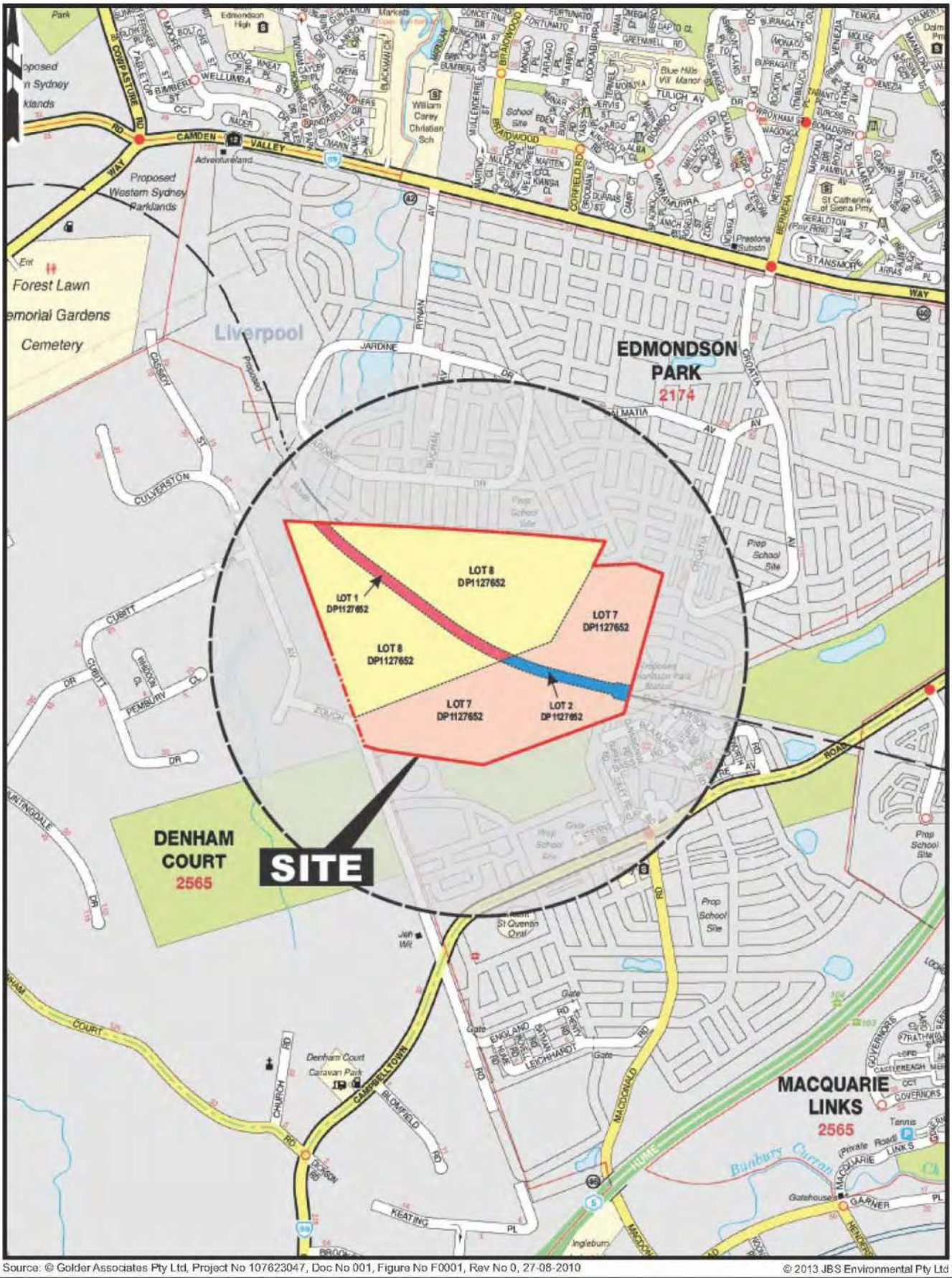
Figure 2: Proposed Site Layout and Development Areas

Client: Landcom

Project: Zouch Rd, Edmondson Park Remediation

Job No: 41945 File Name: 41945_02

Attachment 2: Lot Boundaries



Source: © Golder Associates Pty Ltd, Project No 107623047, Doc No 001, Figure No F0001, Rev No 0, 27-08-2010

© 2013 JBS Environmental Pty Ltd

0 200 400 800 m
Scale: Approximate

Datum: MGA94 Zone 56 - AHD

Rev	Description	Dm.	Date
A4			
A	Original Issue - R02	SE	05-03-2013

Legend:
Approximate Site Boundary

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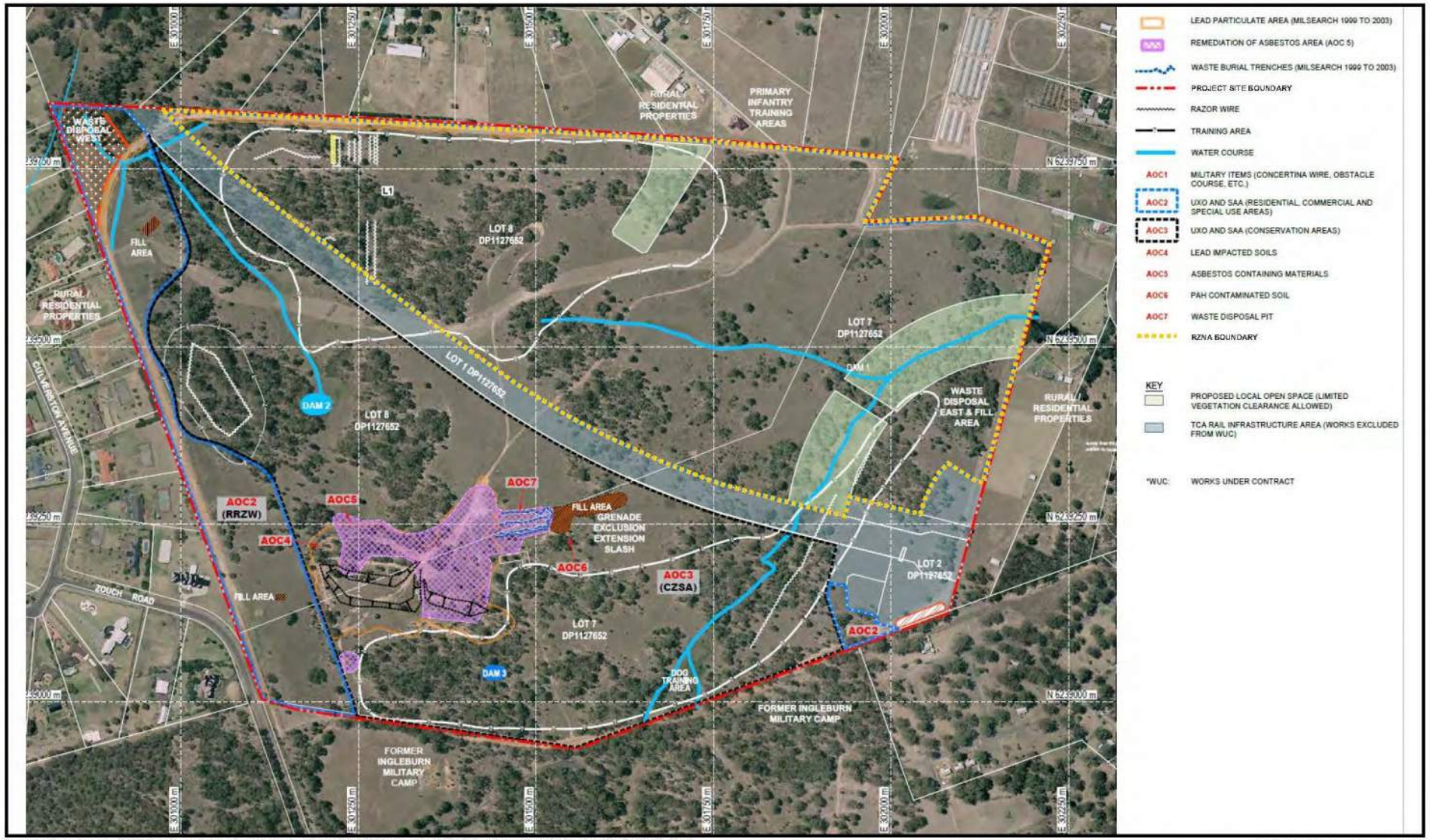
Figure 1: Site Location and Current Cadastral Boundaries

Client: Landcom

Project: Zouch Rd, Edmondson Park Remediation

Job No: 41945 File Name: 41945_01



Source: Base Image - © Golder Associates Pty Ltd, Project No 107623047, Doc No 600_001, Figure No F0001, Rev No 0, 20-09-2010

© 2013 JBS Environmental Pty Ltd

0 75 150 300 m
Scale: Approximate

Datum: MGA94 Zone 56 - AHD

Rev	Description	Dm.	Date
A4			
A	Original Issue - R02	SE	05-03-2013

JBS ENVIRONMENTAL

Figure 3: Pre-remediation Site Layout and Areas of Environmental Concern

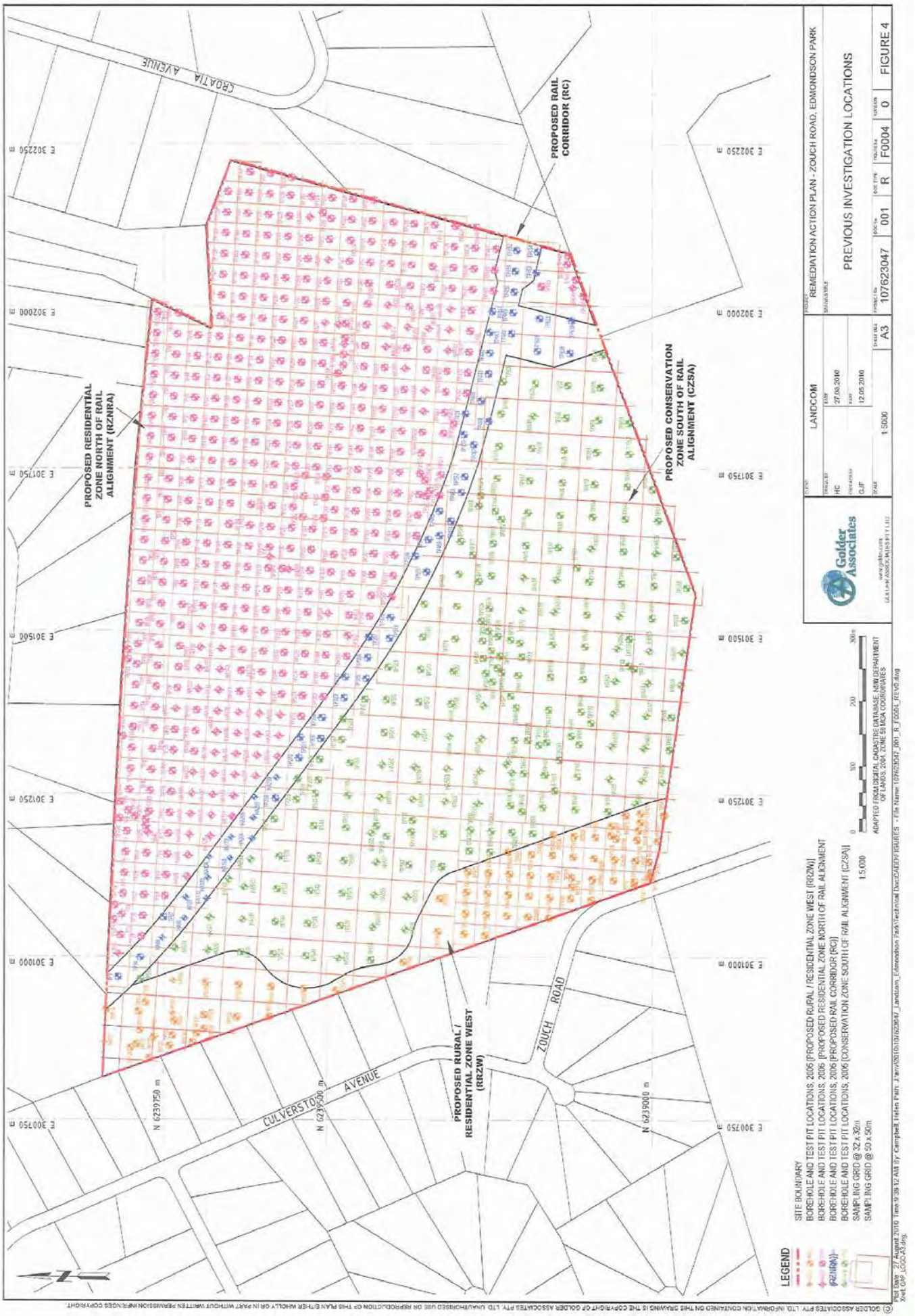
Client: Landcom

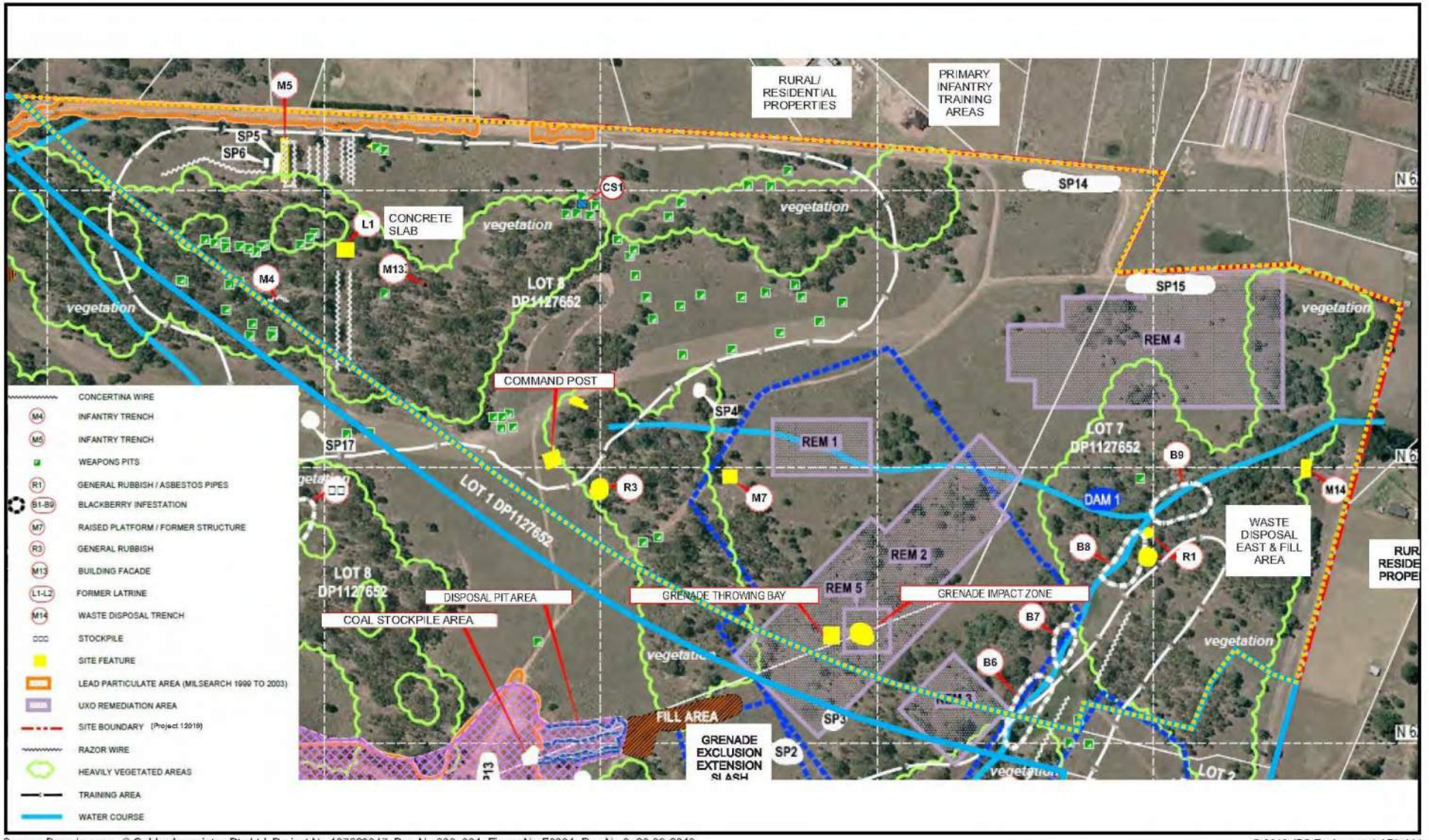
Project: Zouch Rd, Edmondson Park Remediation

Job No: 41945 File Name: 41945_03

Attachment 3: Pre-remediation Site Layout

Attachment 4: Previous Investigation Locations





Source: Base Image - © Golder Associates Pty Ltd, Project No 107623047, Doc No 600_001, Figure No F0001, Rev No 0, 20-09-2010

© 2013 JBS Environmental Pty Ltd

0 50 100 200 m
Scale: Approximate

Datum: MGA94 Zone 56 - AHD

Rev	Description	Dm.	Date
A4			
A	Original Issue - R02	SE	19-03-2013

Legend:
- RZNRA Boundary
- CS1 - Concrete Slab Identified During Clearance Works

JBS ENVIRONMENTAL

Figure 4: Site Boundary and Existing Site Features

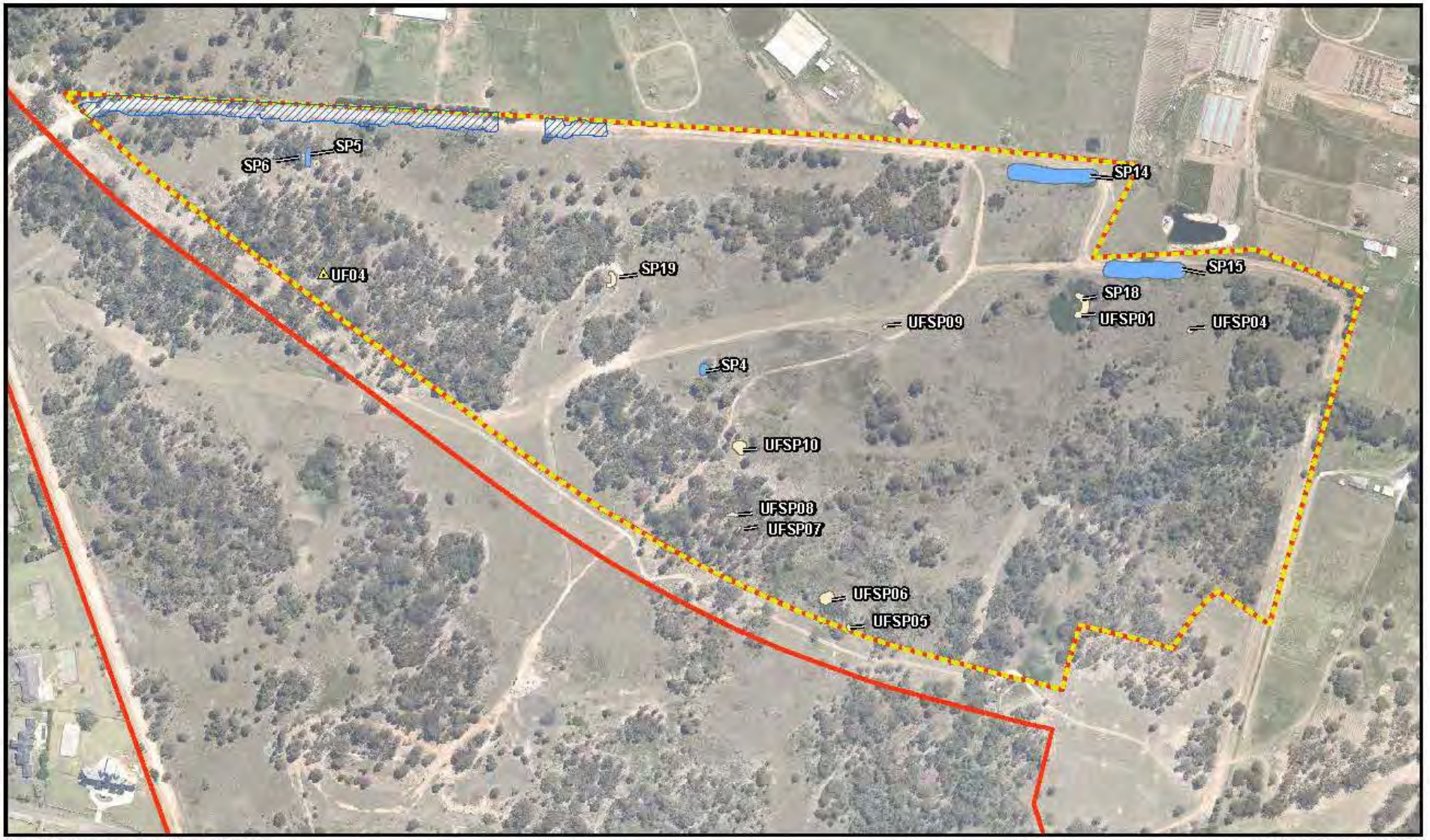
Client: Landcom

Project: Edmondson Park Remedial Works

Job No: 41945 File Name: 41945_04

Attachment 5: Site Features

Attachment 6: Groundwater Monitoring Well Locations



Source: Base Image: Hypertiles - Nearmap 23-10-2011

© 2013 JBS Environmental Pty Ltd

0 50 100 200 m

Scale: 1:5,000

Datum: MGA94 Zone 56 - AHD

Rev	Description	Drn.	Date:
A4			
A	Original Issue - R02	SE	18-03-2013

Legend:

- Approximate Project Boundary
- Approximate RZNRA Boundary
- Clean Stockpile Location
- Additional Stockpile Location
- Approximate Lead Particulate Norht Remediation Extent
- Unnexpected Find Location

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Figure 5: Remeidal Works Location Overview

Client: Landcom

Project: Landcom, 12619 Zouch Rd, Edmondson Park, NSW

Job No: 41945 File Name: 41945_05

Attachment 7: Additional Stockpiles and Unexpected Find

Source: Base Image: Hypertiles - Nearmap 23-10-2011

© 2013 JBS Environmental Pty Ltd

0 10 20 40 m

Scale: 1:6,000

Datum: MGA94 Zone 56 - AHD

Rev	Description	Drn.	Date:
A4			
A	Original Issue - R02	SE	18-03-2013

Legend:

- Approximate Project Boundary
- Approximate RZNRA Boundary
- Approximate Lead Particulate Norht Remediation Extent
- Lead Particualte Excavation Validation Sample Locations

JBS ENVIRONMENTAL

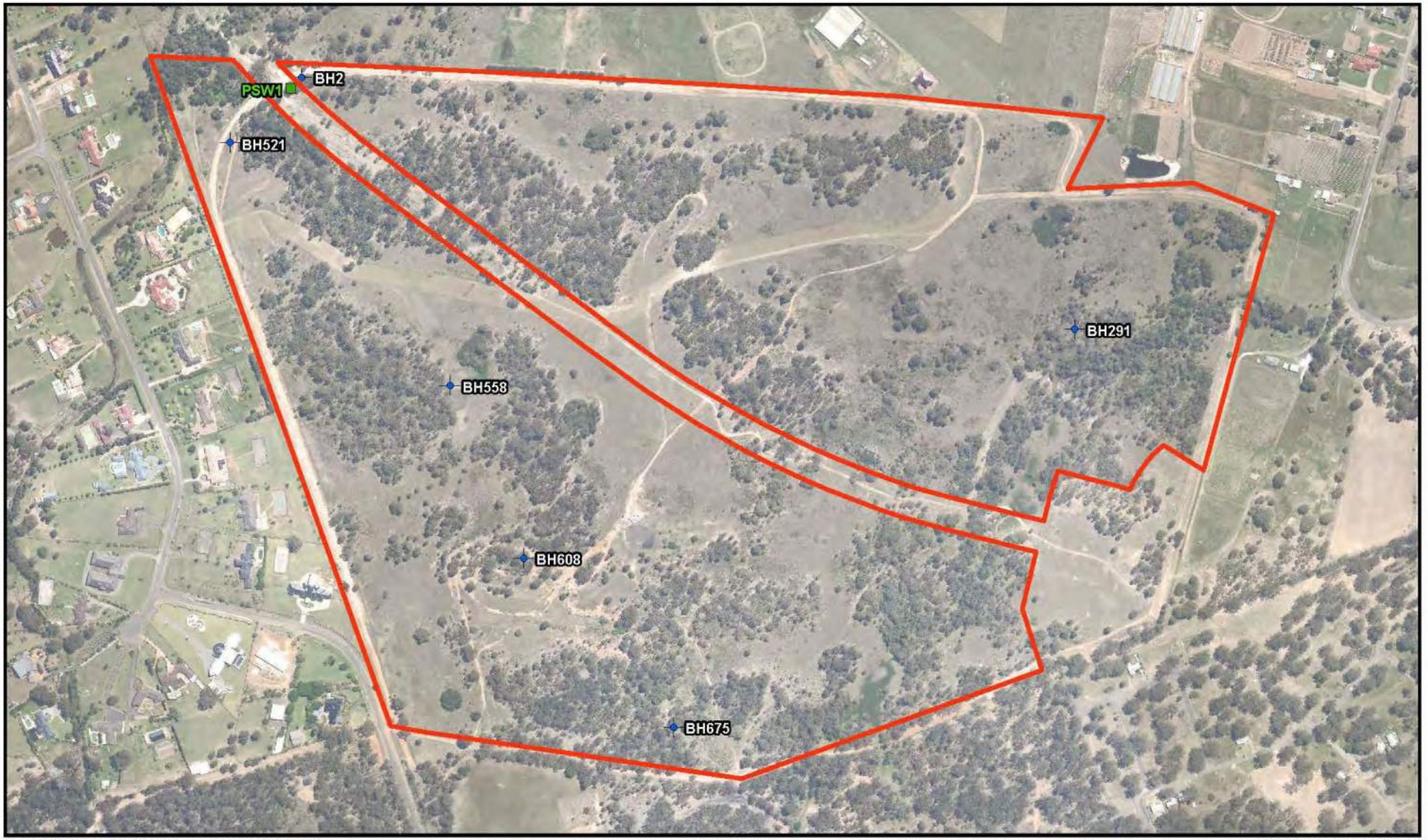
Figure 6: Lead Particulate Excavation Validation Sample Locatoins

Client: Landcom

Project: Landcom, 12619 Zouch Rd, Edmondson Park, NSW

Job No: 41945 File Name: 41945_06

Attachment 8: Lead Particulate Validation Sample Locations



Source: Base Image - Near Map www.nearmap.com, 23-10-2011

© 2012 JBS Environmental Pty Ltd

0 62.5 125 250 m

Scale: 1:6,500

Datum: MGA94 Zone 56 - AHD

Rev	Description	Drn.	Date:
A4			
0	Original Issue - L001	SE	12-04-2012

Legend:

- Approximate Site Boundary
- Borehole Locations (Golder 2005)
- Surface Water Sampling Location

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Figure 2: Water Sampling Locations

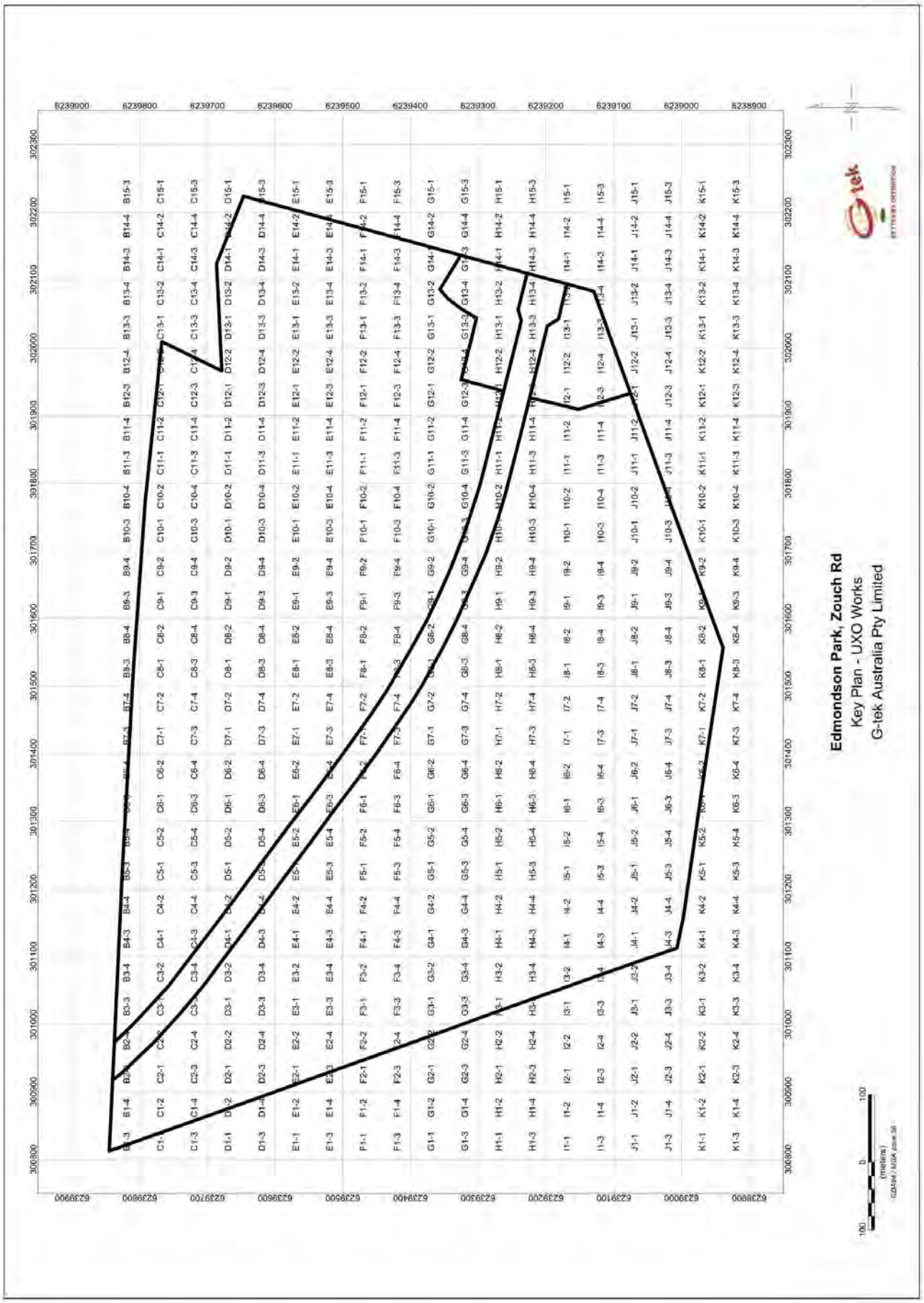
Client: Landcom

Project: Landcom, 12619 Zouch Rd, Edmondson Park

Job No: 41945 File Name: 41945_02

Attachment 9: Surface Water Sample Locations

Attachment 10: UXO Remediation Grid



Appendix B:
Soil and Groundwater Criteria

Soil investigation levels for urban development sites Department of Environment and Conservation NSW (April 2006)

Substance	Health-based investigation levels[1] (mg/kg)				Provisional phytotoxicity-based investigation levels[2] (mg/kg)
	Residential with gardens and accessible soil (home-grown produce contributing < 10% fruit and vegetable intake; no poultry), including children's day-care centres, preschools, primary schools, townhouses, villas (NEHF A)[3]	Residential with minimal access to soil including high-rise apartments and flats (NEHF D)	Parks, recreational open space, playing fields including secondary schools (NEHF E)	Commercial or industrial (NEHF F)	
	Column 1	Column 2	Column 3	Column 4	Column 5
Metals and metalloids					
Arsenic (total)	100	400	200	500	20
Beryllium	20	80	40	100	–
Cadmium	20	80	40	100	3
Chromium (III)[4]	12%	48%	24%	60%	400
Chromium (VI)	100	400	200	500	1
Cobalt	100	400	200	500	–
Copper	1,000	4,000	2,000	5,000	100
Lead	300	1,200	600	1,500	600
Manganese	1,500	6,000	3,000	7,500	500
Methyl mercury	10	40	20	50	–
Mercury (inorganic)	15	60	30	75	1[5]
Nickel	600	2,400	600	3,000	60
Zinc	7,000	28,000	14,000	35,000	200
Organics					
Aldrin + dieldrin	10	40	20	50	–
Chlordane	50	200	100	250	–
DDT + DDD + DDE	200	800	400	1,000	–
Heptachlor	10	40	20	50	–
PAHs (total)	20	80	40	100	–
Benzo(a)pyrene	1	4	2	5	–
Phenol[6]	8,500	34,000	17,000	42,500	–
PCBs (total)	10	40	20	50	–
Petroleum hydrocarbon components[7]					
> C16–C35 (aromatics)	90	360	180	450	–
> C16–C35	5,600	22,400	11,200	28,000	–
> C35 (aliphatics)	56,000	224,000	112,000	280,000	–
Other					
Boron	3,000	12,000	6,000	15,000	–[8]
Cyanides (complex)	500	2,000	1,000	2,500	–
Cyanides (free)	250	1,000	500	1,250	–

1 The limitations of health-based soil investigation levels are discussed in Schedule B(1) Guidelines on the Investigation Levels for Soil and Groundwater and Schedule B(7a) Guidelines on Health-based Investigation Levels, *National Environment Protection (Assessment of Site Contamination) Measure 1999* (NEPC 1999)
2 The provisional phytotoxicity-based investigation levels proposed in this document are single number criteria. Their use has significant limitations because phytotoxicity depends on soil and species parameters in ways that are not fully understood. They are intended for use as a screening guide and may be assumed to apply to sandy loam soils or soils of a closely similar texture for pH 6–8.
3 National Environmental Health Forum (NEHF) is now known as enHealth.
4 Soil discolouration may occur at these concentrations.
5 Total mercury
6 Odours may occur at these concentrations.
7 The carbon number is an 'equivalent carbon number' based on a method that standardises according to boiling point. It is a method used by some analytical laboratories to report carbon numbers for chemicals evaluated on a boiling point GC column.
8 Boron is phytotoxic at low concentrations. A provisional phytotoxicity-based investigation level is not yet available.

Notes:

This table is adapted from Table 5-A in Schedule B(1): Guidelines on Investigation Levels for Soil and Groundwater to the National Environment Protection (Assessment of Site Contamination) Measure 1999 (NEPC 1999).

Soil investigation levels (SILs) may not be appropriate for the protection of ground water and surface water. They also do not apply to land being, or proposed to be, used for agricultural purposes. (Consult NSW Agriculture and NSW Health for the appropriate criteria for agricultural land.)

SILs do not take into account all environmental concerns (for example, the potential effects on wildlife). Where relevant, these would require further consideration.

Impacts of contaminants on building structures should also be considered.

For assessment of hydrocarbon contamination for residential land use, refer to the *Guidelines for Assessing Service Station Sites* (EPA 1994).

Threshold Concentrations for Sensitive Land Use – Soils Guidelines for Assessing Service Station Sites (NSW EPA 1994)	
Contaminant	**Threshold Concentration (mg/kg)**
TPH (C_6-C_9)	65
TPH (C_{10}-C_{36})	1,000
Benzene	1
Toluene	1.4 / 130
Ethylbenzene	3.1 / 50
Xylenes (total)	14 / 25

Trigger Values (TV) for Screening Fresh Water Quality Data (µg/L) for Slightly to Moderately Disturbed Ecosystems (ANZECC 2000)		
Contaminant	**Threshold Concentration (µg/L)**	**Guideline Source**
Metals and Metalloids		
Arsenic – As (III/V)	24/13	ANZECC (2000) 95% protection levels.
Boron - B	370	ANZECC (2000) 95% protection levels (figure may not protect key test species from chronic toxicity)
Cadmium – Cd	0.2	ANZECC (2000) 95% protection levels.
Nickel – Ni	11	
Manganese – Mn	1900	ANZECC (2000) 95% protection levels (figure may not protect key test species from chronic toxicity)
Mercury – Hg	0.06	ANZECC (2000) 99% protection level due to potential for bio-accumulation or acute toxicity to particular species.
Chromium – Cr (III/VI)	3.3/1.0	Low reliability trigger values (95% level of protection) from Volume 2 of ANZECC (2000) for Cr (III) and Co
Cobalt – Co	2.8	
Copper – Cu	1.4	ANZECC (2000) 95% protection levels.
Lead – Pb	3.4	
Zinc – Zn	8.0	ANZECC (2000) 95% protection levels (figure may not protect key test species from chronic toxicity)
Aromatic Hydrocarbons		
Benzene	950	Moderate reliability trigger values (95% level of protection) from Volume 2 of ANZECC (2000)
Toluene	180	Low reliability trigger values (95% level of protection) from Volume 2 of ANZECC (2000)
Ethylbenzene	80	
m-xylene	75	
o-xylene	350	Moderate reliability trigger values (95% level of protection) from Volume 2 of ANZECC (2000)
p-xylene	200	
Polycyclic Aromatic Hydrocarbons		
Naphthalene	16	ANZECC (2000) 95% protection level due to potential for bio-accumulation or acute toxicity to particular species.
Anthracene	0.01	Low reliability trigger values from Volume 2 of ANZECC (2000)
Phenanthrene	0.6	
Fluoranthene	1	ANZECC (2000) 99% protection level due to potential for bio-accumulation or acute toxicity to particular species.
Benzo(a)pyrene	0.1	
Organochlorine Pesticides		
Aldrin	0.001	Low reliability trigger values from Volume 2 of ANZECC (2000)
DDE	0.03	
Dieldrin	0.01	
Endosulfan α	0.0002	
Endosulfan β	0.007	
Chlordane	0.03	ANZECC (2000) 95% protection levels
DDT	0.006	
Lindane	0.2	
Endosulfan	0.03	ANZECC (2000) 99% protection level due to potential for bio-accumulation or acute toxicity to particular species.
Endrin	0.01	
Heptachlor	0.01	
Organophosphorus Pesticides		
Azinphos methyl	0.01	ANZECC (2000) 99% protection level due to potential for bio-accumulation or acute toxicity to particular species.

Trigger Values (TV) for Screening Fresh Water Quality Data (µg/L) for Slightly to Moderately Disturbed Ecosystems (ANZECC 2000)		
Contaminant	**Threshold Concentration (µg/L)**	**Guideline Source**
Methoxychlor	0.005	Low reliability trigger values from Volume 2 of ANZECC (2000)
Dementon-S-methyl	4	
Chloropyrifos	0.01	ANZECC (2000) 95% protection levels
Diazinon	0.01	ANZECC (2000) 95% protection levels
Dimethoate	0.15	
Fenitrothion	0.2	
Malathion	0.05	
Parathion	0.004	
Non-Metallic Inorganics		
Total Ammonia as N (pH of 8)	900	ANZECC (2000) 95% protection levels
Cyanide (Free or unionised)	7	
Nitrate	700	Moderate reliability trigger values (95% level of protection) from Volume 2 of ANZECC (2000)
NO_x	40	ANZECC (2000) Default trigger values for physical and chemical stressors for slightly disturbed ecosystems in lowland rivers of South-east Australia. The trigger values for TP and TN are 25 µg/L and 350 µg/L, respectively, for east flowing coastal rivers in NSW.
Total Nitrogen	500	
Total Phosphorous	50	
Ammonium ($NH4^+$)	20	
Chlorine	3	ANZECC (2000) 95% protection levels.
Phenols		
Phenol	320	ANZECC (2000) 95% protection levels
2,4-dimethylphenol	2	Low reliability values (95% level of protection) from Volume 2 of ANZECC (2000)
Chlorinated Alkanes and Alkenes		
Tetrachloroethene (PCE)	70	Low reliability trigger values (95% level of protection) from Volume 2 of ANZECC (2000)
1,1,2-Trichloroethene (TCE)	330	
Vinyl chloride (chloroethene)	100	
1,1,1-Trichloroethane	270	
1,1-Dichloroethene	700	
1,1-Dichloroethane	90	
1,2-Dichloroethane	1900	
Chloroform	370	
1,1,2-Trichloroethane	6500	Moderate reliability trigger values (95% level of protection) from Volume 2 of ANZECC (2000)
Chlorinated Aromatic Hydrocarbons		
1,3-dichlorobenzene	260	Moderate reliability trigger values (95% level of protection) from Volume 2 of ANZECC (2000)
1,4-dichlorobenzene	60	
1,2,4-trichlorobenzene	85	
Hexachlorobenzene	0.05	Low reliability values (95% level of protection) from Volume 2 of ANZECC (2000). (QSAR derived)
Miscellaneous Industrial Chemicals		
Hexachlorobutadiene	0.04	Environmental Concern Level from Volume 2 of ANZECC (2000)

While the low reliability figures should not be used as default guidelines they will be useful for indicating the quality of groundwater migrating off-site.

Appendix C:
EPA Approved Guidelines

Guidelines made or approved by the EPA under section 105 of the *Contaminated Land Management Act 1997*

(*as of 12 July 2012*)

Section 105 of the Contaminated Land Management Act 1997 (CLM Act) allows the Environment Protection Authority (EPA) to make or approve guidelines for purposes connected with the objects of the Act. These guidelines must be taken into consideration by the EPA whenever they are relevant and by accredited site auditors when conducting a site audit. They are also used by contaminated land consultants in undertaking investigation, remediation, validation and reporting on contaminated sites.

Guidelines made by the EPA

- Guidelines for Assessing Service Station Sites (December 1994)
- Guidelines for the Vertical Mixing of Soil on Former Broad-acre Agricultural Land (January 1995)
- Sampling Design Guidelines (September 1995)
- Guidelines for Assessing Banana Plantation Sites (October 1997)
- Guidelines for Consultants Reporting on Contaminated Sites (reprinted August 2011)
- Guidelines for Assessing Former Orchards and Market Gardens (June 2005)
- Guidelines for the NSW Site Auditor Scheme, 2nd edition (April 2006)
- Guidelines for the Assessment and Management of Groundwater Contamination (March 2007)
- Guidelines on the Duty to Report Contamination under the Contaminated Land Management Act 1997 (June 2009)

Note: All references in the EPA's contaminated sites guidelines to the Australian Water Quality Guidelines for Fresh and Marine Waters (ANZECC, November 1992) are replaced as of 6 September 2001 by references to the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC and ARMCANZ, October 2000), subject to the same terms.

Guidelines approved by EPA

ANZECC publications

- Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites, published by Australian and New Zealand Environment and Conservation Council (ANZECC) and the National Health and Medical Research Council (NHMRC) (January 1992)
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality, published by ANZECC and Agriculture and Resource Management Council of Australia and New Zealand, Paper No 4 (October 2000)

EnHealth publications (formerly National Environmental Health Forum monographs)

- Composite Sampling, Lock, W. H., National Environmental Health Forum Monographs, Soil Series No.3, 1996, SA Health Commission, Adelaide
- Environmental Health Risk Assessment: Guidelines for assessing human health risks from environmental hazards, Department of Health and Ageing and EnHealth Council, Commonwealth of Australia (June 2002)

National Environment Protection Council publications

- National Environment Protection (Assessment of Site Contamination) Measure 1999

The Measure consists of a policy framework for the assessment of site contamination, Schedule A (Recommended General Process for the Assessment of Site Contamination) and Schedule B (Guidelines).

- Schedule B guidelines include:

  B(1) Guideline on Investigation Levels for Soil and Groundwater
  B(2) Guideline on Data Collection, Sample Design and Reporting
  B(3) Guideline on Laboratory Analysis of Potentially Contaminated Soils
  B(4) Guideline on Health Risk Assessment Methodology
  B(5) Guideline on Ecological Risk Assessment
  B(6) Guideline on Risk-based Assessment of Groundwater Contamination
  B(7a) Guideline on Health-based Investigation Levels
  B(7b) Guideline on Exposure Scenarios and Exposure Settings
  B(8) Guideline on Community Consultation and Risk Communication
  B(9) Guideline on Protection of Health and the Environment During the Assessment of Site Contamination
  B(10) Guideline on Competencies and Acceptance of Environmental Auditors and Related Professionals

Other documents

- Guidelines for the Assessment and Clean Up of Cattle Tick Dip Sites for Residential Purposes, NSW Agriculture and CMPS&F Environmental (February 1996)
- Australian Drinking Water Guidelines, NHMRC (2011)

Appendix D:
Stage 1 – Initial Advice, 7 February 2003, ENVIRON Australia Pty Ltd

7 February 2003 Ref: 31-0163

Landcom
C/o Alan Lalich & Associates Pty Ltd
PO Box 5047
Kingsdene NSW 2118

Attn: Mr Alan Lalich

Dear Mr Lalich,

SITE AUDIT, ZOUCH ROAD INGLEBURN

STAGE 1 - INITIAL ADVICE

1 INTRODUCTION

Stage 1 of a site contamination audit has been conducted relating to Landcom property at Zouch Road, Ingleburn, formerly occupied by the Department of Defence (Defence). Stage 1 of the audit was undertaken for the purposes of outlining the additional documentation, investigations and/or remediation required for the site to be eligible to receive a site audit statement certifying its suitability for residential use. The audit is not currently required by regulation or legislation and it is therefore a non-statutory audit.

Details of the audit are:

Requested by:	Alan Lalich, on behalf of Landcom
Request/Commencement Date:	24 January 2003
Auditor:	Graeme Nyland
Accreditation No.:	9808

The scope of Stage 1 of the audit included:

- Audit of the following reports:
  - *Stage 1 Preliminary Contamination Investigation. Zouch Road Ingleburn 92 Ha Site*. Milsearch Pty Ltd. Prepared for Landcom, September 2000; and
  - *Draft Stage 2 Munitions Contamination Investigations. Landcom 92 Ha Site, Zouch Road, Ingleburn (Former Army Infantry Centre). 21 January – 6 April 2002.* Milsearch Pty Ltd. Footer date 30 June 2002.
- Site visit by the Auditor on 31 January 2003.

2 SITE DETAILS

2.1 LOCATION

The site is located on the north and west extremity of the Ingleburn Military Camp, which is located on Campbelltown Road running south west from Liverpool.

Further details follow:

Street address:	Zouch Road, Ingleburn NSW 2565
Identifier:	Lot 1, DP 807460 (54.67 ha) Lot 2, DP 807461 (38.14 ha)
Local Government:	Liverpool City Council
Owner:	Landcom (NSW Government)
Site Area:	92.81 ha

2.2 ZONING

According to the Stage 1 Consultant report, the site zoning status is as follows:

- Previous 5(a) Military
- Current 1(a) Rural
- Proposed 2(a) Residential

2.3 ADJACENT USES

The site has frontage to only one public road, Zouch Road, for only a short distance in the south west corner of the site.

Adjacent site uses are as follows:

- Well-developed semi-urban acreages which front away from the site to Culverston Avenue are located to the **west**;
- A series of small agricultural blocks which also front away from the site are located to the **north** and **east**, fronting onto Jardine Drive and Croatia Avenue, respectively;
- Low cost housing which was formerly Army Married Quarters are located to the **south east**; and
- The now disused Ingleburn Military Camp is located to the **south**.

2.4 SITE CONDITION

Other information prepared for the site and referenced by Milsearch Pty Ltd ('the Consultant'), but not reviewed by the Auditor, include:

- *Preliminary Flora and Fauna Study*. Pelican Environmental Surveys, March 1999;
- July – August 2001 studies of Cumberland Land Snail colonies;
- Topographical surveys of the site, August – September 2001; and
- National Parks and Wildlife Service Section 91 licence providing approval for vegetation slashing to proceed, October 2001.

The site is described as open grassed land with several separate stands of protected Cumberland Plain Woodlands (Grey Box). A number of protected Land Snail colonies are located primarily in nine areas of protected woodland. Although readily accessible areas of grassland are reportedly slashed on a regular bases as a fire protection measure, vegetation overgrowth is extensive at the site.

The topography of the site is described as gently undulating. Key site features described include:

- a low ridge line in the north;
- a small hill in the south east;
- a man-made stop butt as part of a 25m small arms firing range in the south west;
- various earth roads cross the site;
- well-constructed 9m wide dirt perimeter road;
- major creek lines and dams on site are as follows:
    - originating on site, in the east running from south to north, exiting in the north east of the site, Dam 1 is on this creek;
    - feeder creek to the above, south east of the stop butts, Dam 3 is on this feeder creek;
    - originating off-site, in the east, running northerly then easterly, exiting in the north east, Dam 2 is on this creek; and
    - all three dams were dry in 2000.

A number of observations relevant to the contamination assessment were made by the Consultant, as follows:

- Expended blank small arms ammunition (SAA) litters the site as a product of infantry minor tactical training. SAA may be of higher density associated with slit trenches in the west and north of the site, in Cumberland Plain Woodland areas.
- There are a number of areas on site that have been used for disposal of building and domestic waste:

  - Trenches in high ground to the north east of the miniature firing range;
  - Piles in the extreme north west corner of the site, including bonded asbestos sheeting and building rubble;
  - Pile 100m north east of the entrance gate; and
  - Piles in numerous other locations on site.
- There are numerous areas of concertina barbed wire located at the site, which were formerly used as practice obstacles.
- Slit trenches are common across the site, especially on the slopes of the high ground in the north. Many trenches have been partially filled and are likely to contain some star pickets, corrugated iron and possibly expended training ammunition.
- There are two former underground command posts in the north central portion of the site, fenced off by barbed wire. One is filled with water.
- A few concrete building foundations indicating the former presence of structures are located on site, primarily in two zones:
  - In the south east near Dam 2, possibly former dog kennels; and
  - On the north west wooded ridgeline, including two foundations, a latrine and evidence of other wood frame buildings.
- A coal stockpile is located on high ground to the north east of the miniature firing range.
- Car bodies are located in numerous locations, some burnt areas were found where the bodies had evidently been removed.
- Bonded asbestos materials were observed on site as follows:
  - A short length of bonded asbestos 4" water conduit was observed south of the miniature firing range, possibly imported with building rubbish;
  - Five piles of asbestos sheeting and building rubble were present north of the miniature firing range, close to the access road;
  - Two more piles are present on the crest of the hill north of the miniature firing range; and
  - Asbestos was noted in the waste dumping in the extreme north west corner of the site.

The Auditor's observations during the site inspection were consistent with the site conditions described by the Consultant.

2.5 PROPOSED DEVELOPMENT

It is understood that the site is proposed to be subdivided into a residential development (zoning 2(a) Residential). The audit will be conducted against criteria applicable to the "Residential with gardens and accessible soil" land use exposure standards.

3 SITE HISTORY

The Consultant compiled site history information from the following sources:

- Literature search including Gavin Lang's history of the Second World War; various unit histories and war diaries; and a magazine produced at Ingleburn Camp during the period of the universal National Service Scheme (1950-1959);
- Archival material from National Archives, Canberra; National Archives, NSW and from the Australian War Memorial Public Documents Archive;
- Interviews with serving and former soldiers who had trained at Ingleburn camp at some time during their careers, or who could have knowledge of the camp's history;
- Review of records and drawings held by the Defence Property Office NSW and information from the period Defence Hirings Register, made available by the Defence Regional Office Sydney;
- Examination of the Defence 1996 Unexploded Ordnance (UXO) Assessment for Ingleburn Military Camp along with supporting Explosive Ordnance Incident Reports (EOIR) and EOIRs from 1996 to 2000;
- Review of available aerial photographs from 1947 to 1998; and
- Site inspection.

It is reported that the site was used for farming purposes until 1939 when Defence hired 'vacant land' near Ingleburn Camp as a 'manoeuvre area'. Usage by Defence continued through the WW2 period and the land was purchased by the Commonwealth in 1953. Land within the wider Ingleburn area was acquired by the Army and used to establish camps and to conduct training for wartime expansion. The land remained in active Defence use primarily for infantry training purposes until the mid 1990's, at which time a 92 ha portion surplus to Defence requirements (the site in question) was purchased by the NSW Government for later urban development.

Key aspects of the site history relevant to the contamination assessment abstracted from the reviewed reports are as follows:

- A grenade range was present in the centre of the site from the early 1950s for up to 30 years. The range was used for live grenade throwing practices and possibly also mortar practice bombs.
- A miniature, small arms firing range was present in the south west of the site from the early 1950s for up to 30 years. The range was originally oriented firing to the north but now is oriented to fire to the south. The original stop butt

material, which contained lead particulate, was spread about the range and built into roads at the site in the 1970s.

- The dams may have been used for disposal of unwanted munitions.
- A trench disposal area, located in high ground to the north east of the miniature firing range, was reportedly filled by the former disposal practices of the 'Boards of Survey' of 'burn, bash and bury'. This area would contain general stores materials which were damaged or surplus to requirements.
- No underground storage tanks (USTs) were identified by the site history review or site inspection.
- From review of aerial photographs, the vegetation on site (Cumberland Plain Woodland) was far less dense in 1978 and prior. Tree growth has been significant since the 1978 photograph was taken.

In the Auditor's opinion, the site history review has been detailed and the major potential contamination issues on site have been identified. Some uncertainty remains with respect to the potential for:

- additional waste disposal trenches;
- additional areas of lead particulate;
- the location of slit trenches that may have been backfilled; and
- unexpended (live) blank SAA possibly disposed during tactical training exercises.

4 CONTAMINANTS OF CONCERN

The Consultant identified a number of potential contaminants at the site. Based on the reviewed reports, site history and site condition, the potential contaminants of concern in the opinion of the Auditor are as shown in Table 4.1 below:

Activity	Area	Contaminants of concern
Live grenade throwing practices and possibly also mortar practice bombs	Grenade range	UXO and grenade explosion residues
Miniature (small arms) firing range	Firing range stop butts Roadways where reengineered stop butt material was placed Dam 3 (runoff)	Lead particulate and other heavy metals
Possible munitions disposal	Dams 1, 2 and 3	UXO
Waste disposal in trenches	3 burial trenches, NE of miniature firing range Possible additional unknown locations	Unknown, could include heavy metals, petroleum hydrocarbons, pesticides, asbestos, household chemicals

Activity	Area	Contaminants of concern
Waste disposal in piles, including building rubble	Extreme north west corner of the site 100m north east of the entrance gate South of miniature firing range 5 piles north of miniature firing range 2 piles on crest of hill north of miniature firing range Potential locations across entire site	Unknown, could include heavy metals, petroleum hydrocarbons, pesticides, asbestos, household chemicals
In-ground structures used for infantry minor tactical training	Known slit trench locations Underground command posts Possible additional unknown locations	Physical objects such as star pickets and corrugated iron Unknown, possibly heavy metals (significant contamination would not be expected with this type of material, removal would be desirable for aesthetic purposes)
Infantry minor tactical training	Entire site, especially near slit trenches	Expended SAA, small percentage live (unexpended) SAA
Pest and weed control	Entire site	Pesticides, herbicides, arsenic, mercury
Runoff of contaminants	All waterways on site	Lead particulate primarily Pesticides, herbicides, arsenic, mercury
Building products and treatments	Former building	Pesticides, asbestos, lead
Storage and distribution of coal	Coal stockpile	Coal dust Possibly PAH, phenols (significant contamination would not be expected with unburnt coal, however constituent compounds should be tested in underlying soils)
Practice obstacles	Numerous locations	Barbed wire physical hazard
Car body disposal and burning	Numerous locations	PAH, heavy metals, petroleum hydrocarbons
Car body disposal, surface dumping and practice obstacles	Numerous locations	Physical objects including cars and barbed wire Unknown, possibly PAH, heavy metals, petroleum hydrocarbons (significant contamination would not be expected with these types of surface dumpings, removal would be desirable for aesthetic purposes)

Table 4.1 – Contaminants of concern

According to the Consultant, while live blank SAA ammunition constitutes a lesser hazard than live ball ammunition, blanks can still cause significant injury, particularly eye damage, if detonated through tampering.

Although the waste types likely to be encountered in the burial trenches or surface dumps are likely to vary, the classes of contaminants of concern likely to be associated with waste disposal are well known, and are listed in Table 4.1, above.

5 STRATIGRAPHY AND HYDROGEOLOGY

Detailed information regarding the site stratigraphy and hydrogeology has not yet been provided.

The only subsurface investigations undertaken to date involved excavation of burial pits. The type of natural soil encountered during this exercise was reported as clay. The pits were reported to have contained foul smelling water. An underground command post was noted as being filled with water.

The site area is known by the Auditor to comprise clay soils, overlying shale bedrock with occasional sandstone and laminite. An outcrop of bedrock was observed adjacent to the perimeter road in the north west of the site during the site inspection.

It is expected that there are limited quantities of groundwater in bedrock at the site. A survey of local groundwater usage and springs should be conducted, but there is unlikely to be a usable aquifer under the site. There does not appear to be any sensitive receiving environments for groundwater near the site.

6 QUALITY ASSURANCE AND QUALITY CONTROL

Investigation of soil and groundwater quality, and associated QA/QC requirements, has not yet been undertaken. For certification of the proposed site usage, a detailed site investigation in accordance with the requirement of the "*Guidelines for Consultants Reporting on Contaminated Sites*" (EPA, 1997) is required to be conducted in accordance with preset Data Quality Objectives (to be set prior to commencement of investigations).

Data Quality Objectives in relation to the assessment of munitions contamination, including UXO, also need to be addressed.

7 ENVIRONMENTAL QUALITY CRITERIA

Environmental quality criteria related to chemicals in soil and groundwater or the presence of munitions have not yet been developed for the site.

With a proposed residential usage, relevant environmental quality criteria for the site **soils** would include:

- "Soil Investigation Levels for Urban Redevelopment Sites in NSW" (Column 1 – "Residential with gardens and accessible soil" and Column 5 – "provisional Phytotoxicity based investigations level") found in the EPA (1998) "*Guidelines for The NSW Site Auditor Scheme"*.
- "Threshold concentrations for sensitive land use – soils" found in the EPA (1994) "*Guidelines for Assessing Service Station Sites"* would also be relevant.

For **groundwater**, the Trigger Values for Freshwater found in the ANZECC (2000) "*Australian and New Zealand Guidelines for Fresh and Marine Water Quality*" would be relevant.

With relation to **munitions**, reference should be made to "The assessment and management of land contaminated with unexploded ordnance" published in the National Environmental Health Forum Fourth Workshop Proceedings on the Health Risk Assessment and Management of Contaminated Lands (1998). There are currently no EPA endorsed environmental quality criteria for UXO or live SAA. The Consultant should benchmark with similar sites in Australia and overseas to determine appropriate environmental quality criteria for these types of contaminants.

Environmental quality criteria for **aesthetic issues** such as car bodies, barbed wire and expended SAA need to be addressed.

8 EVALUATION OF MUNITIONS INVESTIGATION RESULTS

The reports reviewed to date have documented the investigation of areas of the site with munitions contamination. Details of these investigations and their results are as follows.

8.1 STAGE 1

The scope of work undertaken for Stage 1 comprised:

- site history review;
- a very coarse preliminary instrumented sampling program comprising metal detector transects at 50m intervals over the entire site, the field work allowed for the detection of surface and near-surface metallic items and was found to be effective over 65-70% of the site (the remainder being inaccessible); and
- identification of existing and potential contaminants other than munitions.

Soil and groundwater issues were not addressed.

The Stage 1 report identified many of the issues of concern listed in Sections 2 and 3, and provided a good basis for detailed scoping of the Stage 2 investigations.

8.2 STAGE 2

The objectives and scope of Stage 2, and corresponding results, are outlined below:

a) Identify zones of grenade or mortar UXO

The range was used for live grenade throwing practices and possibly also mortar practice bombs. Investigation of this zone involved initially slashing vegetation over a 6.5 ha "Grenade Exclusion Zone" area. The investigation method was by analogue detector and magnetometer sampling surveys along 1m wide transects at intervals of

20m, with some fill in at 10m intervals around impact zones identified initially. The total sampling achieved was approximately 6% of the Grenade Exclusion Zone. Detectors used were Minelab Electronics F1A4 mine detectors. All readings were investigated by hand and the nature and location of finds recorded and removed from site.

The investigations have identified three grenade impact areas with the Grenade Exclusion Zone, as follows

- IA1 – rectangular area in the north, six impact points.
- IA2 – central portion, 30 impact points (more investigations required to define this area).
- IA3 – south, four impact points (more investigations required to define this area).

Part c, below, provides details of additional grenade impact areas found during the SAA validation process.

Additional investigations in this area used a Forester analogue magnetometer along 1m swaths at 5m intervals throughout the Grenade Exclusion Zone. Due to strong interference from mineralised rocks and soil, the setting of the detector was adjusted, narrowing the effective swath width to something less than 10% of the Grenade Exclusion Zone. No additional mortar bomb impacts were identified from this search and it was concluded that while more of the mortar bombs may exist in the Grenade Exclusion Zone, they are only likely to be in small numbers.

The Consultant has identified some additional investigations that are required to complete the assessment in this area. The results of further investigations will need to be reviewed by the Auditor. In order to allow completion of the Auditor's assessment of this area, the Consultant should provide a clear statement regarding what impacts have been cleaned up; what, if any, remediation is required; what are the residual risks in this area; and justification for the acceptance criteria that has been adopted. The Consultant should ensure that the additional investigations undertaken are sufficient to demonstrate that appropriate environmental quality criteria have been met.

b) Delineate all zones of lead particulate

The original stop butt material, which contained lead particulate, was spread about the range and built into roads at the site in the 1970s. Investigations involved initially slashing over a 3.5ha area in the vicinity of the stop butts, along sampling transect lines at 10m intervals. The investigation method was by digital detector sampling surveys to delineate the spread of lead particulate contained in the re-engineered firing range stop butt material. Additional lead particulate material in roads and other locations was also located and mapped using the blank SAA delineation method discussed in part c, below. External limits were confirmed by analogue follow-up investigations with an F1A4 mine detector.

Investigations have delineated the extent of lead-impacted material at the site, as follows:

- A 4.1 ha area surrounding the stop butts. Delineation was successful except for defining the exact extent in the high ground to the east. Since this area is also impacted by broken asbestos sheeting and coal dust from the stockpile, this

poor definition was not considered significant since remediation of this area would already be required.

- A 0.65 ha area of the north west perimeter road.
- Two small tip truck back dumpings north west of the stop butt area, approximately 4 to 5 m^3 each pile.
- In the road formation at the Zouch Road entrance gate.

Soil samples have yet to be analysed to determine the concentration of lead in the areas identified, however, the concentration of lead particulate was reported to vary considerably within each of the larger areas identified.

Quantification of the concentration of lead in soils in the identified areas is required, including an assessment of the likely variability in concentration. Without any justification to the contrary, remediation of all materials with a lead concentration exceeding 300 mg/kg would be required for the proposed residential use.

c) Delineate zones of blank SAA and determine their relative density

Expended blank small arms ammunition (SAA) litters the site as a product of infantry minor tactical training.

Investigations involved slashing into permissible areas of the site along nominally parallel sampling transect lines at 20m intervals over approximately 80 ha (the balance of the site). The investigation method was by digital detector sampling surveys to map and measure the density of expended SAA blank ammunition. The detector used was the TM5 EMU computer assisted large coil metal detector which had been demonstrated in laboratory tests to detect surface and near surface blanks at a typical carrying height and at a fast walking speed. Similar tests had also confirmed that zones of lead particulate soil could also be differentiated confidently (refer part b, above).

Digital metallic densities were recorded for a network of 'cells' or 'tiles' across the site. These densities were validated with analogue equipment during close inspection of 1% of the cells. A number of areas of the site were excluded from measurement due to inaccessibility or interference from other impacts (eg, grenade zone, burial pits). During validation, it was found that extraneous metallic material such as barbed wire and domestic rubbish interfered to some degree with the detector method used.

The types of SAA encountered include brass and plastic, intact (at surface) and degraded (buried). The investigations have estimated the density of occurrence as between 1600 and 1800 SAA per hectare, with approximately 2% of the SAA estimated as being live (unexpended). The SAA is likely to be of higher density associated with slit trenches in the west and north of the site, in Cumberland Plain Woodland areas.

This exercise also allowed for accurate location of several car bodies and areas of barbed wire and a possible additional four areas of asbestos sheeting impact.

The validation process based on checking high metallic concentrations was found to be an effective site-wide check of unexpected potential metallic ordnance contamination. Additional impacts located included:

- *A target area for 3.5" anti-tank practice rocket projectiles*. 19 pieces of fragmentation were found in a 1m line encompassing an apparent target and

drop short area. The area appeared to have been searched and partially cleared, however potential exists for some inert rocket heads to be below-ground. While they present no hazard, this would be an aesthetic issue requiring a remedial search.

- *A target area or areas for No 94 Energa rifle-projected anti-tank grenades*. Several stabilizer fins from an anti-tank rifle grenade were found in one area (further investigations are required in this area).
- *A possible target area for 36M practice rifle-projected grenades*. An unexploded grenade was found 10m from the north east corner of Dam 3 (further investigations are required in this area).
- *An additional 36M grenade impact area south east of the Grenade Exclusion Zone.* An additional 36M grenade fuze well area was found (further investigations are required in this area).

The Consultant has identified some additional investigations that are required that were uncovered by the assessment of this issue. The results of further investigations will need to be reviewed by the Auditor. In order to allow completion of the Auditor's assessment of this issue, further work is required in determining appropriate acceptable criteria for the presence of SAA across the site, including an assessment of aesthetic issues as well as the residual risk associated with a possible 2% presence of live blank SAA across the site. EPA advice to the Consultant so far has indicated that a 100% search and removal would be required if there is any potential for live blank SAA. If this is the acceptance criteria to be adopted, significant remedial searches will be required. If an alternate acceptance criteria is established, there is still the potential for further investigations to be required.

The Consultant should also consider re-assessment of the areas of the site that were originally excluded from measurement due to inaccessibility, or else provide further justification for the exclusion of these areas from the assessment.

d) Determine the extent of stores disposal burials in one area

Three parallel pits were delineated by a digital detector survey (using the TM5 EMU computer assisted large coil metal detector) in the vicinity of the open pit originally identified. The pits run downhill to the east away from the coal stockpile. The combined area of the pits was determined to be 0.25 ha. The length of each pit was found to be (from the north), 64, 72 and 71 m long. The average width was 6m and the average depth was 2.5m.

500mm wide trench cross sections were excavated to the bottom of the pits at 10m intervals. The pit contents were found to include:

- Bonded asbestos sheeting;
- Building waste (including bricks, pipes, concrete blocks, guttering, downpipes);
- Household waste (including fridges, water heaters, metal cabinets); and
- Foul water was encountered when the crust of the pits was broken through.

No munitions were observed in the pits. It was determined that buildings demolished in the departure of the Infantry Centre to Singleton in the early 1990's were placed in the

pits. The pits were observed to be terminated in clay. Large metal wastes were observed on the ground surface in the vicinity of the pits.

While the visual observations indicate the only confirmed contaminant within the burial pits is asbestos sheeting fragments, the potential exists for unknown contaminants to have been disposed of in this manner. As a result, it is recommended by the Auditor that the contents of waste burial pits and surface waste dumpings across the site be removed to removal the potential for impact from unknown contaminants, physical hazards and aesthetic impacts.

e) Conduct instrumental searches for munitions in three dams

Instrumented detector searches (magnetometer and metal detector) were conducted following slashing of the dry dam beds.

Dam 1 was found to have high magnetic naturally occurring interference, with no munitions found.

Dam 2 contained sections of water pipe at 700mm depth, with no munitions found.

Dam 3 was not assessed due to other commitments in the field and needs to be assessed.

The proposed investigation of Dam 3 should complete the action required within the dams in regards to munitions.

Consultant's Recommendations

The Stage 2 report identifies the need for further investigations to complete the assessment of munitions contamination at the site, including:

- Munitions assessment of Dam 3.
- Remedial search of 3.5" practice rocket zone.
- Additional slashing and searches in three areas:
    1. 1 ha south of Dam 2, where practice 36M projected grenade was found.
    2. 3 ha in south east of the site, where 36M grenade impact zone and No 94 Energa rifle-projected anti-tank grenade fragments were found.
    3. 1.75 ha extension of the Grenade Exclusion Zone to the west.

This proposed additional scope appears appropriate. Any remediation strategies will need to be defined based on the results of all of the munitions investigations undertaken to date and should take note of the Auditor comments outlined in the above sections a to e.

As a general item in auditing the munitions investigations undertaken, the Auditor would like the opportunity to review the various qualifications of the Consultants involved in the munitions investigations.

9 SOIL AND GROUNDWATER INVESTIGATION

Analytical assessment of soil and groundwater quality at the site has not yet been undertaken, although a number of potentially contaminated areas have been identified. It will be necessary for a qualified environmental consultant to undertake a detailed soil and groundwater investigation prior to assessment by the Auditor of the suitability of the site for residential usage. A Sampling Plan should be prepared, including Data Quality Objectives and proposed environmental quality criteria, prior to commencement for review by the Auditor. Reporting on the investigation should be in accordance with the EPA (1997) "*Guidelines for Consultants Reporting on Contaminated Sites*".

Based on the reports reviewed, the Auditor recommends that investigation of the areas listed in Table 4.1 would be required as part of any detailed soil investigation.

The extent of groundwater investigation required will depend on the conditions encountered. The groundwater investigation is recommended to include as a minimum:

- Determination of the presence and levels of groundwater across the site;
- Assessment of groundwater quality in the main impact areas of lead particulate (stop butt material) and waste burial in trenches; and
- A survey of local groundwater usage and springs.

10 ASSESSMENT OF RISK

An assessment of risk due to munitions contamination will be undertaken once the remediation strategy and proposed acceptance criteria for the various impacts and affected areas has been confirmed by the Consultant.

An assessment of risk based on soil and groundwater quality cannot yet be undertaken.

11 EVALUATION OF REMEDIATION

Aside from collection of located munitions fragments, no other remediation has yet been undertaken at the site. Further investigations and detail of any proposed remediation works is required before an evaluation of their adequacy can be made. The Consultant should note the various Auditor comments included in Section 8.2, parts a to e in documenting the proposed remediation strategy for the site; the proposed acceptance criteria; and any residual risks.

It is anticipated that remediation at the site will require, as a minimum, removal and validation of the following impacts already identified:

- Remedial search of 3.5" practice rocket zone.
- Surface waste dumpings, including asbestos-containing materials (note special disposal requirements for asbestos);

- Car bodies, barbed wire, star pickets and corrugated iron;
- Contents of waste burial pits;
- Lead particulate occurring in stop butt material at the firing range and spread around the site; and
- Coal stockpile and areas affected by coal dust.

12 COMPLIANCE WITH REGULATORY GUIDELINES AND DIRECTIONS

Guidelines currently approved by the EPA under section 105 of the Contaminated Land Management Act 1997 are attached as Appendix A. The Auditor has used these guidelines in assessing the activities to date, and they will be applied to future activities.

The Stage 1 Preliminary Contamination Investigation was generally prepared in accordance with the requirement of the "*Guidelines for Consultants Reporting on Contaminated Sites*" (EPA, 1997) for **preliminary site investigations** (Stage 1). The checklist included in that document has been completed and is kept in file. Exceptions relate to the detail reported on soil stratigraphy, hydrogeology and some other environmental field conditions.

13 CONTAMINATION MIGRATION POTENTIAL

An assessment of contamination migration potential based on soil and groundwater quality cannot yet be undertaken.

14 CONCLUSIONS AND RECOMMENDATIONS

14.1 MUNITIONS

A detailed history review and several stages of field investigation have been undertaken to date in the assessment of munitions contamination at the site. Completion of additional munitions investigations and review by the Auditor is required.

The work undertaken to date appears to have been appropriate, however, the relevant acceptance criteria and any remediation proposed for the various impacts identified have not yet been discussed by the Consultant.

Definition of, and justification for, 1) the proposed remedial strategies, 2) the proposed acceptance criteria, and 3) any residual risks is required to complete the site investigation with respect to munitions and to allow for an assessment by the Auditor of the suitability of the site for residential usage.

The Consultant should also provide details of their qualifications for undertaking the munitions investigations.

14.2 SOIL AND GROUNDWATER

Analytical assessment of soil and groundwater quality at the site has not yet been undertaken, although a number of potentially contaminated areas have been identified. It will be necessary for a qualified environmental consultant to undertake a detailed soil and groundwater investigation prior to the assessment by the Auditor of the suitability of the site for residential usage. The minimum soil and groundwater investigation requirements determined by the Auditor, based on the reports reviewed, are described in Section 9.

A Sampling Plan including Data Quality Objectives should be prepared for review by the Auditor prior to commencement of any such investigations. Reference should be made to the guidelines currently approved by the EPA under section 105 of the Contaminated Land Management Act 1997 (attached as Appendix A) in preparing the Sampling Plan and subsequent investigation reports.

The assessment of risk, evaluation of remediation and assessment of contamination migration potential components of the Audit will be undertaken following completion of the detailed site investigations.

* * *

This letter completes the scope of services outlined in our proposal 31-02-225 dated 20 January 2003, authorised by Landcom purchase order number PARR103188 dated 24 January 2003. Please do not hesitate to contact the undersigned or Rowena Salmon if you have any questions or comments regarding the above.

Yours faithfully,
ENVIRON Australia Pty Ltd

Graeme Nyland
EPA Accredited Site Auditor 9808

Appendix E:
Interim Advice #2, 8 July 2003, ENVIRON Australia Pty Ltd

8 July 2003 Ref: 31-0163

Landcom
C/o Alan Lalich & Associates Pty Ltd
PO Box 5047
Kingsdene NSW 2118

Attn: Mr Alan Lalich

Dear Mr Lalich,

SITE AUDIT, ZOUCH ROAD INGLEBURN

INTERIM ADVICE # 2

1 INTRODUCTION

The initial stages of a site contamination audit have been conducted relating to Landcom property at Zouch Road, Ingleburn, formerly occupied by the Department of Defence (Defence).

The audit is being conducted for the purpose of determining what investigation or remediation remains necessary before the land is suitable for a specified use, in this case residential, i.e. an audit for the purpose stated in Section 47 (1) (b) (iii) of the NSW *Contaminated Land Management Act 1997* (the CLM Act). The audit is not currently required by regulation or legislation and it is therefore a non-statutory audit.

The Audit is being conducted in stages, with Interim Advice provided by the Auditor throughout the audit. The findings of Stage 1 (Initial Advice) were reported on by the Site Auditor on 7 February 2003.

This letter does not constitute a Summary Site Audit Report and Site Audit Statement. A final Summary Site Audit Report and accompanying Site Audit Statement will be produced following completion of the required investigations and remediation.

Details of the audit are:

Requested by:	Alan Lalich, on behalf of Landcom
Request/Commencement Date:	24 January 2003
Auditor:	Graeme Nyland
Accreditation No.:	9808

The scope of work completed to date for the audit and covered by this Letter Report includes:

- Review of the following reports:
  - **Stage 1 Report**: *Stage 1 Preliminary Contamination Investigation. Zouch Road Ingleburn 92 Ha Site*. By Milsearch Pty Ltd. Prepared for Landcom, September 2000; and
  - *Draft Stage 2 Munitions Contamination Investigations. Landcom 92 Ha Site, Zouch Road, Ingleburn (Former Army Infantry Centre). 21 January – 6 April 2002.* By Milsearch Pty Ltd. Footer date 30 June 2002.
  - **Stage 2A Report**: *Final Stage 2 Munitions Contamination Investigations. Landcom 92 Ha Site, Zouch Road, Ingleburn (Former Army Infantry Centre). 21 January – 6 April 2002.* By Milsearch Pty Ltd. Footer date 30 June 2002.
  - **Stage 2B Report**: *Stage 2 Munitions Contamination Investigations, Additional Investigations. Landcom 92 Ha Site, Zouch Road, Ingleburn (Former Army Infantry Centre). 14-16 January & 9 February 2003, 30 April-2 May 2003, 21-22 May 2003.* By Milsearch Pty Ltd. Footer date 10 June 2003.
- Site visit by the Auditor on 31 January 2003.

2 SITE DETAILS

2.1 LOCATION

The site is located on the north and west extremity of the Ingleburn Military Camp, which is located on Campbelltown Road running south west from Liverpool.

Further details follow:

Street address:	Zouch Road, Ingleburn NSW 2565
Identifier:	Lot 1, DP 807460 (54.67 ha) Lot 2, DP 807461 (38.14 ha)
Local Government:	Liverpool City Council
Owner:	Landcom (NSW Government)
Site Area:	92.81 ha

2.2 ZONING

According to the Stage 1 Consultant report, the site zoning status is as follows:

- Previous 5(a) Military

- Current 1(a) Rural
- Proposed 2(a) Residential

2.3 ADJACENT USES

The site has frontage to only one public road, Zouch Road, for only a short distance in the south west corner of the site.

Adjacent site uses are as follows:

- Well-developed semi-urban acreages which front away from the site to Culverston Avenue are located to the **west**;
- A series of small agricultural blocks which also front away from the site are located to the **north** and **east**, fronting onto Jardine Drive and Croatia Avenue, respectively;
- Low cost housing which was formerly Army Married Quarters are located to the **south east**; and
- The now disused Ingleburn Military Camp is located to the **south**.

2.4 SITE CONDITION

Refer *"Site Audit, Zouch Road Ingleburn*, *Stage 1 – Initial Advice"* by ENVIRON dated 7 February 2003.

2.5 PROPOSED DEVELOPMENT

It is understood that the site is proposed to be subdivided into a residential development (zoning 2(a) Residential). The audit will be conducted against criteria applicable to the "Residential with gardens and accessible soil" land use exposure standards.

3 SITE HISTORY

Refer *"Site Audit, Zouch Road Ingleburn*, *Stage 1 – Initial Advice"* by ENVIRON dated 7 February 2003.

4 CONTAMINANTS OF CONCERN

Refer *"Site Audit, Zouch Road Ingleburn*, *Stage 1 – Initial Advice"* by ENVIRON dated 7 February 2003.

5 STRATIGRAPHY AND HYDROGEOLOGY

Detailed information regarding the site stratigraphy and hydrogeology has not yet been provided.

The only subsurface investigations undertaken to date involved excavation of burial pits. The type of natural soil encountered during this exercise was reported as clay. The pits were reported to have contained foul smelling water. An underground command post was noted as being filled with water.

The site area is known by the Auditor to comprise clay soils, overlying shale bedrock with occasional sandstone and laminite. An outcrop of bedrock was observed adjacent to the perimeter road in the north west of the site during the site inspection.

It is expected that there are limited quantities of groundwater in bedrock at the site. A survey of local groundwater usage and springs should be conducted, but there is unlikely to be a usable aquifer under the site. There does not appear to be any sensitive receiving environments for groundwater near the site.

6 QUALITY ASSURANCE AND QUALITY CONTROL

Investigation of soil and groundwater quality, and associated QA/QC requirements, has not yet been undertaken. For certification of the proposed site usage, a detailed site investigation in accordance with the requirement of the EPA (1997) "*Guidelines for Consultants Reporting on Contaminated Sites*" is required to be conducted in accordance with preset Data Quality Objectives (to be set prior to commencement of investigations).

Data Quality Objectives in relation to the assessment of munitions contamination, including UXO, were not specifically addressed by the Consultant. The Auditor has assessed QA/QC for these investigations by considering the adequacy of investigation for each issue/ impact identified and the qualifications of personnel involved in the munitions investigation personnel. The results were found to be generally reliable for the purposes of the audit.

Quality control and calibration requirements for potential UXO remediation works are specified by the Consultant in their report.

7 ENVIRONMENTAL QUALITY CRITERIA

7.1 MUNITIONS

There are currently no EPA endorsed environmental quality criteria for UXO or live SAA. The Auditor recommended that reference should be made to "The assessment and management of land contaminated with unexploded ordnance" by Ranald Scott published in the National Environmental Health Forum Fourth Workshop Proceedings on

the Health Risk Assessment and Management of Contaminated Lands (1998). It was also recommended that the Consultant should benchmark with similar sites in Australia and overseas to determine appropriate environmental quality criteria for these types of contaminants.

7.1.1 Grenade Impact Areas

According to the Consultant, it is generally accepted throughout the military and UXO remediation community that around 3% of any conventional munitions that are fired or projected will fail to function as intended and will remain as UXO. It follows that around 33 grenades on average would need to be detonated in an area to generate a single UXO. Discovery of a large number of detonated grenades would indicate a high risk for UXO to be present.

When assessing potentially contaminated zones of this nature, the Consultant has differentiated 'impact points' from areas where fragmentation alone exists. Detonation of a grenade spreads fragmentation in a radial pattern. The effective killing or injury zone is a 5-10m radius, but heavy fragments, such as base filling plugs, may travel as far as 150m. Identification of a grenade impact point is generally associated with finding fuze well portions which tend to remain closer to the point of detonation and are non-ferrous and therefore corrode more slowly. However, this method is not precise since fuze wells can also be projected away from the detonation point. According to the Consultant, the finding of a single fuze well is not conclusive evidence that a grenade has detonated at that point. An appropriate conclusion would be that at least one grenade, or a very small number of grenades, had detonated in the vicinity if other portions of a grenade were also found. Supporting evidence would include fuze striker spring assemblies and other light weight non-ferrous portions or a large amount of smaller ferrous fragmentation. If only heavier ferrous fragments were found, this would indicate that grenades had been utilised nearby (within 150m) but have not detonated in that location. During the course of investigations, isolated finds of grenade fragmentation have been used as a trigger for further investigations and closer examination.

Due to strict controls of activities and the need for protection of personnel by site preparation and planning, the Consultant argued that detonation of thrown hand grenades at the site for training purposes would have most likely been on a concentrated basis rather than in isolated use.

According to the Consultant (Stage 2B report, page 8) *"There are currently no nationally or internationally defined and objective criteria for what constitutes a grenade impact area requiring remediation. Without the benefit of established criteria, such decisions are currently based on judgement, experience and training".* Generally speaking, the density of fragmentation present will increase with the number of grenades that have been detonated. This represents a fragmentation 'signature' that can be related to the potential for UXO to be present. In assessing the various impacts identified at the site, the Consultant has used the fragmentation 'signature' and other evidence to determine the need for remediation based on the relative potential for UXO to be present.

The remediation approach and environmental quality criteria proposed by the Consultant relating to grenade and mortar impacts appear to be generally appropriate and have been applied and proven in recent applications in Australia, however, further detail is required on some aspects (refer Section 10.1).

7.1.2 Blank SAA

EPA advice to the Consultant in September 2000 indicated that a 100% search and removal would be required if there is any potential for live blank SAA.

According to the Consultant, while live blank SAA ammunition constitutes a lesser hazard than live ball ammunition, blanks can still cause significant injury, particularly eye damage, if detonated through tampering. Brass blank ammunition is understood to be particularly dangerous.

The results of blank SAA investigations are discussed in Section 8.3. The Consultant calculated the average inferred blank density to be 702/ha. Further, the Consultant defined a very low density as less than 250/ha and a low density as between 250 and 500/ha.

The Consultant developed an argument for a "threshold" blank SAA density of 250/ha based on the likelihood of live and expended blank SAA to be found for residential block sizes of 700m^2 (Stage 2B report, page 18-19). The Auditor is not necessarily in agreement with the defined threshold limit due to a number of reasons that are discussed in Section 8.3. Further consideration of an appropriate blank SAA threshold criteria is considered necessary.

7.2 AESTHETIC ISSUES

Non-hazardous munitions items such as expended blank SAA, 3.5" anti-tank practice rockets, practice grenades and practice mortar bombs present no explosive hazard but would be alarming in appearance to someone who was not familiar with them. In response to this, the Consultant has recommended remediation of some, but not all, non-hazardous munitions issues based on aesthetic grounds (refer Section 10.1).

Other issues such as domestic waste, car bodies and barbed wire also need to be addressed (refer Section 10.2).

7.3 SOIL AND GROUNDWATER

Environmental quality criteria related to chemicals in soil and groundwater have not yet been developed for the site.

With a proposed residential usage, relevant environmental quality criteria for the site soils would include:

- "Soil Investigation Levels for Urban Redevelopment Sites in NSW" (Column 1 – "Residential with gardens and accessible soil" and Column 5 – "provisional Phytotoxicity based investigations level") found in the EPA (1998) "*Guidelines for The NSW Site Auditor Scheme"*.
- "Threshold concentrations for sensitive land use – soils" found in the EPA (1994) "*Guidelines for Assessing Service Station Sites"* would also be relevant.

For groundwater, the Trigger Values for Freshwater found in the ANZECC (2000) "*Australian and New Zealand Guidelines for Fresh and Marine Water Quality*" would be relevant.

8 EVALUATION OF MUNITIONS INVESTIGATION RESULTS

The reports reviewed to date have documented the investigation of the site with respect to munitions contamination. Investigations have been conducted in a number of fieldwork stages, as follows:

- **Stage 1**: September 2000;
- **Stage 2A**: 21 January to 5 February, 12 to19 February, 5 to 8 March, 2 to 6 April 2002; and
- **Stage 2B**: 14 to 16 January 2003, 9 February 2003, 30 April 2003 to 2 May 2003, 21 to 22 May 2003.

The scope of work undertaken for Stage 1 comprised:

- site history review;
- a very coarse preliminary instrumented sampling program comprising metal detector transects at 50m intervals over the entire site, the field work allowed for the detection of surface and near-surface metallic items and was found to be effective over 65-70% of the site (the remainder being inaccessible); and
- identification of existing and potential contaminants other than munitions.

Soil and groundwater issues were not addressed. The Stage 1 report identified many of the issues of concern listed in Sections 2 and 3, and provided a good basis for detailed scoping of the Stage 2 investigations.

The various methodologies adopted for the different stages and objectives of the munitions investigations as interpreted by the Auditor based on review of the relevant reports are described in the following sections and detailed in Table 8.1, below.

Results from the munitions investigations are also discussed in the following sections. Where remediation has been recommended by the Consultant, this is discussed further in Section 10.1.

Table 8.1 – Munitions Sampling Methodology

Location	Investigation Objective/ Stage	Date	Investigation Method	Comments
Entire Site	*Stage 1* Coarse preliminary sampling program to improve site knowledge. Targeting larger calibre weapon impacts (2 or 3" mortars) and blank SAA	9/2000	Metal mine detector transects at 50m intervals (nominally 2% sample). Minelab Electronics F1A4 mine detectors were used.	Allowed detection of surface and near-surface metallic items. Found to be effective over 65-70% of the site. Equipment chosen for good detection range considering high grass growth.
Grenade Exclusion Zone	*Stage 2A* Grenade impact delineation.	12-19/ 3/2002	Analogue detector. Sampling surveys along 1m wide transects at intervals of 20m with some fill in at approx. 10m intervals (approximately 6%). Minelab Electronics F1A4 mine detectors were used.	All readings were investigated by hand and the nature and location of finds recorded and removed from site.
	Stage 2A Further grenade impact delineation.	5-8/3/ 2002	Analogue magnetometer sampling surveys along 1m swaths at intervals of 5m (approximately 10%). Forester analogue magnetometer detector was used.	Setting of the detector was adjusted, narrowing the effective swath width, due to strong interference from mineralised rocks and soil. This method was later deemed to be inadequate to identify grenade sized targets.
Stop Butts area	*Stage 2A* Delineation of lead particulate.	12-19/ 2/2002	Digital detector sampling surveys along sampling transect lines at intervals of 10m. TM5 EMU computer assisted 18" coil digital metal detector was used (implemented by sub-contractor Geophysical Technology Limited (GTL)).	Equipment used was demonstrated by laboratory tests to differentiate lead particulate soil at a typical carrying height and at a fast walking speed. The central zone comprising the steep butts was not surveyed.
Stop Butt material in roads and other areas	*Stage 2A* Delineation of lead particulate.	12-19/ 2/2002	Digital detector sampling surveys along parallel transects at intervals of 10m. TM5 EMU computer assisted 18" coil digital metal detector was used.	Equipment used was demonstrated by laboratory tests to differentiate lead particulate soil at a typical carrying height and at a fast walking speed.
Stop Butt material – all areas	*Stage 2A* Confirmation of external limits of lead particulate.	12-19/ 2/2002	Analogue detector. Minelab Electronics F1A4 mine detectors were used.	

Location	Investigation Objective/ Stage	Date	Investigation Method	Comments
Balance of site	*Stage 2A* Delineation and density determination for blank SAA	12-19/ 2/2002	Digital detector sampling surveys along parallel transects at intervals of 20m. TM5 EMU computer assisted 18" coil digital metal detector was used.	Equipment used was demonstrated by laboratory tests to detect surface and near surface blanks at a typical carrying height and at a fast walking speed. Results are reported as a digital metallic density for a network of 'cells' or 'tiles'. Extraneous metallic material such as barbed wire interfered to some degree with the detector method used. Many areas were not accessed, shown as white cells devoid of data. Filters of 100EMU and 200EMU were used for presentation of data. 100 EMU was selected as being most representative of the situation on the ground.
Blank SAA cells subject to validation	*Stage 2A* Round 1 Validation of blank SAA density Aim was to determine: What type of items had generated the readings. What proportion were attributable to SAA blanks. How valid was the blank SAA numerical estimate.	5-8/3/ 2002	Analogue detector. Minelab Electronics F1A4 mine detectors were used. Targeted cells with the highest density readings. Commenced covering 2% of the cell area (200m^2), was modified to cover only 1% (100m^2).	
Blank SAA cells subject to validation	*Stage 2A* Round 2 Validation of blank SAA density Emphasis was placed on determining what type of items had generated the readings.	2-6/4/ 2002	Analogue detector. Minelab Electronics F1A4 mine detectors were used. Targeted high density contours. Covered 1% of the cell area (100m^2).	

Location	Investigation Objective/ Stage	Date	Investigation Method	Comments
Stores disposal burial pits	*Stage 2A* Delineation of burial pits	12-19/ 2/2002 2-6/4/ 2002	Digital detector sampling survey at 3m cross sections. TM5 EMU computer assisted 18" coil digital metal detector was used. Opening and characterisation of pits by backhoe. 500mm wide trench cross sections were excavated to the bottom of fill at 10m intervals.	
Dam 1 and 2	*Stage 2A* Munitions search	21-30/ 1/2002	Instrumented detector searches. Magnetometer and metal detector were used.	
1.75 ha Extension to Grenade Exclusion Zone to the west and south east (IA2 and IA3)	*Stage 2B* Further grenade impact delineation	14-16/ 1/2003 9/2/ 2003	Analogue detector. Sampling surveys at intervals of 10m. Minelab Electronics F1A4 mine detectors were used.	
3ha Additional Grenade Impact Zone and Energa impact in south east (near cricket pitch)	*Stage 2B* Grenade impact delineation, rifle-projected practice anti-tank grenade impact delineation	14-16/ 1/2003 9/2/ 2003	Analogue detector. Sampling surveys at intervals of 10m (approximately 10%). Minelab Electronics F1A4 mine detectors were used.	
1ha Near Dam 3	*Stage 2B* Practice grenade impact delineation	14-16/ 1/2003 9/2/ 2003	Analogue detector. Sampling surveys at intervals of 5m (approximately 20%). Minelab Electronics F1A4 mine detectors were used.	
Dam 3	*Stage 2B* Munitions search	14-16/ 1/2003 9/2/ 2003	Instrumented detector searches. Magnetometer and metal detector were used over 100% of area (1m lane intervals).	
3.5" practice rocket zone	*Stage 2B* Delineation of 3,5" practice rocket zone	30/4- 2/5/ 2003	Analogue magnetometer sampling surveys along 1m swaths at intervals of 5m (approximately 10%). Forester analogue magnetometer detector was used.	Despite hostile soil conditions, Forester magnetometer was determined to be adequate to identify larger ferrous targets such as the 3.5" practice rockets and 81mm

Location	Investigation Objective/ Stage	Date	Investigation Method	Comments
		21-22/ 5/2003		practice mortars.
Non-data Blank SAA cells (4 or more)	*Stage 2B* Identification of unexpected impacts	30/4-2/5/ 2003	Analogue detector. Targeted groups of 4 or more cells where no data had previously been recorded (total 13). Sampling surveys down the centre of smaller zones or at intervals of 20m in larger zones. Minelab Electronics F1A4 mine detectors were used.	Three areas were not adequately surveyed (Zones 10, 12 and 13).
Non-data Blank SAA cells (2 or more)	*Stage 2B* Identification of unexpected impacts	21-22/ 5/2003	Analogue detector. Targeted groups of 2 or more cells where no data had previously been recorded (total 20). Sampling surveys down the centre of smaller zones or at intervals of 20m in larger zones. Minelab Electronics F1A4 mine detectors were used.	Two areas were not accessible.
Nil-very low content Blank SAA cells	*Stage 2B* Validation of nil blank SAA density	30/4-2/5/ 2003 21-22/ 5/2003	Analogue detector. Targeted cells where low-very low data had previously been recorded (total nine selected). Sampling surveys down the centre of smaller zones or at intervals of 20m in larger zones. Minelab Electronics F1A4 mine detectors were used.	
1ha Extension to Grenade Exclusion Zone to the south west (IA2)	*Stage 2B* Grenade impact delineation	21-22/ 5/2003	Analogue detector. Sampling surveys at intervals of 10m (10% sample). Minelab Electronics F1A4 mine detectors were used.	

8.1 GRENADE OR MORTAR UXO

8.1.1 Main Grenade Range

A range was used for live grenade throwing practices and possibly also mortar practice bombs. Investigation of this zone involved initially slashing vegetation over a 6.5 ha "Grenade Exclusion Zone" area. The investigation method was by analogue metal detector and magnetometer sampling surveys along 1m wide transects at intervals of 20m, with some fill in at 10m intervals around impact zones identified initially. The total sampling achieved was approximately 6% of the Grenade Exclusion Zone. Detectors used were Minelab Electronics F1A4 mine detectors.

All readings were investigated by hand and the nature and location of finds recorded and removed from site. Evidence of grenade impact points was found, as well as a single practice 81mm mortar bomb. Additional investigations in this area used a Forester analogue magnetometer along 1m swaths at 5m intervals throughout the Grenade Exclusion Zone. Due to strong interference from mineralised rocks and soil, the setting of the detector was adjusted, narrowing the effective swath width to something less than 10% of the Grenade Exclusion Zone.

The investigations have identified three grenade impact areas requiring remediation within the Grenade Exclusion Zone, as follows:

- IA1 – rectangular area in the north, six impact points.
- IA2 – central portion, 30 impact points, 19 within the dense bursting zone. Stage 2A recommended additional investigations of 1 ha along the western boundary of the Grenade Exclusion Zone, extending the Grenade Exclusion Zone in a westerly direction by 50m. A zone within IA2 was found to be the main bursting zone.
- IA3 – south, four impact points. Stage 2A recommended additional minor investigations of around 1 ha to extend the southern limit of the Grenade Exclusion Zone to the creek line.

An additional 1ha zone to the south west of IA2 was investigated as the final task of Stage 2B. Investigation of this area was undertaken due to tentative indications of possible grenade impact identified during Stage 2B investigations, including nil-data SAA validation. This was also the general direction from which the sole practice 81mm mortar bomb found during Stage 2A was thought to have been fired. While numerous heavy grenade base plugs were located, no further indications of grenade impact areas were found and no additional practice 81mm mortar bombs were found. It was concluded that this additional 1ha zone was not a recognizable target area and that remediation of this zone was not justified. It was recognized, however, that it was quite possible that additional practice 81mm mortar bombs may exist on site since they do not leave a fragmentation 'signature'. The Consultant concluded it was likely that additional items would be present, most likely within the central portion of the site.

8.1.2 Dam Areas

Instrumented detector searches (magnetometer and metal detector) were conducted following slashing of the dry dam beds.

Dam 1 was found to have high magnetic naturally occurring interference, with no munitions found.

Dam 2 contained sections of water pipe at 700mm depth, with no munitions found.

Dam 3 was found to have high magnetic naturally occurring interference, with no munitions found.

8.1.3 Additional Impact Areas

The validation process based on checking high metallic concentrations (discussed in Section 8.3) was found to be an effective site-wide check of unexpected potential metallic ordnance contamination. Other investigations undertaken in Stage 2B also found unexpected impacts. Additional impacts located across the site are summarised in Table 8.2.

Table 8.2 – Additional Grenade and Mortar Impacts

Impact	Description	Identification Method
A target area for 3,5" anti-tank practice rocket projectiles	19 pieces of fragmentation were found in a 1m line encompassing an apparent target and drop short area. The area appeared to have been searched and partially cleared, however potential exists for some inert rocket heads to be below-ground. While they present no hazard, this constitutes an aesthetic issue that requires remediation. Further investigations were conducted in Stage 2B to delineate this area for the purposes of remediation.	Stage 2A SAA validation
A target area or areas for No 94 Energa rifle-projected anti-tank grenades, near cricket pitch	Several stabilizer fins from an anti-tank rifle grenade were found in one area in Stage 2A. Further investigations over a 3ha area in Stage 2B found no other more substantial remnants. The pieces found were originally painted black, consistent with practice ammunition of this type. No fragments from live firing were found. It was concluded that only inert practice ammunition was used in this location and that the reusable practice grenade had been collected from the previously well maintained target area. There was considered to be only a very slight possibility that any practice projectiles of this type would remain on site and remediation is not required.	Stage 2A SAA validation
An additional 36M grenade impact area south east of the Grenade Exclusion Zone.	An additional 36M grenade fuze well area was found in Stage 2A. Further investigations in Stage 2B (incorporated with the 3ha investigation area for Energa impacts, above) found no additional indications of 36M grenade impact in this area. It was concluded that the earlier find was an isolated one, with either a single grenade or possibly a very small number of grenades having detonated in that vicinity. The possibility of the single fuze well having been transported to this location from the recognised bursting ground to the north west was also raised. Further investigation/ remediation in this area was not recommended.	Stage 2A SAA validation

Impact	Description	Identification Method
A possible target area for 36M practice rifle-projected grenades	An unexploded (complete) practice grenade was found 10m from the north east corner of Dam 3 in Stage 2A. While not hazardous, the practice grenades present an aesthetic issue due to their alarming appearance. Since the practice grenades do not explode, they do not generate a fragmentation 'signature'. Further investigations in Stage 2B of a 1ha area at 5m intervals (20% coverage) did not find any other practice grenades. It was concluded that the area was not a recognizable target area and that remediation of this zone was not justified. It was recognized, however, that it was quite possible that other similar inert items may exist in small numbers in isolated and impossible to identify locations at the site. Management of this issue was recommended via education of on-site personnel for the forthcoming investigations and site development works.	Stage 2A SAA validation
None identified – search access not gained	No additional impact areas were identified from validation searching of non-data blank SAA cells grouped in four or more (refer Section 8.3), however, three of the checked zones were not able to be assessed fully: ▪ Zone 10, heavily vegetated watercourse. The Consultant recommended that additional checking be undertaken in this area during development. ▪ Zone 12, blackberry infested watercourse. The Consultant recommended that additional checking be undertaken in this area during development. ▪ Zone 13, narrow blackberry infested watercourse. The Consultant recommended that further checking of this area was not warranted.	Stage 2B SAA validation, four or more cells Zone 1 to 13
36M grenade base plugs	Validation searching of non-data blank SAA cells grouped in two or more (refer Section 8.3) identified 36M grenade base plugs in Zone 26 (2) and Zone 29 (1), however, there was no evidence that munitions impact had occurred in these zones. The Consultant found it probable that the base plugs were projected or transported to where they were found. Two of the checked zones (two or more cells) were not able to be assessed since they were occupied by a watercourse. The Consultant did not recommend further checking in these areas.	Stage 2B SAA validation, two or more cells Zone 14 to 33
None identified – search not conducted	Sampling of non-data blank SAA single cells was not undertaken. The Consultant considered that these cells were physically too small to contain a munitions impact area.	Stage 2B SAA validation, one cell

From the above results, it is clear that significant grenade or mortar impacts were located outside the "expected" zones of impact, being primarily the main grenade range and also the dams. Consideration must therefore be given to the adequacy of overall site investigative coverage to identify these "unexpected impacts".

The unexpected impacts were primarily identified during the Stage 2A validation exercises which focused on cells of high metallic density as determined by digital metal detector. However, the Consultant indicates that (Stage 2B report, page 16) "it cannot

be stated with certainty that all areas of indicated higher metallic dentistry have been checked". The Consultant has recommended additional work in the form of remedial searches in order to provide confidence that "the vast majority of potential UXO hazard has been addressed on the site" (refer Section 10.1).

8.2 LEAD PARTICULATE

The original stop butt material, which contained lead particulate, was spread about the range and built into roads at the site in the 1970s. Investigations involved initially slashing over a 3.5ha area in the vicinity of the stop butts, along sampling transect lines at 10m intervals. The investigation method was by digital detector sampling surveys to delineate the spread of lead particulate contained in the re-engineered firing range stop butt material. Additional lead particulate material in roads and other locations was also located and mapped using the blank SAA delineation method discussed in part c, below. External limits were confirmed by analogue follow-up investigations with an F1A4 mine detector.

Investigations have delineated the extent of lead-impacted material at the site, as follows:

- A 4.1 ha area surrounding the stop butts. Delineation was successful except for defining the exact extent in the high ground to the east. Since this area is also impacted by broken asbestos sheeting and coal dust from the stockpile, this poor definition was not considered significant since remediation of this area would already be required.
- A 0.65 ha area of the north west perimeter road.
- Two small tip truck back dumpings north west of the stop butt area, approximately 4 to 5 m^3 each pile.
- In the road formation at the Zouch Road entrance gate.

Soil samples have yet to be laboratory analysed to determine the concentration of lead in the areas identified, however, the concentration of lead particulate as determined by the detector method used was reported to vary considerably within each of the larger areas identified.

8.3 BLANK SAA

Expended blank small arms ammunition (SAA) litters the site as a product of infantry minor tactical training.

Stage 2A investigations involved slashing into permissible areas of the site along nominally parallel sampling transect lines at 20m intervals over approximately 80 ha (the balance of the site). The investigation method was by digital detector sampling surveys to map and measure the density of expended SAA blank ammunition. The detector used was the TM5 EMU computer assisted large coil metal detector which had been demonstrated in laboratory tests to detect surface and near surface blanks at a typical carrying height and at a fast walking speed. Similar tests had also confirmed that zones

of lead particulate soil could also be differentiated confidently (refer Section 8.2, above).

Digital metallic densities were recorded for a network of 'cells' or 'tiles' across the site. These densities were validated with analogue equipment during close inspection of 1% of the cells. A number of areas of the site were excluded from measurement due to inaccessibility or interference from other impacts (eg, grenade zone, burial pits). During validation, it was found that extraneous metallic material such as barbed wire and domestic rubbish interfered to some degree with the detector method used.

The types of SAA encountered include brass and plastic, intact (at surface) and degraded (buried). The investigations estimated the density of occurrence as between 1600 and 1800 SAA per hectare, with approximately 2% of the SAA estimated as being live (unexpended). The SAA is likely to be of higher density associated with slit trenches in the west and north of the site, in Cumberland Plain Woodland areas.

At the completion of Stage 2A, the Auditor recommended that the Consultant should consider re-assessment of the areas of the site that were originally excluded from measurement due to inaccessibility, or else provide further justification for the exclusion of these areas from the assessment. In response to this recommendation, the Consultant undertook additional validation-style investigations in Stage 2B using analogue equipment, as follows:

- Sampling of non-data blank SAA cells grouped in *four or more* (Zone 1 to 13) or *two or more cells* (Zone 14 to 33). Blank SAA data was recorded for the groups of four or more cells, however the primary objective of this process was to identify unexpected munitions impacts. Blank SAA density data was not able to be determined for the groups of two or more cells since accurate area records were not kept.
- Sampling of nine larger nil to very low blank SAA cells (Zone A to I). No blank SAA were found in only two of the assessed zones. Between 1 and 16 blanks were found in the remaining zones. Inferred SAA densities ranged between 46 and 533/ha for zones with detections. Very little in the way of other metallic contamination was found in these zones.

The validation process utilised during Stage 2A and 2B, based on checking high metallic concentrations, was found to be an effective site-wide check of unexpected potential metallic ordnance contamination. Additional impacts located by this method were discussed in Section 8.1.3. This exercise also allowed for accurate location of several car bodies, rubbish sites and areas of barbed wire and a possible additional four areas of asbestos sheeting impact.

The various blank SAA densities estimated throughout the course of the investigations as interpreted by the Auditor based on review of the relevant reports are detailed in Table 8.3, below. The number of live ammunition found in each area, where recorded, is also provided.

Table 8.3 – Estimated Blank SAA Densities Through Various Investigation Stages

Location	Investigation Objective/ Stage	Area	Estimated SAA blank density (blanks/ ha)	No. live ammunition recovered
Grenade Exclusion Zone	*Stage 2A* Grenade impact delineation.	6.5ha	1500	15
Blank SAA cells subject to validation	*Stage 2A* Validation of blank SAA density - first round	0.3ha (validation of 29 cells)	1600 - 1800	NR (estimated as 2% of expended numbers)
Blank SAA cells subject to validation	*Stage 2A* Validation of blank SAA density - second round	0.41ha (validation of 41 cells)	NE	1
Non-data Blank SAA cells (4 or more)	*Stage 2B* Identification of unexpected impacts	0.38ha	363	NR
Nil-very low content Blank SAA cells	*Stage 2B* Validation of nil blank SAA density	0.3ha	156	NR
		Area – weighted average	1400	-

NR not recorded

NE not estimated

The Consultant calculated the site average inferred blank density to be 702/ha, based on an arithmetic average of the various densities determined in various investigation stages. A very low density was defined as less than 250/ha and a low density as between 250 and 500/ha. The Consultant concluded the following with regards to blank SAA:

- Blank SAA will still be found in the nil/low count areas derived from the TM5 EMU (GTL) data. Therefore this technique cannot be relied upon to identify areas where no blank SAA exists.
- While blanks are likely to exist in the nil/low count areas, they are likely to be present in low numbers relative to other portions of the site. Therefore this technique may have some use to identify zones where blank SAA impact is lowest.

The Consultant developed an argument for a "threshold" blank SAA density of 250/ha based on the likelihood of live and expended blank SAA to be found for residential block sizes of 700m^2 (Stage 2B report, page 18-19). The basic logic of their argument was as follows:

With an area of 700m^2 and a density of 250/ha, 17.5 expended blank SAA would be expected to be found, with 0.35 of these (2%) being live. This correlates to a live blank SAA being present on 1 in 3 building blocks.

An occurrence of around 0.2 live blank SAA per building block (based on a 'very low' density of 136/ha) was found by the Consultant to represent an 'extremely low' risk with the likelihood of an incident occurring being 'almost negligible'. In addition, the aesthetic concern associated with the occurrence of 10 expended blank SAA per building block was assessed by the Consultant to be negligible.

The Auditor is not necessarily in agreement with the defined threshold limit due to a number of reasons, including the following:

- The average inferred blank density calculation method is not considered to be valid. An area-weighted average such as that calculated above (1400/ha) or an alternate weighted average is considered more appropriate to use as a starting point in predictive calculations for the number of blank SAA likely to be encountered across the site.
- Areas not requiring remediation are proposed to be determined based on simple sampling counts to determine the anticipated blank SAA density beforehand (refer Section 10.1). Further details of this method are not provided. The reliability of this method will need to be demonstrated since the previous method has been demonstrated to provide a general indication of SAA density only. Cells selected as being nil to very low blank SAA cells yielded inferred SAA densities up to 533/ha and could not be relied upon to identify areas where no blank SAA exists.
- The risk definitions used by the Consultant such as 'extremely low' and 'almost negligible' do not appear to be comparable with the level of risk implied by similar terms used in assessment of risk to site occupants from site contamination. In addition, the treatment of this issue does not follow the risk assessment method advocated by Ranald Scott (1998), which incorporates 'hazard incident probability', 'hazard severity' and 'perceived risk' concepts.

Further consideration of an appropriate blank SAA threshold criteria is considered necessary.

8.4 STORES DISPOSAL BURIALS

Three parallel pits were delineated by a digital detector survey (using the TM5 EMU computer assisted large coil metal detector) in the vicinity of the open pit originally identified. The pits run downhill to the east away from the coal stockpile. The combined area of the pits was determined to be 0.25ha. The length of each pit was found to be (from the north), 64, 72 and 71m long. The average width was 6m and the average depth was 2.5m.

500mm wide trench cross sections were excavated to the bottom of the pits at 10m intervals. The pit contents were found to include:

- Bonded asbestos sheeting;

- Building waste (including bricks, pipes, concrete blocks, guttering, downpipes);
- Household waste (including fridges, water heaters, metal cabinets); and
- Foul water was encountered when the crust of the pits was broken through.

No munitions were observed in the pits. It was determined that buildings demolished in the departure of the Infantry Centre to Singleton in the early 1990's were placed in the pits. The pits were observed to be terminated in clay. Large metal wastes were observed on the ground surface in the vicinity of the pits.

9 SOIL AND GROUNDWATER INVESTIGATION

Analytical assessment of soil and groundwater quality at the site has not yet been undertaken, although a number of potentially contaminated areas have been identified. It will be necessary for a qualified environmental consultant to undertake a detailed soil and groundwater investigation prior to assessment by the Auditor of the suitability of the site for residential usage. A Sampling Plan should be prepared, including Data Quality Objectives and proposed environmental quality criteria, prior to commencement for review by the Auditor. Reporting on the investigation should be in accordance with the EPA (1997) "*Guidelines for Consultants Reporting on Contaminated Sites*".

Based on the reports reviewed, the Auditor recommends that investigation of the areas listed in Table 4.1 would be required as part of any detailed soil investigation.

The extent of groundwater investigation required will depend on the conditions encountered. The groundwater investigation is recommended to include as a minimum:

- Determination of the presence and levels of groundwater across the site;
- Assessment of groundwater quality in the main impact areas of lead particulate (stop butt material) and waste burial in trenches; and
- A survey of local groundwater usage and springs.

10 EVALUATION OF REMEDIATION

10.1 MUNITIONS

Remediation that has been undertaken at the site to date includes collection of located munitions fragments. A Remediation Action Plan for additional remedial works required has not been prepared, however, in their Stage 2B report, the Consultant has provided details on a number of recommended remedial works. These have been summarised in Table 10.1, below.

Table 10.1 – Summary of Proposed Remediation – Munitions Impacts

ID #	Impact	Area(s)	Proposed Remediation Method	Proposed Timing	Interim Considerations
1	36M grenade impact areas	REM1 (IA1) REM2 (IA2, excluding REM 5) REM3 (IA3) Total 3.47ha	100% remedial searching for 36M UXO proposed Digital imaging electromagnetic survey (a range of possible systems are defined), 0.5m survey lane spacing Expansion of remediation zones may be required based on finds during remediation	Prior to soil and groundwater investigations	Impact currently presents a potential hazard to site users
2	3.5" anti-tank (A-Tk) rocket warheads	REM 4, 2.625ha	Aesthetic issue only, impact is inert 100% remedial searching for practice 3.5" A-Tk rockets proposed Digital imaging electromagnetic survey or multiple sensor array magnetics, 1m survey lane spacing (digital imaging magnetic survey recommended as primary search tool) Expansion of remediation zone may be required based on finds during remediation	Prior to soil and groundwater investigations (recommended to be undertaken at this time for efficiency of remediation)	
3	36M grenade bursting zone	REM 5 (within IA2) 0.16ha	100% remedial searching for 36M UXO proposed Mechanical screening, 30mm screen size	Prior to soil and groundwater investigations	Impact currently presents a potential hazard to site users

ID #	Impact	Area(s)	Proposed Remediation Method	Proposed Timing	Interim Considerations
4	Unknown UXO	Areas not previously searched for potential UXO impacts due to inaccessibility - Zones 10 and 12	Search proposed, method not defined	During development	Education of personnel (soil and groundwater investigations and site development personnel)
5	Inert practice munitions (including grenades and possibly 81mm mortar bombs)	Entire site (identification of these items was difficult during investigations due to lack of fragmentation 'signature')	Aesthetic issue only, impact is inert, specific remediation not proposed	NA	Education of personnel (soil and groundwater investigations and site development personnel)
6	Blank SAA/ other unknown UXO	Entire site Blank SAA density determination Further check on potential UXO impacts	Simple sampling counts of minimum 10% coverage (To determine the anticipated blank SAA density and identify potential additional grenade and mortar impact areas)	After vegetation has been reduced and before earthworks Applied ahead of development of each development stage	Education of personnel (soil and groundwater investigations and site development personnel)
7	Blank SAA	Areas of greater than 250/ha density as determined by the above	100% area searching by metal detector to remove expended and live blank SAA Remedial searching is not proposed where it can be satisfactorily established ahead of development that a blank SAA density of no more than a threshold of 250/ha can be expected.	During development Coincide with vegetation reduction and the removal of barbed wire and other rubbish	

The remediation works proposed by the Consultant relating to **grenade and mortar impacts** appear to be generally appropriate and have been proven in recent applications in Australia. The following key issues are noted:

- Those areas that currently presents a potential hazard to site users should be clearly marked and the site should remain secure until remediation of these

areas is complete;

- Personnel undertaking vegetation clearing or other works at the site including soil and groundwater investigations (following remediation of identified hazard zones) should be educated as to the potential for UXO and inert practice munitions and protocols for action to be taken if suspect items are found;
- Further detail of the search method proposed in the previously inaccessible Zones 10 and 12 is required; and
- The Consultant has stated that the only way to "completely remove the possibility" of grenade or mortar impacts going unidentified would be to conduct percentage sampling investigations over the entire site at 10 to 15m intervals. It is not clear from the remediation detail provided by the Consultant what additional searching is proposed for potential UXO. A clear statement of the residual risk following the proposed additional searching is required.

With regards to the proposed threshold approach to **blank SAA** remediation searches, consideration of the Auditor comments in Section 8.3 is required. In addition, further details of the proposed density determination method are required, and the reliability of this method will need to be demonstrated since the previous method has been demonstrated to provide only a general indication of SAA density.

10.2 SOIL AND GROUNDWATER

No investigation or remediation in relating to soil and groundwater has yet been undertaken at the site. Further investigations and detail of any proposed remediation works is required before an evaluation of their adequacy can be made.

It is anticipated that soil and groundwater remediation at the site will require, as a minimum, removal and validation of the following impacts already identified:

- Surface waste dumpings, including asbestos-containing materials (note special disposal requirements for asbestos);
- Contents of waste burial pits: *While the visual observations indicate the only confirmed contaminant within the burial pits is asbestos sheeting fragments, the potential exists for unknown contaminants to have been disposed of in this manner. As a result, it is recommended by the Auditor that the contents of waste burial pits and surface waste dumpings across the site be removed to removal the potential for impact from unknown contaminants, physical hazards and aesthetic impacts*;
- Car bodies, barbed wire, star pickets and corrugated iron;
- Lead particulate occurring in stop butt material at the firing range and spread around the site: *Quantification of the concentration of lead in soils in the identified areas is required, including an assessment of the likely variability in concentration. Without any justification to the contrary, remediation of all materials with a lead concentration exceeding 300 mg/kg would be required for the proposed residential use*; and

- Coal stockpile and areas affected by coal dust.

11 CONTAMINATION MIGRATION POTENTIAL

The potential for off-site migration of munitions related contaminants is considered to be very low.

An assessment of contamination migration potential based on soil and groundwater quality cannot yet be undertaken.

12 ASSESSMENT OF RISK

12.1 MUNITIONS

- There is considered to be a moderate risk that practice 36M grenades, practice anti-tank rifle grenades and practice 81mm mortar bombs may be present, primarily in the central portion of the site. These items are difficult to locate due to the lack of fragmentation 'signature'. These items are not hazardous but represent an aesthetic issue due to their alarming appearance. Following site development, this risk is likely to be reduced to a low level.
- There is considered to be a low risk that a small number of grenades were detonated in the vicinity of a single 36M grenade fuze well south east of the identified main grenade range. The potential for UXO to be associated with this possible impact area is considered to be very low.
- Investigation of a narrow blackberry infested watercourse (Zone 13) was not performed. The potential for UXO to be present in this area is considered to be very low.
- In order to strengthen the investigation for potential unknown UXO impacts, a simple sampling count of minimum 10% coverage across the entire site is proposed.
- The Consultant has stated that the only way to "completely remove the possibility" of grenade or mortar impacts going unidentified would be to conduct percentage sampling investigations over the entire site at 10 to 15m intervals. It is not clear from the remediation detail provided by the Consultant (Section 10.1) what additional searching is proposed for potential UXO. The residual risk of UXO following the proposed additional searching cannot be assessed without further information from the Consultant.
- The Consultant has proposed a 'threshold' blank SAA density method of determining areas that require blank SAA remedial searches. The risks associated with this method have not been fully assessed and do not follow the risk assessment method advocated by Ranald Scott (1998) which incorporates 'hazard incident probability', 'hazard severity' and 'perceived risk' concepts.

Risks include the potential hazard associated with live blank SAA and also the aesthetic issue associated with expended blank SAA being encountered on the proposed residential blocks. Further consideration of an appropriate blank SAA threshold criteria is considered necessary and further detail regarding the reliability of the proposed density determination is required.

12.2 SOIL AND GROUNDWATER

An assessment of risk based on soil and groundwater quality cannot yet be undertaken.

13 COMPLIANCE WITH REGULATORY GUIDELINES AND DIRECTIONS

Guidelines currently approved by the EPA under section 105 of the Contaminated Land Management Act 1997 are attached as Appendix A. The Auditor has used these guidelines in assessing the activities to date, and they will be applied to future activities.

The Stage 1 Preliminary Contamination Investigation was generally prepared in accordance with the requirement of the EPA (1997) "*Guidelines for Consultants Reporting on Contaminated Sites*" for preliminary site investigations (Stage 1). The checklist included in that document has been completed and is kept in file. Exceptions relate to the detail reported on soil stratigraphy, hydrogeology and some other environmental field conditions.

14 CONCLUSIONS AND RECOMMENDATIONS

14.1 MUNITIONS

A detailed history review and several stages of field investigation have been undertaken to date in the assessment of munitions contamination at the site. The investigation works undertaken to date appear to have been appropriate and the results have been reported on in adequate detail.

Remediation that has been undertaken to date includes collection of located munitions fragments. A Remediation Action Plan for additional remedial works required has not been prepared, however, in their Stage 2B report, the Consultant has provided details on a number of recommended remedial works. Further detail is required with respect to some items, as noted in Section 10.1.

The remediation works proposed by the Consultant relating to **grenade and mortar impacts** appear to be generally appropriate and have been proven in recent applications in Australia. Key management issues relating to these impacts are as follows:

- Those areas that currently present a potential hazard to site users should be clearly marked and the site should remain secure until remediation of these areas is complete; and
- Following remediation of identified hazard zones, personnel undertaking vegetation clearing or other works at the site, including soil and groundwater investigations, should be educated as to the potential for UXO and inert practice munitions to be encountered, and protocols for action to be taken if suspect items are found.

The Consultant has stated that the proposed additional works should provide confidence that "the vast majority of potential UXO hazard has been addressed on the site" and that the only way to "completely remove the possibility" of grenade or mortar impacts going unidentified would be to conduct percentage sampling investigations over the entire site at 10 to 15m intervals. It is not clear from the remediation detail provided by the Consultant (Section 10.1) what additional searching is proposed for potential UXO. Further information is required from the Consultant regarding the residual risk of UXO following the proposed additional searching.

The Consultant has proposed a 'threshold' **blank SAA** density method of determining areas that require blank SAA remedial searches. Further consideration of this issue, taking note of the Auditor comments in Section 8.3, is considered necessary. In addition, further details of the proposed density determination method are required, and the reliability of this method will need to be demonstrated since the previous method has been demonstrated to provide only a general indication of SAA density.

14.2 SOIL AND GROUNDWATER

Analytical assessment of soil and groundwater quality at the site has not yet been undertaken, although a number of potentially contaminated areas have been identified. It will be necessary for a qualified environmental consultant to undertake a detailed soil and groundwater investigation prior to the assessment by the Auditor of the suitability of the site for residential usage. The minimum soil and groundwater investigation requirements determined by the Auditor, based on the reports reviewed, are described in Section 9.

A Sampling Plan including Data Quality Objectives should be prepared for review by the Auditor prior to commencement of any such investigations. Reference should be made to the guidelines currently approved by the EPA under section 105 of the Contaminated Land Management Act 1997 (attached as Appendix A) in preparing the Sampling Plan and subsequent investigation reports.

The evaluation of remediation, assessment of contamination migration potential and assessment of risk components of the Audit with respect to soil and groundwater contamination will be undertaken following completion of the detailed site investigations.

* * *

This letter constitutes advice provided during the course of the subject Audit and does not constitute a Summary Site Audit Report and Site Audit Statement. A Summary Site Audit Report and accompanying Site Audit Statement will be produced following completion of the required investigations and remediation. Please do not hesitate to contact the undersigned or Rowena Salmon if you have any questions or comments regarding the above.

Yours faithfully,
ENVIRON Australia Pty Ltd

Graeme Nyland
EPA Accredited Site Auditor 9808

Appendix F:
Interim Advice #3 – Zouch Road, Edmondson Park, NSW. 8 September 2005, ENVIRON Australia Pty Ltd

ENVIRON

Interim Advice #3

Zouch Road, Edmondson Park, NSW

for

Landcom

September 2005

Ref: 31-0163

8 September 2005 Ref: 31-0163

Landcom
c/o APP Corporation Pty Ltd
Level 1, 53 Berry Street
North Sydney NSW 2060

Attn: Scott Johnston

Dear Scott,

Interim Advice #3 – Zouch Road, Edmondson Park, NSW

I have pleasure in submitting Interim Advice #3 for the subject site. The Audit was commissioned by Landcom ultimately to assess the suitability of the site for its intended residential and conservation use. This Site Audit is not currently required by regulation or legislation and therefore a non-statutory audit.

Thank you for giving me the opportunity to conduct this Audit. Please call me on 9954 8100 if you have any questions.

Yours faithfully,
ENVIRON Australia Pty Ltd

Graeme Nyland
EPA Accredited Site Auditor 9808

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Attachment 1: Site Location

Attachment 2: Site Layout and Key Features

Attachment 3: Groundwater Contours

Attachment 4: Investigation Locations

Attachment 5: Proposed Remediation Areas

LIST OF ABBREVIATIONS

AOC	Area of Concern
AHD	Australian Height Datum
ALS	Australian Laboratory Services
ASET	Australian Safer Environment and Technology Pty Ltd. (Laboratory)
ANZECC	Australian and New Zealand Environment and Conservation Council
BACTEC	BACTEC SE Asia Pty Ltd
BaP	Benzo(a)pyrene
BGL	below ground level
BTEX	Benzene, Toluene, Ethylbenzene & Xylenes (Monocyclic aromatic Hydrocarbons)
DP	Deposited Plan
DQO	Data Quality Objectives
EPA	Environment Protection Authority (NSW)
Golder	Golder Associates Pty Ltd
ha	Hectare
km	Kilometres
LOR	Limit of Reporting
m	Metres
MAH	Monocyclic Aromatic Hydrocarbons
Mercury	Inorganic mercury unless noted otherwise
Metals	As: Arsenic, Cd: Cadmium, Cr: Chromium, Cu: Copper, Ni: Nickel, Pb: Lead, Zn: Zinc, Hg: Mercury
mg/kg	Milligrams per Kilogram
mg/L	Milligrams per Litre
m BGL	Metres below ground level
µg/L	Micrograms per Litre
Milsearch	Milsearch Pty Ltd
NATA	National Association of Testing Authorities
ng/L	Nanograms per Litre
NEHF	National Environmental Health Forum
NEPM	National Environment Protection Measure
NHMRC	National Health and Medical Research Council
n	Number of Samples
OCPs	Organochlorine Pesticides
OPPs	Organophosphorus Pesticides
PAHs	Polycyclic Aromatic Hydrocarbons
PB	Parsons Brinkerhoff Australia Pty Ltd
PCBs	Polychlorinated Biphenyls
PID	Photoionisation Detector
PQL	Practical Quantitation Limit
pH	a measure of acidity, hydrogen ion activity
QA/QC	Quality Assurance/Quality Control
REM	Remediation Area
RPD	Relative Percent Difference
SAA	Small Arms Ammunition
SILs	Soil Investigation Levels
SVOCs	Semi Volatile Organic Compounds
TPHs	Total Petroleum Hydrocarbons
UCL	Upper Confidence Limit
UXO	Unexploded Ordnance
VENM	virgin excavated natural material
VHC	Volatile Halogenated Compounds
-	On tables is "not calculated", "no criteria" or " not applicable"

1 INTRODUCTION

A site contamination audit is being conducted for Landcom relating to property at Zouch Road, Edmondson Park, formerly occupied by the Department of Defence (Defence).

The audit is being conducted ultimately to provide an independent review of whether the land is suitable for any specified use or range of uses by an EPA Accredited Auditor i.e. an Audit under Section 47 (1) (b) (iia) of the NSW *Contaminated Land Management Act* 1997 (the CLM Act).

The Audit is being conducted in stages, with initial investigations conducted by Milsearch Pty Ltd (2000 to 2003) focussing on the military history of the site and the potential for contamination by munitions. Parsons Brinkerhoff Australia Pty Ltd (2004) then prepared a *Sampling, Analysis and Quality Plan for Detailed Site Assessment,* which covered munitions issues as well as soil and groundwater contamination issues. Golder Associates Pty Ltd (2005) have recently completed and reported on the *Detailed Contamination Site Investigation* of the site. The munitions aspects of this most recent assessment were conducted by BACTEC SE Asia Pty Ltd (BACTEC).

Advice has previously been provided by the Auditor throughout the audit, as follows:

- Stage 1 - Initial Advice, 7 February 2003;
- Interim Advice #2, 8 July 2003; and
- Various comments on the Sampling Analysis and Quality Plan, 21 April to 19 May 2004.

Consistent with Department of Environment and Conservation (DEC and formerly NSWEPA) requirements for staged "sign off" of sites that are the subject of progressive assessment, remediation and validation, I am required to advise that:

- This opinion letter does not constitute a Site Audit Report or Site Audit Statement.
- At the completion of the remediation and validation I will provide a Site Audit Statement and supporting documentation that will conclude as to the suitability of the site for its intended purposes.
- In the final Site Audit Report this interim advice will be documented.

Details of the audit are:

Requested by:	Alan Lalich & Associates, on behalf of Landcom
Request/Commencement Date:	24 January 2003
Auditor:	Graeme Nyland
Accreditation No.:	9808

The scope of work completed to date for the audit and covered by this Interim Advice includes:

- Review of the following reports:
  - Report *"Stage 1 Preliminary Contamination Investigation. Zouch Road Ingleburn 92 Ha Site"*. By Milsearch Pty Ltd (Milsearch). Prepared for Landcom, September 2000; and
  - Draft Report *"Draft Stage 2 Munitions Contamination Investigations. Landcom 92 Ha Site, Zouch Road, Ingleburn (Former Army Infantry Centre). 21 January – 6 April 2002".* By Milsearch. Footer date 30 June 2002.
  - Report *"Final Stage 2 Munitions Contamination Investigations. Landcom 92 Ha Site, Zouch Road, Ingleburn (Former Army Infantry Centre). 21 January – 6 April 2002".* By Milsearch. Footer date 30 June 2002.
  - Report *"Stage 2 Munitions Contamination Investigations, Additional Investigations. Landcom 92 Ha Site, Zouch Road, Ingleburn (Former Army Infantry Centre)". 14-16 January & 9 February 2003, 30 April-2 May 2003, 21-22 May 2003.* By Milsearch. Footer date 10 June 2003.
  - Draft Report *" For Discussion – Sampling, Analysis and Quality Plan (SAQP), Detailed Site Assessment, Zouch Road, Ingleburn"*. By Parsons Brinkerhoff Australia Pty Ltd (PB). Date March 2004.
  - Draft Report *" For Discussion – SAQP, Detailed Site Assessment, Zouch Road, Ingleburn"*. By PB. Date April 2004.
  - Report *"SAQP, Detailed Site Assessment, Zouch Road, Ingleburn"*. By PB. Date May 2004.
  - Draft Report *" Detailed Contamination Site Investigation, Landcom Project No: 12619, Zouch Road, Edmondson Park, NSW".* By Golder Associates Pty Ltd (Golder). Date May 2005 (2005a).
  - Report *" Detailed Contamination Site Investigation, Landcom Project No: 12619, Zouch Road, Edmondson Park, NSW".* By Golder. Date August 2005 (2005b).
- Site visits by the Auditor or representative on 31 January 2003 and 1 March 2005.
- Discussions with the Client (Landcom) and Consultants (Milsearch, PB and Golder) who undertook the investigation.

2 SITE DETAILS

2.1 Location

The site is located on the north and west extremity of the Ingleburn Military Camp, which is located on Campbelltown Road running south west from Liverpool. The site location is shown in Attachment 1, Appendix A.

Further details follow:

Street address:	Zouch Road, Edmondson Park NSW 2171
Identifier:	Lot 1, DP 807460 (54.67 ha) Lot 2, DP 807461 (38.14 ha)
Local Government:	Liverpool City Council
Owner:	Landcom (NSW Government)
Site Area:	92.81 ha (Golder report area as "about 94 ha")

A survey plan of the site has not been provided. If this Summary Site Audit were used for statutory purposes the surveyed site boundaries would be required.

2.2 Zoning

According to the Stage 1 Milsearch report, the previous site zoning status is 5(a) Military and the current zoning is 1(a) Rural.

The proposed future zoning for the site is 2(a) Residential, however, a large portion of the site is proposed to be used for a conservation (open space) area.

2.3 Adjacent Uses

The site has frontage to only one public road, Zouch Road, for only a short distance in the south west corner of the site.

Adjacent site uses are as follows:

- Well-developed semi-urban acreages which front away from the site to Culverston Avenue are located to the **west**;
- A series of small agricultural blocks which also front away from the site are located to the **north** and **east**, fronting onto Jardine Drive and Croatia Avenue, respectively;
- Low cost housing which was formerly Army Married Quarters are located to the **south east**; and
- The now disused Ingleburn Military Camp is located to the **south**.

None of the surrounding land uses were identified as having the potential to cause significant contamination at the site.

2.4 Site Condition

The majority of the following description is summarised from the Milsearch Stage 1 report (2000), with some additional comments from the Golder investigation (2005). Attachment 2, Appendix A, shows the site layout and key features as identified by Golder in their investigation.

Information prepared for the site and referenced by Milsearch, but not reviewed by the Auditor, includes:

- *Preliminary Flora and Fauna Study*. Pelican Environmental Surveys, March 1999;
- July – August 2001 studies of Cumberland Land Snail colonies by Gunninah Environmental Consultants;
- Topographical surveys of the site, August – September 2001; and
- National Parks and Wildlife Service Section 91 licence providing approval for vegetation slashing to proceed, October 2001.

The site is described as open grassed land with several separate stands of protected Cumberland Plain Woodlands (Grey Box). A number of protected Land Snail colonies are located primarily in nine areas of protected woodland. Although readily accessible areas of grassland are reportedly slashed on a regular basis as a fire protection measure, vegetation overgrowth is extensive at the site, with common blackberry infestations (shown on Attachment 2, Appendix A).

The topography of the site is described as gently undulating. The site elevation ranges from 50 to 70 m with reference to Australian Height Datum (AHD) with the highest point in the southwest corner of the site. Key site features described include:

- a low ridge line in the north;
- a small hill in the south east;
- a man-made stop butt as part of a small arms firing range in the south west;
- various earth roads cross the site;
- well-constructed 9m wide dirt perimeter road;
- major creek lines and dams on site are as follows:
    - Cabramatta Creek runs across the north west corner of the site and receives runoff from the north west area;
    - originating on site, in the east running from south to north, exiting in the north east of the site, Dam 1 is on this creek;
    - feeder creek to the above, south east of the stop butts, Dam 3 is on this feeder creek;
    - originating off-site, in the east, running northerly then easterly, exiting in the north east, Dam 2 is on this creek;
    - all three dams were dry in 2000; and
    - Dam 3 was dry and Dams 1 and 2 had a small amount of water in 2005.

A number of additional observations relevant to the contamination assessment were made by Milsearch and Golder, as follows:

- Expended blank small arms ammunition (SAA) litters the site as a product of infantry minor tactical training. SAA may be of higher density associated with slit trenches in the west and north of the site, in Cumberland Plain Woodland areas.
- There are a number of areas on site that have been used for disposal of building and domestic waste, with some illegal dumping:
  - Trenches in high ground to the north east of the small arms firing range;
  - Piles in the extreme north west corner of the site, including soil, bonded asbestos sheeting and building rubble;
  - Pile 100m north east of the entrance gate; and
  - Piles in numerous other locations on site.
  - Golder identified 15 stockpile locations on Attachment 2, Appendix A.
- There are numerous areas of concertina barbed wire located at the site, which were formerly used as practice obstacles.
- There is a high concentration of concertina barbed wire at a prisoner of war camp simulation area in the central west of the site. General rubbish including whitegoods, scrap metal and vehicle parts were also present in the western part of this compound. Weapons pits less than 1m deep were also observed within the area.
- Slit trenches are common across the site, especially on the slopes of the high ground in the north. Many trenches have been partially filled and are likely to contain some star pickets, corrugated iron and possibly expended training ammunition.
- Golder identified numerous weapons pits across the site, as shown on Attachment 2, Appendix A.
- There are two former underground command posts in the north central portion of the site, fenced off by barbed wire. One was filled with water in 2000 and 2005.
- A few concrete building foundations indicating the former presence of structures are located on site, primarily in two zones:
  - In the south east near Dam 2, possibly former dog kennels; and
  - On the north west wooded ridgeline, including two foundations, a latrine and evidence of other wood frame buildings.
- A coal stockpile is located on high ground to the north east of the small arms firing range (about 200 m^3) and in the south east corner of the site (about 150 m^3).
- Car bodies are located in numerous locations, some burnt areas were found where the bodies had evidently been removed.

- Bonded asbestos materials were observed on site as follows:
  - A short length of bonded asbestos 4" water conduit was observed south of the small arms firing range, possibly imported with building rubbish;
  - Five piles of asbestos sheeting and building rubble were present north of the small arms firing range, close to the access road;
  - Two more piles are present on the crest of the hill north of the small arms firing range;
  - Golder identified a large area overlapping the small arms firing range of fragmented pieces of bonded asbestos sheeting scattered across the ground surface;
  - Asbestos was noted in the waste dumps in the extreme north west corner of the site; and
  - Golder identified a stockpile of asbestos pipes in the east of the site.

The Auditor's observations during the site inspection were consistent with the site conditions described by the Consultants.

2.5 Proposed Development

Golder (2005) provides a summary of the proposed development for the site. The site forms part of the Edmondson Park Release Area, and is currently the subject of a rezoning proposal. Key features of the proposed development include:

- A proposed rail line from the south east to north west corner of the site;
- Approximately 38 ha of Conservation Zone and riparian protection park south of the proposed rail alignment; and
- Approximately 55 ha of development including elements of a town center and residential districts in the northern and western parts of the site.

For the purposes of this audit, the "residential with gardens and accessible soil" and "open space" land use scenarios will be assumed.

Golder has divided the site into four areas for assessment purposes:

- Residential zone north of rail alignment (RZNRA);
- Residential zone south west corner (RZSWC);
- Residential zone north west corner (RZNWC); and
- Conservation zone south of rail alignment (CZSRA).

3 SITE HISTORY

Milsearch compiled site history information from the following sources:

- Literature search including Gavin Lang's history of the Second World War; various unit histories and war diaries; and a magazine produced at Ingleburn Camp during the period of the universal National Service Scheme (1950-1959);
- Archival material from National Archives, Canberra; National Archives, NSW and from the Australian War Memorial Public Documents Archive;
- Interviews with serving and former soldiers who had trained at Ingleburn camp at some time during their careers, or who could have knowledge of the camp's history;
- Review of records and drawings held by the Defence Property Office NSW and information from the period Defence Hirings Register, made available by the Defence Regional Office Sydney;
- Examination of the Defence 1996 Unexploded Ordnance (UXO) Assessment for Ingleburn Military Camp along with supporting Explosive Ordnance Incident Reports (EOIR) from 1996 to 2000;
- Review of available aerial photographs from 1947 to 1998; and
- Site inspection.

Golder undertook additional site history investigations which included the following:

- Review of aerial photographs from 1947, 1956, 1961, 1965, 1970, 1978, 1986, 1991, 1994, 1998 and 2002;
- Review of historical title information; and
- Review of Section 149 certificates from Liverpool City Council.

The Auditor has summarised the site history provided by Milsearch and Golder in Table 3.1.

Table 3.1 – Site History

Date	Activity
1819	Original land grant, private ownership, farming usage likely.
1939	Defence hired 'vacant land' near Ingleburn Camp as a 'manoeuvre area'. Usage by Defence continued through the WW2 period.
1953	Purchased by Commonwealth of Australia. Land within the wider Ingleburn area was acquired by the Army and used to establish camps and to conduct training for wartime expansion. Site was used primarily for infantry training purposes. First features developed at the site were the Small Arms Firing Range, Golf Course, grenade throwing bay and impact zone and cricket pitch.

Date	Activity
	The grenade range was located in the center of the site and was used for live grenade throwing practices and possibly also mortar practice bombs for up to 30 years. The firing range, located in the south west of the site, was also used for up to 30 years.
Between 1956 and 1961	Golf course is disused. Dams 1 to 3 are present. The dams may have been used for disposal of unwanted munitions.
Between 1970 and 1978	Small arms Firing Range has been reconfigured to fire in the opposite direction. The original stop butt material, which contained lead particulate, was spread about the range and built into roads at the site in the 1970s. Vegetation cover at the site is increasing from this time.
Between 1978 and 1986	Three disposal trenches have been excavated, located in high ground to the north east of the firing range. The pits were reportedly filled by the former disposal practices of the 'Boards of Survey' of 'burn, bash and bury'. This area would contain general stores materials which were damaged or surplus to requirements.
1990	Purchased by NSW Land and Housing Corporation (Landcom). Usage by Defence ceased.

In the Auditor's opinion, the site history review has been detailed and the major potential contamination issues on site have been identified. Some uncertainty remains with respect to the potential for:

- additional waste disposal trenches;
- additional areas of lead particulate;
- the location of slit trenches that may have been backfilled; and
- unexpended (live) blank SAA possibly disposed during tactical training exercises.

4 CONTAMINANTS OF CONCERN

Milsearch identified a number of potential contaminants at the site. Based on the reviewed reports, site history and site condition, the potential contaminants of concern in the opinion of the Auditor are as shown in Table 4.1 below.

Table 4.1 – Contaminants of concern

Activity	Area	Contaminants of concern
Live grenade throwing practices and possibly also mortar practice bombs	Grenade range	UXO and grenade explosion residues
Small arms firing range	Firing range stop butts Roadways where reengineered stop butt material was placed Dam 3 (runoff)	Lead particulate and other heavy metals
Possible munitions disposal	Dams 1, 2 and 3	UXO
Waste disposal in trenches	3 burial trenches, NE of small arms firing range Possible additional unknown locations	Unknown, could include heavy metals, petroleum hydrocarbons, pesticides, asbestos, household chemicals
Waste disposal in piles, including building rubble	Extreme north west corner of the site 100m north east of the entrance gate South of small arms firing range 5 piles north of small arms firing range 2 piles on crest of hill north of small arms firing range Potential locations across entire site	Unknown, could include heavy metals, petroleum hydrocarbons, pesticides, asbestos, household chemicals
In-ground structures used for infantry minor tactical training	Known slit trench locations Underground command posts Possible additional unknown locations	Physical objects such as star pickets and corrugated iron Unknown, possibly heavy metals (significant contamination would not be expected with this type of material, removal would be desirable for aesthetic purposes)
Infantry minor tactical training	Entire site, especially near slit trenches	Expended SAA, small percentage live (unexpended) SAA
Pest and weed control	Entire site	Pesticides, herbicides, arsenic, mercury
Runoff of contaminants	All waterways on site	Lead particulate primarily Pesticides, herbicides, arsenic, mercury
Building products and treatments	Former building	Pesticides, asbestos, lead
Storage and distribution of coal	Coal stockpile	Coal dust Possibly PAH, phenols
Practice obstacles	Numerous locations	Barbed wire physical hazard
Car body disposal and burning	Numerous locations	PAH, heavy metals, petroleum hydrocarbons

Activity	Area	Contaminants of concern
Car body disposal, surface dumping and practice obstacles	Numerous locations	Physical objects including cars and barbed wire Unknown, possibly PAH, heavy metals, petroleum hydrocarbons (significant contamination would not be expected with these types of surface dumpings, removal would be desirable for aesthetic purposes)

This table was adopted by PB for the SAQP and was subsequently also adopted by Golder as the basis for their investigation.

An additional issue identified by Golder during their investigations was the asbestos impact area that overlaps the small arms range, where fragmented pieces of bonded asbestos sheeting were scattered across the ground surface;

According to Milsearch, while live blank SAA ammunition constitutes a lesser hazard than live ball ammunition, blanks can still cause significant injury, particularly eye damage, if detonated through tampering.

Although the waste types likely to be encountered in the burial trenches or surface dumpings are likely to vary, the classes of contaminants of concern likely to be associated with waste disposal are well known, and are listed in Table 4.1, above.

5 STRATIGRAPHY AND HYDROGEOLOGY

Subsurface conditions at the site were investigated by Golder (2005) by the following:

- 628 test pits to between 0.3 and 4.3 m Below Ground Level (BGL) (generally less than 1 m BGL)
- 112 hand auger locations to between 0.5 and 1 m BGL
- 10 drilled boreholes to between 8 and 16.3 m BGL
- 13 test pits into stockpiled material to between 0.6 and 1.8 m BGL

The Auditor has compiled the following summary of the site stratigraphy and hydrogeology following review of the Golder (2005) report.

5.1 Stratigraphy

The regional geology comprises Bringelly Shale of the Wianamatta Group which comprises shale, carbonaceous claystone, claystone, laminite, fine to medium grained lithic sandstone, rare coal and tuff. This shale would be expected to be underlain by Ashfield Shale and then Hawkesbury Sandstone.

The stratigraphy of the Site is summarised in Table 5.1.

Table 5.1 – Stratigraphy

Unit	Depth (m BGL)	Description
Topsoil	To between 0.05 and 0.5	Clayey silt/ silt, brown, dry to moist, trace fine gravel
Fill (total 80 locations) Occurs in general stockpiles, small arms range, disposal trenches and northwest disposal area	To between 0.1 and 3.4m	General fill is silty/ gravelly clay, low to medium plasticity, brown, red and grey **Small arms range –** silty clay, red grey, fine to medium ironstone gravels, pieces of lead particulate **Disposal trenches –** described in Section 9.7. **Northwest disposal area –** silty/ gravelly clay, concrete blocks, bricks, timber, general building waste
Residual	Between topsoil/ fill and bedrock	Silty clay, medium to high plasticity, moist, some fine to medium ironstone gravels
Bedrock	From between 0.2 and 3.2	Shale, weathered, grey brown. A weathered, sandy shale outcrop was observed in the south west corner of the site.

5.2 Hydrogeology

Limited groundwater investigations have been undertaken at the site. Ten deep boreholes were drilled and wells were installed in the seven locations that encountered groundwater. Groundwater was present at between 2.54 and 14.6 m BGL, occurring within the shale/ sandstone bedrock. The equivalent reduced levels for groundwater at the site were 46.15 to 54.8 m AHD.

Perched water was encountered in three test pits at the eastern end of the waste disposal trenches (TP598, 706 and 708). The standing water level in these pits was about 0.5 m BGL and the water had a foul odour.

Golder expected perched groundwater to occur within alluvial deposits near main drainage lines and dams, flowing in the direction of the ground slope. The regional groundwater flow direction was inferred as likely to flow in an east to north easterly direction towards the Georges River.

The measured groundwater levels indicate that true groundwater flows in two directions away from the ridgeline in the centre of the site to the northwest and southeast directions. The inferred groundwater contours are shown on Attachment 3, Appendix A.

The nearest registered bores in the area are located approximately 1.5km from the site.

6 EVALUATION OF QUALITY ASSURANCE AND QUALITY CONTROL

A detailed Sampling, Analysis and Quality Plan (SAQP) was prepared by PB. The Auditor provided review comments on draft versions of this document.

6.1 Munitions

Data Quality Objectives in relation to the assessment of munitions contamination, including UXO, were not specifically addressed by Milsearch. The Auditor has assessed QA/QC for these investigations by considering the adequacy of investigation for each issue/ impact identified and the qualifications of personnel involved in the munitions investigation. The investigations undertaken are discussed in Section 9 and were found to be generally reliable for the purposes of the audit.

The methodology for the recent UXO investigation and remediation works undertaken by BACTEC was defined in the PB SAQP. Works were undertaken in accordance with the SAQP with the following two exceptions:

- The method for remediation of the REM 5 area was defined in the SAQP as mechanical screening, however, this method was not considered appropriate and was changed to a metal detector search to 300mm depth (two man team at 1m line spacings) with concurrence from the Auditor.
- Areas where geophysics found metallic anomalies were not investigated by 10m transects as proposed in the SAQP due to restrictions on disturbing vegetation in the areas with the highest readings. As an alternative, a visual inspection was undertaken with concurrence from the Auditor.

Quality control and calibration requirements for UXO remediation works are specified by BACTEC in their report. Key elements of QA/QC were as follows:

- Remediation searches were extended 4-5m outside the REM boundary areas to ensure full coverage of the areas.
- Searches comprised both a visual search and metal detector search.
- All detection equipment was calibrated daily over a prepared test pit. BACTEC reported that the test pit was established at the site with two targets, representative of the targets to be located during the project, buried at different depths.

6.2 Soil and Groundwater

The Auditor has assessed the overall quality of the soil and groundwater data by review of the information presented in the referenced reports, supplemented by field observations. The recent Golder detailed investigations were conducted largely in accordance with the approved SAQP, except as noted below.

The Auditor's assessment follows in Tables 6.1 and 6.2.

Table 6.1 – QA/QC – Sampling and Analysis Methodology Assessment

Sampling and Analysis Plan and Sampling Methodology	Auditor Comments
Sampling Pattern and Locations	**Soil**: Investigation locations were spaced on a systematic grid to gain coverage of the entire site. Further judgemental locations were targeted to features such as drainage lines, stockpiles and areas of contaminant observations. The grid spacings were defined according to the proposed usage of each area. The grid spacings were 32m for residential and 50m for conservation areas. The total number of sampling locations was 741 systematic and 92 judgemental. Locations could not be placed in areas of protected vegetation or blackberry infestations. Where possible, nearby alternate locations were found. The lack of investigation locations in those specific areas is not considered by the Auditor to affect the findings of the investigations. It was also necessary to slightly move locations from their proposed grid position due to the proximity of trees, military objects or other access restrictions. Further grid locations were shifted to intercept nearby areas of potential contamination such as fill/ stockpiles, training pits or drainage channels. In the Auditor's opinion the soil investigation locations adequately characterise general areas of the site and target the main areas of concern. Digital GPS was used to locate investigation locations and remediation areas. **Groundwater** monitoring wells were located in judgemental locations to gain coverage of upgradient and downgradient conditions, and to provide a broad indication of groundwater quality, particularly in the vicinity of contaminating activities.
Sampling Density	**Soil**: The EPA (1995) *"Sampling Design Guidelines"* does not provide guidance on the minimum number of sampling locations for sites larger than 5 ha, however, the selected grid spacing for the residential areas, 32m, is comparable to the minimum hotspot diameter recommended for sites of over 2 hectares. The Auditor considers that the adopted sampling densities for both the residential and conservation areas are appropriate. The proposed usage of one area, RZNWC, was changed following completion of the field works, therefore the grid spacing in this area is larger than for the other residential areas, and is not in accordance with the SAQP. Given the lack of contaminant detections in general areas of the site and the large volume of data for the site as a whole, the reduced density of sampling in this area is not considered by the Auditor to be significant. The analytical program was designed in the SAQP to assess the various contaminants of concern at appropriate sampling densities. The frequency of analysis was generally as follows:

Sampling and Analysis Plan and Sampling Methodology	Auditor Comments
	▪ Heavy metals – all samples ▪ PAH, TPH, BTEX – 16 to 26% of samples ▪ OCP, OPP, PCB, Explosives – 11 to 16% of samples ▪ Asbestos – 20-30% of samples The Auditor considers that the adopted sampling and analysis program was adequate to characterise the primary contaminants on site. **Groundwater**: A total of 10 groundwater wells were installed at the site, however, three of these wells were dry upon completion and could not be sampled. Three other wells were extended deeper, in consultation with the Auditor, to ensure groundwater was encountered in key locations. In addition, three samples of perched water collected within trenches in the waste disposal area were also collected. All groundwater and trench water samples were analysed for all target contaminants. The Auditor is satisfied with the adopted groundwater investigation density and analytical program.
Sample depths	Subsurface conditions were investigated by the following: ▪ Test pits - 0.3-4.3 mBGL ▪ Hand auger holes - 0.5-1.0 mBGL ▪ Boreholes - 8 to 16.3 mBGL ▪ Test pits in stockpiles - 0.6-1.8 mBGL ▪ Hand auger holes in ACM area - 0.5 mBGL Soil samples were collected from the surface (0-0.1m), 0.1-0.3m, 0.3-0.5m, 1m then 1m intervals or at visual/ olfactory signed of contamination or changes in lithology. The following number of samples were collected: ▪ Minimum 3 samples per hand auger hole ▪ Minimum 4 samples collected per test pit/ borehole Samples were selected for analysis from all material types encountered. The analytical program included analysis of at least one sample per investigation location. The most common sample intervals selected for laboratory analysis were the surface layer, then the immediate subsurface (to 0.3 or 0.5m BGL). The deepest sample analysed was to 3.7 mBGL in TP625 from the small arms range/ lead particulate area. Locations were extended 0.5m into natural soil or 0.5m beyond the extent of observed contamination. In the Auditor's opinion, this sampling strategy was appropriate and adequate to characterise the primary material types present on site.
Well construction	A total of 10 groundwater wells were installed at the site, seven to 8m BGL and 3 to around 15 m BGL. Three of the shallow wells were dry upon completion. Remaining wells contained sufficient water to sample. For all of these wells,

Sampling and Analysis Plan and Sampling Methodology	Auditor Comments
	the top of water table occurs within the screened interval. Wells were constructed of Class 18 50mm uPVC pipe. A 1.5mm graded sand filter pack was used with a bentonite seal of at least 1m. All groundwater level measurements were taken on the same day except for BH2 (5 days later).
Sample Collection Method	**Soil**: Soil samples were collected as follows: ▪ Test pits – Stainless steel trowel from the test pit walls or the centre of the excavator bucket for pit depths of greater than 1m. ▪ Hand auger holes - 75mm hand auger, sample collected directly from the auger flights. ▪ Boreholes - Truck mounted drill rig, 100mm solid flight auger, samples collected directly from the auger flights. Attempts to collect undisturbed samples with a split spoon sampler were not successful. The collection of soil samples from the auger flights is not ideal as it can result in loss of volatiles and sample cross contamination. However, given the limited number of samples required to have been collected in this way, and given the key contaminants at the site are heavy metals and PAH, this deficiency is not considered to be of great significance. Sample compositing was not undertaken. Test pits were loosely backfilled with excavated material on completion **Groundwater**: Wells were installed in boreholes that were auger drilled and cored at depth. Wells were developed and samples were collected with a dedicated disposable plastic bailer.
Decontamination Procedures	**Soil**: All sampling equipment was reportedly cleaned with detergent, rinsed twice in clean tap water. Augers were reportedly decontaminated between sample locations since soil sampling was directly from the auger flights. The use of high pressure water for cleaning of augers was not discussed. **Groundwater**: Dedicated sampling equipment was used for each well. The report does not state the decontamination method for groundwater meters.
Sample handling and containers	All samples were placed into appropriately prepared and preserved sampling containers provided by the laboratory. Samples were chilled during storage and subsequent transport to the laboratories. Samples to be analysed for heavy metals were field filtered with a 0.45µm filter.
Chain of Custody	Completed chain of custody forms were provided in the report.
Detailed description of field screening protocols including calibration	Field screening of soil samples for volatiles was undertaken using a PID. The PID screening procedure was provided. Half filled plastic bag samples were shaken and allowed to stand

Sampling and Analysis Plan and Sampling Methodology	Auditor Comments
	for at least 5 minutes prior to measurement of vapours. The PID was reported to have been calibrated prior to use. Calibration certificates were provided. PID readings are provided on borehole logs, tabulated in the appendix and are discussed in the results section of the report. The highest PID concentration was 18.6 ppm, in HA99/2. This sample was not submitted for analysis, but there were no contaminant indicators in this natural clay sample. The cause of this elevated reading is not known, but is not considered likely to be a contamination impact. The vast majority of PID concentrations were less than 5 ppm indicating a general lack of impact by volatile contaminants at the site. Groundwater field parameters including temperature, pH, electrical conductivity (Ec) and Total Dissolved Solids (TDS) were measured during well sampling and development. Meters were reported to have been calibrated prior to use each day. Calibration certificates were provided.
Sampling Logs	Soil logs are provided within the report, indicating sample depth, PID readings and lithology. Separate sample registers were also provided for each area. Groundwater field sampling records were not provided, although measured field parameters are included in the report.

Table 6.2 – QA/QC – Field and Lab Quality Assurance and Quality Control

Field and Lab QA/QC	Auditor Comments
Field quality control samples	Field quality control samples including intra- and inter-laboratory duplicates, trip blanks, trip spikes and wash blanks were undertaken. Individual soil analyte duplicate frequencies for each area generally met the targets of 10% for intra-laboratory (blind) duplicates and 5% for inter-laboratory (split) duplicates. The exception to this was that no intra-laboratory duplicate samples were analysed for asbestos samples from the entire site. However, inter-laboratory duplicate samples were analysed for asbestos at an overall frequency of 10%, exceeding the target of 5%. The groundwater duplicate sampling rates were 10% for intra-laboratory (blind) duplicates and 10% for inter-laboratory duplicates. The overall sampling numbers were as follows: ■ 1107 primary soil samples ■ 10 primary groundwater samples ■ 172 duplicate samples ■ 20 trip blanks and 19 trip spikes

Field and Lab QA/QC	Auditor Comments
	▪ 34 wash blanks The overall duplicate frequency exceeded the 15% target. The frequency of field QA/QC sampling and analysis is considered by the Auditor to be acceptable for the purposes of the investigation.
Field quality control results	The results from all ***trip blank samples*** were appropriate. Some ***trip spike samples*** returned recoveries below the desirable range of 70-130%. These minor variations are not considered significant given the lack of volatile organic detections in all soil and water samples from the site. Low levels of zinc were commonly detected in the ***wash blank samples*** with a maximum of 0.1 mg/L detected. Golder investigated this occurrence and was advised by the laboratory that rinsate water outside of a specific holding time can return detectable concentrations of zinc. However, Golder reportedly obtained rinsate water regularly from the laboratory and the laboratory would not confirm if the supplied water was out of holding time. Golder argued and the Auditor accepts that this issue is not reflective of poor decontamination practices and does not affect the findings of the investigation due to the following: ▪ no other metals were reported in the wash blank samples; and ▪ few elevated concentrations of zinc were reported in the soil samples. The results of all organic ***duplicate*** analyses for soil and groundwater (inter- and intra-laboratory duplicates) were non-detect in both the primary and secondary samples, therefore duplicate results were acceptable. Inorganic duplicate results are discussed below. **Soil:** For duplicate sample pairs for which RPDs could be calculated, over 8% of analyses returned RPDs outside the target of 50%, and 1.5% were over 100%. RPDs could not be calculated for sample pairs with non-detections. Golder concluded that these results "...indicate an adequate level of repeatability...". Golder did not undertake any further assessment of the findings and did not utilise the higher duplicate results in their assessment of results. Upon closer examination of the findings, a number of duplicate results were found to potentially affect the findings of the investigation. While it is acknowledged that these discrepancies would most likely be due to sample heterogeneity, the results still require consideration. Significant findings from duplicate analyses for inorganics were as follows: ▪ Several inter-laboratory duplicate samples pairs were non-detect (<0.05mg/kg) for mercury in the primary sample, but low level mercury detections (0.05-0.07mg/kg) were made in the duplicate sample.

Field and Lab QA/QC	Auditor Comments
	Results were also occasionally inconsistent between intra-laboratory duplicates, however it was far more common with the inter-laboratory samples, with Labmark commonly reporting detections where SGS did not. Due to the low concentrations involved, this does not affect the findings of the investigation, however, it should be recognised as a potential indication of underestimation of mercury and possibly other metals concentrations by the primary laboratory (SGS). ■ In the CZSRA, one intra-laboratory duplicate and one inter-laboratory duplicate exceeded the phototoxicity/ open space human health criterion for lead of 600 mg/kg while the primary samples were less than the criterion. These samples were both of fill from within known areas of contamination – the open trench and small arms range. The need for remediation in these areas has already been identified, therefore these findings do not affect the conclusions of the investigation. ■ In the CZSRA, one inter-laboratory duplicate exceeded the phototoxicity criterion for copper while the primary sample was below this criterion. This sample was from within a known area of contamination – the small arms range. The need for remediation in this area has already been identified, therefore this finding does not affect the conclusions of the investigation. ■ One board sample analysed for asbestos was identified as containing chrysotile asbestos by the primary laboratory (SGS) however the secondary laboratory (ASET) identified this sample as containing chrysotile and amosite asbestos. Remedial action is planned in the affected area based on the presence of asbestos with no regard for the type of asbestos, therefore this finding does not affect the conclusions of the investigations. The above issues are not considered likely to affect the overall data useability due to the large volume of data and the generally low concentrations, therefore having a lower potential to change conclusions in the event of laboratory error. **Groundwater:** Two groundwater duplicate samples were analysed – one intra-laboratory duplicate and one inter-laboratory duplicate. Seven of the 16 individual analyte pairs exceeded the targetwith RPDs of between 40 and 173%. Three of these were found to potentially affect the conclusions of the investigation, all from the inter-laboratory duplicate of sample BH291as follows: ■ Mercury was detected at the detection limit of 0.0001 mg/L in the duplicate sample when all other sample results for the site were non-detect. This detection

Field and Lab QA/QC	Auditor Comments
	exceeds the threshold value of 0.00006 mg/L. ■ The duplicate sample exceeded the threshold values for nickel and zinc, with the zinc detection being the highest made at the site. The Auditor has considered these findings in the context of the overall groundwater results (refer Section 10) and they do not affect the conclusions of the groundwater investigation.
NATA registered laboratory and NATA endorsed methods	The primary laboratory utilised for the project was SGS Environmental Services (SGS Australia Pty Ltd). All analyses were conducted internally with the exception of explosives analyses which were analysed by MGT Victoria. The SGS certificates were NATA stamped however they noted that the accreditation does not cover the identification of Synthetic Mineral Fibre via asbestos analysis. SGS also reported the accreditation number for MGT Victoria. The secondary laboratory utilised for inter-laboratory duplicate sampling was LabMark Pty Ltd. Duplicate asbestos analyses were reportedly undertaken by ASET. The LabMark certificates for groundwater were NATA stamped. LabMark certificates for asbestos were not included in the report, nor were the ASET certificates.
Analytical methods and holding times	For SGS, the analytical methods used were described in the laboratory test certificates with the exception of the MGT analyses (explosives). In-house analytical methods were included in the LabMark laboratory test certificates. Golder report that the methods used conform to the NEPM where guidelines are available (excluding asbestos). Golder reported that required holding times have been met for all data. Due to the volume of data, the Auditor has not undertaken a full review of COCs against laboratory certificates to check that the holding times had been met. However, spot checks have been undertaken and indicate holding time compliance.
Practical Quantitation Limits (PQLs)	Not all PQLs for the groundwater assessment were sufficiently low, with the following PQLs exceeding the relevant trigger values: ■ Mercury 0.0001, trigger value 0.00006 mg/L ■ Some PAHs (anthracene, benzo(a)pyrene) ■ Some OCP/OPP (Aldrin, Dieldrin, Chlorpyrifos) These discrepancies are not considered significant due to the following: ■ No soil contamination by mercury was detected that could be a potential source of impact to groundwater. ■ No PAH were detected in any groundwater samples and only limited soil detections were made. ■ No OCP or OPP were detected in any soil or groundwater samples.
Laboratory quality control	For SGS, laboratory quality control samples including blanks,

Field and Lab QA/QC	Auditor Comments
samples	matrix spikes and duplicates were undertaken at appropriate frequencies. Laboratory quality control could not be reviewed for LabMark since laboratory certificates for soils were not provided.
Laboratory quality control results	The laboratory quality control results reviewed are considered acceptable given the limited number of results outside desirable ranges and the large bulk of analytical data for the project.
Data Quality Objectives and Data Evaluation (completeness, comparability, representativeness, precision, accuracy)	Predetermined data quality objectives (DQOs) were defined in the PB SAQP document and were developed based on the seven step data quality process. Golder undertook an assessment of QA/QC for each of the investigation areas and for groundwater. Individual conclusions were provided in the appendix, however, an overall conclusion was not provided within the body of the report. The individual conclusions were all as follows: "The field QA/QC and internal laboratory QA/QC results indicate an acceptable reproducibility, precision and accuracy. Therefore Golder considers that overall the data quality objectives have been met and the data generated is sufficient to support the interpretation of results."

In considering the data as a whole the Auditor concludes that the data is likely to be reliable and useable for the purpose of this audit.

7 ENVIRONMENTAL QUALITY CRITERIA

7.1 Munitions

There are currently no EPA endorsed environmental quality criteria for UXO or SAA (live or blank). The Auditor recommended that reference should be made to "The assessment and management of land contaminated with unexploded ordnance" by Ranald Scott published in the National Environmental Health Forum Fourth Workshop Proceedings on the Health Risk Assessment and Management of Contaminated Lands (1998). It was also recommended that the Consultant should benchmark with similar sites in Australia and overseas to determine appropriate environmental quality criteria for these types of contaminants.

Grenade and Mortar Impact Areas

According to Milsearch, it is generally accepted throughout the military and UXO remediation community that around 3% of any conventional munitions that are fired or projected will fail to function as intended and will remain as UXO. It follows that around 33 grenades on average would need to be detonated in an area to generate a single UXO. Discovery of a large number of detonated grenades would indicate a high risk for UXO to be present.

When assessing potentially contaminated zones of this nature, Milsearch has differentiated 'impact points' from areas where fragmentation alone exists. Detonation of a grenade spreads fragmentation in a radial pattern. The effective killing or injury zone is a 5-10m radius, but heavy fragments, such as base filling plugs, may travel as far as 150m. Identification of a grenade impact point is generally associated with finding fuze well portions which tend to remain closer to the point of detonation and are non-ferrous and therefore corrode more slowly. However, this method is not precise since fuze wells can also be projected away from the detonation point. According to Milsearch, the finding of a single fuze well is not conclusive evidence that a grenade has detonated at that point. An appropriate conclusion would be that at least one grenade, or a very small number of grenades, had detonated in the vicinity if other portions of a grenade were also found. Supporting evidence would include fuze striker spring assemblies and other light weight non-ferrous portions or a large amount of smaller ferrous fragmentation. If only heavier ferrous fragments were found, this would indicate that grenades had been utilised nearby (within 150m) but have not detonated in that location. During the course of investigations, isolated finds of grenade fragmentation have been used as a trigger for further investigations and closer examination.

Due to strict controls of activities and the need for protection of personnel by site preparation and planning, Milsearch has argued that detonation of thrown hand grenades at the site for training purposes would have most likely been on a concentrated basis rather than in isolated use.

According to Milsearch (2003, page 8) *"There are currently no nationally or internationally defined and objective criteria for what constitutes a grenade impact area requiring remediation. Without the benefit of established criteria, such decisions are currently based on judgement, experience and training".* Generally

speaking, the density of fragmentation present will increase with the number of grenades that have been detonated. This represents a fragmentation 'signature' that can be related to the potential for UXO to be present. In assessing the various impacts identified at the site, the Consultants used the fragmentation 'signature' and other evidence to determine the need for remediation based on the relative potential for UXO to be present.

The remediation approach and environmental quality criteria applied by the Consultants to date relating to grenade and mortar impacts appear to be generally appropriate. Further remediation works are proposed with regards to potential UXO impacts. Further information is required in the Remedial Action Plan (RAP) regarding the proposed acceptance/ validation criteria for remediation of UXO.

Blank SAA

According to Milsearch, while live blank SAA constitutes a lesser hazard than live ball ammunition, blanks can still cause significant injury, particularly eye damage, if detonated through tampering. Brass blank ammunition is understood to be particularly dangerous.

Milsearch previously proposed that a very low density of SAA occurrence would be less than 250/ha and a low density would be between 250 and 500/ha. A "threshold" blank SAA density of 250/ha was developed based on the likelihood of live and expended blank SAA to be found for residential block sizes of 700m^2 (Milsearch, 2003, pages 18-19). The Auditor is not necessarily in agreement with the defined threshold limit due to a number of reasons that were discussed in my Interim Advice #2 dated July 2003.

Golder (2005b) reported that similar projects have typically had a zero tolerance threshold criteria for SAA within residential developments. Similar projects within conservation areas were not identified. Further remediation works are proposed with regards to potential SAA impacts. Further information is required in the Remedial Action Plan (RAP) regarding the proposed acceptance/ validation criteria for remediation of SAA.

7.2 Soil

The Auditor has assessed the soil data provided by Golder in reference to Soil Investigation Levels for Urban Redevelopment Sites in NSW (SIL) in EPA (1998) *Guidelines for the NSW Site Auditor Scheme*:

- SIL Column 1 – "residential with gardens and accessible soil";
- SIL Column 3 – "parks, recreational open space"; and
- SIL Column 5 – "provisional phytotoxicity-based investigation levels".

EPA (1994) *Guidelines for Assessing Service Station Sites* have also been referred to for assessing TPH and BTEX results. These guidelines relate to sensitive land uses and are therefore appropriate for the site.

There are no EPA-endorsed guidelines for asbestos in soil. The EPA states that the position of the Health Department is that there should be no asbestos in surface soil.

7.3 Groundwater

The Auditor has assessed the groundwater data in reference to ANZECC (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* for fresh waters. Trigger values (TVs) provided are concentrations that, if exceeded, indicate a potential environmental problem and "trigger" further investigation.

There are no reliable Australian criteria for TPH in groundwater. The current NSW EPA position is that there should be no free phase product in groundwater, and that the aromatic components of dissolved-phase TPH in groundwater should be assessed using the ANZECC (2000) TVs where available. These guidelines include criteria for some BTEX compounds and for some polycyclic aromatic hydrocarbons.

8 EVALUATION OF MUNITIONS INVESTIGATION RESULTS

8.1 Investigations Undertaken

Investigations have been conducted in a number of fieldwork stages, as follows:

- Milsearch
    a. **Stage 1**: September 2000;
    b. **Stage 2A**: 21 January to 5 February, 12 to19 February, 5 to 8 March, 2 to 6 April 2002; and
    c. **Stage 2B**: 14 to 16 January 2003, 9 February 2003, 30 April 2003 to 2 May 2003, 21 to 22 May 2003.
- Golder/ BACTEC
    d. **Detailed Contamination Site Assessment:** 24 January to 18 February 2005.

Stage 1 comprised coarse preliminary instrumented sampling program with metal detector transects at 50m intervals over the entire site. The field work allowed for the detection of surface and near-surface metallic items and was found to be effective over 65-70% of the site (the remainder being inaccessible). Stage 2A and B comprised several sub-investigations to target issues identified during Stage 1. Table 8.1 within the Auditor's Interim Advice # 2 (July 2003) summarises the various methodologies adopted for the different stages and objectives of the munitions investigations undertaken by Milsearch.

The key munitions issues identified by the Stage 1 and 2 investigations were summarised in the Auditor's Interim Advice # 2 (July 2003) as follows:

- Grenade range and impact zones (Remediation Area (REM) 1 to 3, 5)
- Additional grenade and mortar impacts including Anti Tank Rocket impact zone (REM 4)
- Small Arms Ammunitions (SAA)

The Detailed Contamination Site Assessment included the following scope of work for munitions:

- 100% search and remediation of identified areas REM 1 to 5 (refer Section 11)
- 100% search and remediation of additional identified areas (refer Section 11):
    e. Inert 81mm practice mortar (REM 6)
    f. Anti Tank training mine (REM 7)
- Clearance of contamination sampling locations over 2x2m area using visual search and Minelab Metal Detector. Groundwater well locations were searched using a Forester Magnetometer which is capable of detecting ordnance to a depth of over 3 m.

- Contamination sampling locations were on a 50x50m or 32x32m grid.
- Visual sweep between contamination sampling locations.

The results of the munitions investigations are discussed in the following sections and issues requiring remediation are discussed further in Section 11. Areas of lead particulate including the small arms range and waste disposal trenches were also investigated by Milsearch, however, the results for these issues are discussed in Section 9.

8.2 Grenade range and impact zones (REM 1 to 3, 5)

A range was used for live grenade throwing practices and possibly also mortar practice bombs. Investigation of this zone was initially undertaken over a 6.5 ha "Grenade Exclusion Zone" area. Evidence of grenade impact points was found, as well as a single practice 81mm mortar bomb. Extensions to this initial area were made during the course of investigations to delineate the extent of the grenade impact area.

Three grenade impact areas were identified as requiring remediation, as follows:

- IA1 (REM 1) – rectangular area in the north, six impact points.
- IA2 (REM 2) – central portion, 30 impact points, 19 within the dense bursting zone. A zone within IA2 was found to be the main bursting zone (REM 5).
- IA3 (REM 3) – south, four impact points.

An additional 1ha zone to the south west of IA2 was investigated as the final task of Stage 2B ('grenade exclusion extension slash' on Attachment 2, Appendix A). Investigation of this area was undertaken due to tentative indications of possible grenade impact identified during Stage 2B investigations, including nil-data SAA validation. This was also the general direction from which the sole practice 81mm mortar bomb found during Stage 2A was thought to have been fired. While numerous heavy grenade base plugs were located, no further indications of grenade impact areas were found and no additional practice 81mm mortar bombs were found. It was concluded that this additional 1ha zone was not a recognizable target area and that remediation of this zone was not justified. It was recognized, however, that it was quite possible that additional practice 81mm mortar bombs may exist on site since they do not leave a fragmentation 'signature'. Milsearch concluded it was likely that additional items would be present, most likely within the central portion of the site.

8.3 Anti Tank Rocket impact zone (REM 4)

During the Stage 1 and 2 investigations, numerous grenade or mortar impacts were located outside the "expected" zones of impact, being primarily the main grenade range and also the dams. The majority of these were isolated, and did not indicate an additional area that required remediation, however, remediation of one such area was required.

A target area for 3,5" anti-tank practice rocket projectiles was found, with 19 pieces of fragmentation in a 1m line encompassing an apparent target and drop short

area. The area appeared to have been searched and partially cleared, however potential existed for some inert rocket heads to be below-ground. While they present no hazard, this issue was identified as an aesthetic issue that requires remediation. Further investigations were conducted in Stage 2B to delineate this area for the purposes of remediation.

8.4 Inert 81mm practice mortar (REM 6) and Anti Tank training mine (REM 7)

During the clearance of 763 contamination sampling locations recently completed by BACTEC as part of the Detailed Site Investigation, two items of interest were located between investigation locations. These were:

- Inert 81mm practice mortar (REM 6) located near TP580; and
- Anti Tank training mine (REM 7) located near TP549.

Further investigation and remediation of these impacts was undertaken during the Detailed Site Investigation.

8.5 Small Arms Ammunitions (SAA)

Expended blank small arms ammunition (SAA) litters the site as a product of infantry minor tactical training. The investigation of SAA has followed two approaches:

1. Analogue metal detector transects including investigation of contacts and collection of identified items (Milsearch and BACTEC).
2. Digital detector sampling surveys to map and measure the density of expended SAA blank ammunition (Milsearch). The detector used was the TM5 EMU computer assisted large coil metal detector which had been demonstrated in laboratory tests to detect surface and near surface blanks at a typical carrying height and at a fast walking speed. Digital metallic densities were recorded for a network of 'cells' or 'tiles' across the site. A number of additional investigations were undertaken to validate these densities with analogue equipment by closer inspection of certain cells. During validation, it was found that extraneous metallic material such as barbed wire and domestic rubbish interfered to some degree with the detector method used. The validation process utilised was found to be an effective site-wide check of unexpected potential metallic ordnance contamination, but did not provide a reliable relationship for the estimation of SAA density.

The various blank SAA densities estimated throughout the course of the investigations as interpreted by the Auditor based on review of the relevant reports are detailed in Table 8.1, below. The number of live ammunition found in each area, where recorded, is also provided.

Table 8.1 – Estimated Blank SAA Densities Through Various Investigation Stages

Location	Investigation Objective/ Stage	Area (ha)	Estimated SAA blank density (blanks/ ha)	No. live ammunition recovered
Grenade Exclusion	*Stage 2A (Milsearch)*	6.5	1500	15

Location	Investigation Objective/ Stage	Area (ha)	Estimated SAA blank density (blanks/ ha)	No. live ammunition recovered
Zone (includes REM 1,2,3 and 5)	Grenade impact delineation.			
REM 1, 2 (excl. REM 5) and 3 (grenade impact areas)	*DSI (BACTEC)* 100% remedial search	3.47	123	0
REM 5 (grenade bursting zone)	*DSI (BACTEC)* 100% remedial search)	0.16	3550	0
REM 4 (3.5" practice rocket)	*DSI (BACTEC)* 100% remedial search	2.625	7	0
Grid across entire site	*DSI (BACTEC)* Clearance of 751 investigation locations, 2x2m area each	0.3	107	0
Blank SAA cells subject to validation	*Stage 2A (Milsearch)* Validation of blank SAA density - first round	0.3 (validation of 29 cells)	1600 - 1800	NR (estimated as 2% of expended numbers)
Blank SAA cells subject to validation	*Stage 2A (Milsearch)* Validation of blank SAA density - second round	0.41 (validation of 41 cells)	NE	1
Non-data Blank SAA cells (4 or more)	*Stage 2B (Milsearch)* Identification of unexpected impacts	0.38	363	NR
Nil-very low content Blank SAA cells	*Stage 2B (Milsearch)* Validation of nil blank SAA density	0.3	156	NR

DSI Detailed Site Investigation

NR not recorded

NE not estimated

The types of SAA encountered include brass and plastic, intact (at surface) and degraded (buried). Milsearch found the SAA to be of higher density associated with slit trenches in the west and north of the site, in Cumberland Plain Woodland areas. Golder concluded that the SAA was concentrated within areas identified as primary

training areas (associated with weapons pits and military obstacles) located within the northern, south eastern, southern and western parts of the site.

Milsearch calculated the site average inferred blank density to be 702/ha, based on an arithmetic average of the various densities determined in various investigation stages. Golder concurred that this density seemed realistic. The Auditor has further considered an area-weighted average based on all data in Table 8.1 which yields an average of 820/ha. Golder estimate the SAA density across the site as follows:

- Primary training areas – range 50 to 2500/ha, average approximately 700/ha.
- Remainder of site – 5 to 500/ha, average approximately 250/ha.

Milsearch estimated approximately 2% of the SAA was likely to be live (unexpended). Although no live SAA was encountered by BACTEC during the recent investigations, they estimated a more realistic live SAA proportion that would be expected to be encountered on site would in the order of 5 to 10%.

8.6 Exclusions/ Areas Not Investigated

A number of areas were excluded from all stages of the investigations, as follows:

2. Areas of protected vegetation.
3. Areas of blackberry infestations.
4. Areas where geophysics found metallic anomalies. 10m transects were proposed to investigate these in the SAQP, however, the highest readings were in areas of protected vegetation and therefore this process was not completed (with Auditor concurrence). As an alternative, a visual inspection was undertaken at this stage.

8.7 Conclusion

Grenade and Mortar Impacts

During all investigation stages at the site, no live UXO has been found. Consistent with the known site history, the items found have all been practice/ inert infantry weapons. The Auditor considers the likelihood for live UXO to be present on site to be very low. While these practice items do not present an explosive hazard, their discovery on site would be alarming to any future workers or occupants at the site.

During the munitions investigations, significant grenade or mortar impacts were located outside the initial "expected" zones of impact, which were primarily the main grenade range and also the dams. Consideration must therefore be given to the adequacy of overall site investigative coverage to identify these "unexpected impacts". The unexpected impacts were primarily identified during the Stage 2A validation exercises which focused on cells of high metallic density as determined by digital metal detector. Following completion of those works, Milsearch found that (2003, page 16) "it cannot be stated with certainty that all areas of indicated higher metallic density have been checked" and recommended additional work in the form of remedial searches in order to provide confidence that "the vast majority of potential UXO hazard has been addressed on the site".

Further investigations undertaken at the site in 2005 have included clearance of 763 locations and pathways between. During this process, only two "unexpected impacts" were found by BACTEC, indicating that their occurrence is becoming less common, providing a greater assurance of having identified "unexpected impacts".

However, the ongoing identification of "unexpected impacts", the scale of the site and the various limitations on the investigations undertaken to date (refer Section 8.6) indicate that the possibility of further "unexpected impacts" being present on site is likely. Further remediation works are therefore required and are proposed by Golder (refer Section 11).

SAA

The average SAA densities estimated for the site are approximately 700/ha in high intensity usage training areas and approximately 250/ha in remaining areas of the site. The proportional occurrence of live blank SAA has been estimated at between 2 and 10%.

According to Milsearch, while live blank SAA constitutes a lesser hazard than live ball ammunition, blanks can still cause significant injury, particularly eye damage, if detonated through tampering. Brass blank ammunition is understood to be particularly dangerous. While presenting no explosive hazard, the discovery of expended blank SAA could be alarming to site workers or occupants.

Further remediation works are evidently required with respect to SAA and are proposed by Golder (refer Section 11). Golder (2005b) has reported that similar projects have typically had a zero tolerance threshold criteria for SAA within residential developments. The Auditor has previously commented that a threshold concentration of 250 SAA/ha is not considered appropriate.

9 EVALUATION OF SOIL ANALYTICAL RESULTS

9.1 Investigations Undertaken

Soil investigations including test pits, hand auger holes and drilled boreholes were undertaken in the four areas of the site as summarised in Table 9.1, below. Locations were spaced on a grid, with additional targeted locations for features such as drainage lines, stockpiles and areas of contaminant observations. The grid spacings were originally defined according to the proposed residential or conservation usage of each area. However, the proposed usage of one area, RZNWC, was changed following completion of the field works, therefore the grid spacing in this area is larger than for the other residential areas, and is not in accordance with the SAQP. This issue was discussed in Section 6 and is not considered by the Auditor to be significant.

Soil sampling locations are shown on Attachment 4, Appendix A.

Table 9.1 – Soil Investigation Summary

Area	Approximate Area (ha)	Number of Locations	Grid spacing (m)
RZNRA [4]	43	479	32
RZSWC [1, 2, 4]	4	49	32
RZNWC [1, 4]	8	43	50
CZSRA [1, 3, 4]	38	192	50

1 includes small arms range/ lead particulate area
2 includes waste disposal trenches
3 includes asbestos impact area
4 includes stockpiles

Soil samples were analysed for a variety of contaminants including:

- Heavy metals (arsenic, cadmium, chromium (total and VI), copper, lead, mercury, nickel and zinc)
- Total petroleum hydrocarbons (TPH)
- Benzene, toluene, ethylbenzene and xylenes (BTEX)
- Polycyclic aromatic hydrocarbons (PAH)
- Speciated phenols
- Volatile halogenated compounds (VHC)
- Asbestos
- Explosives
- Organochlorine and organophosphorous pesticides (OCP/ OPP)
- Polychlorinated biphenyls (PCBs)

The results have been assessed against the proposed land use criteria (Section 7):

- SIL Column 1 – "residential with gardens and accessible soil";
- SIL Column 3 – "parks, recreational open space"; and
- SIL Column 5 – "provisional phytotoxicity-based investigation levels".

The results of the investigations are discussed in the following sections for each of the four areas, with a further discussion of results for identified contamination impacts including small arms range/ lead particulate area, waste disposal trenches, asbestos impact area and stockpiles.

9.2 Residential Zone North of Rail Alignment (RZNRA)

Table 9.2 – Summary of Soil Analytical Results – RZNRA (mg/kg).

Analyte	n	Detections	Maximum	n > EPA (1994)	n > SIL Column 1 (EPA 1998)	n > SIL Column 5 (EPA 1998)
pH	6	Min-5.1	6.2	-	-	-
Arsenic	641	563	28	-	0	**1**
Cadmium	641	0	<0.5	-	0	0
Total Chromium	641	641	42	-	0	**641** [1]
Chromium VI	6	0	<1	-	0	0
Copper	641	640	55	-	0	0
Lead	641	641	210	0	0	0
Mercury (inorganic)	641	74	0.14	-	0	0
Nickel	641	641	40	-	0	0
Zinc	641	641	810	-	0	**3**
TPH (C6-C9)	105	0	<20	0	-	-
TPH (C10-C36)	105	2	800	0	-	-
BTEX	105	0	<0.5	0	-	-
Phenols	6	0	<0.5	-	0	-
VCH	5	0	<0.5	-	-	-
Total PAHs	105	1	0.1	-	0	-
Benzo(a)pyrene	105	0	<0.1	-	0	-
OCP/ OPP	83	0	<0.1	-	0	-
PCBs	83	0	<0.1	-	0	-
Explosives	101	0	<1	-	-	-
Asbestos	125	1	-	-	-	-

n number of samples
- No criteria available/used
1 Chromium VI criteria

No samples from the Residential Zone North of Rail Alignment exceeded human health guidelines (SIL Column 1).

A limited number of metals detections exceeded the phytotoxicity guidelines (SIL Column 5), as follows:

- Arsenic was detected in one sample (BH249/3, 0.6-1.05m) at 28 mg/kg compared to the guideline of 20 mg/kg. This was a sample of deeper natural material from a borehole in the centre of the area.
- Zinc was detected in three samples exceeding the guideline of 200 mg/kg with concentrations of 470, 720 and 810mg/kg. These samples were of natural soil from the surface or near surface from locations near a building footing (HA140/1) and in the grenade range (TP469/1 and TP471/2).

The above detections are unlikely to effect vegetation growth at the site due to their very infrequent occurrence.

- All 641 samples analysed for total Chromium exceeded the guideline of 1 mg/kg for Chromium VI. However, these results were well below the Chromium III guideline of 400 mg/kg, with a maximum of 42 mg/kg. Chromium VI analyses were performed on six samples containing relatively high Total Chromium concentrations and Chromium VI was not detected. Further, there is nothing in the site history to indicate the Chromium VI form would be present, therefore these detections are not considered to represent a risk to vegetation at the site.

One PAH compound was detected in one sample at a concentration equivalent to the detection limit and well below the human health guidelines (SIL Column 1) of 20 mg/kg.

Heavy end TPH in the C15 to C36 range was detected in two samples at 260 and 800 mg/kg, compared to the EPA guideline of 1000 mg/kg. Both samples were of surface soil and had no other contaminant detections. One was from a borehole near the track in the north west (BH2/1) and the other from the central east of the zone (TP285/1). The source of these detections is not known, but may be due to road runoff of vehicle contaminants in the case of BH2.

The above minor organic detections do not present a risk to human health or indicate the presence of widespread contamination in the zone.

No other organic compounds were detected in any samples from this zone, including TPH C6-C9, BTEX, Phenols, VCH, OCP, OPP, PCB and explosives.

There was one detection of chrysotile asbestos in soil from a stockpile (TPSP6/1). A further detection of Synthetic Mineral Fibre was noted by the laboratory in TP9/1, along the northern boundary, however this was not reported by Golder.

The sampled soils from this zone were mildly acidic, with a pH range of 5.1 to 6.2.

In conclusion, the RZNRA area of the site is considered to have been adequately characterised for the purposes of site remediation planning.

9.3 Residential Zone South West Corner (RZSWC)

Table 9.3 – Summary of Soil Analytical Results – RZSWC (mg/kg).

Analyte	n	Detections	Maximum	n > EPA (1994)	n > SIL Column 1 (EPA 1998)	n > SIL Column 5 (EPA 1998)
pH	2	Min-5.4	5.5	-	-	-
Arsenic	67	49	13	-	0	0
Cadmium	67	1	0.6	-	0	0
Total Chromium	67	67	40	-	0	**67** [1]
Chromium VI	3	0	<1	-	0	0
Copper	67	67	52	-	0	0
Lead	67	67	72	0	0	0
Mercury (inorganic)	67	2	0.06	-	0	0
Nickel	67	67	37	-	0	0
Zinc	67	67	97	-	0	0
TPH	14	0	<50	0	-	-
BTEX	14	0	<0.5	0	-	-
Total PAHs	14	0	<0.2	-	0	-
Benzo(a)pyrene	14	0	<0.1	-	0	-
OCP/ OPP	12	0	<0.1	-	0	-
PCBs	12	0	<0.1	-	0	-
Explosives	12	0	<1	-	-	-
Asbestos	20	0	-	-	-	-

n number of samples
- No criteria available/used
1 Chromium VI criteria

No samples from the Residential Zone South West Corner exceeded human health guidelines (SIL Column 1).

Metals detections exceeding the phytotoxicity guidelines (SIL Column 5) were all samples analysed for Total Chromium. These exceeded the guideline of 1 mg/kg for Chromium VI however they were well below the Chromium III guideline of 400 mg/kg, with a maximum of 40 mg/kg. Chromium VI analyses were performed on three samples containing relatively high Total Chromium concentrations and Chromium VI was not detected. Further, there is nothing in the site history to indicate the Chromium VI form would be present, therefore these detections are not considered to represent a risk to vegetation at the site.

No organic compounds were detected in any samples from this zone, including TPH, BTEX, PAH, OCP, OPP, PCB and explosives.

There were no detections of asbestos in the zone.

The sampled soils from this zone were mildy acidic, with a pH range of 5.4 to 5.5.

In conclusion, the RZSWC area of the site is considered to have been adequately characterised for the purposes of site remediation planning.

9.4 Residential Zone North West Corner (RZNWC)

Table 9.4 – Summary of Soil Analytical Results – RZNWC (mg/kg).

Analyte	n	Detections	Maximum	n > EPA (1994)	n > SIL Column 1 (EPA 1998)	n > SIL Column 5 (EPA 1998)
pH	1	-	5.5	-	-	-
Arsenic	66	36	11	-	0	0
Cadmium	66	0	<0.5	-	0	0
Total Chromium	66	66	24	-	0	**66** [1]
Chromium VI	1	0	<1	-	0	0
Copper	66	66	50	-	0	0
Lead	66	66	110	0	0	0
Mercury (inorganic)	66	3	0.11	-	0	0
Nickel	66	66	16	-	0	0
Zinc	66	66	77	-	0	0
TPH	13	0	<50	0	-	-
BTEX	13	0	<0.5	0	-	-
Phenols	6	0	<0.5	-	0	-
VHC	2	0	<0.5	-	-	-
Total PAHs	13	0	<0.1	-	0	-
Benzo(a)pyrene	13	0	<0.05	-	0	-
OCP/ OPP	6	0	<0.1	-	0	-
PCBs	6	0	<0.1	-	0	-
Explosives	7	0	<0.5	-	-	-
Asbestos [2]	21	0	-	-	-	-

n number of samples
- No criteria available/used
1 Chromium VI criteria
2 soil and sheeting samples

No samples from the Residential Zone South West Corner exceeded human health guidelines (SIL Column 1).

Metals detections exceeding the phytotoxicity guidelines (SIL Column 5) were all samples analysed for Total Chromium. These exceeded the guideline of 1 mg/kg for Chromium VI however they were well below the Chromium III guideline of 400 mg/kg, with a maximum of 40 mg/kg. Chromium VI analysis was performed on one sample containing relatively high Total Chromium concentrations and Chromium VI was not detected. Further, there is nothing in the site history to indicate the Chromium VI form would be present, therefore these detections are not considered to represent a risk to vegetation at the site.

No organic compounds were detected in any samples from this zone, including TPH, BTEX, PAH, OCP, OPP, PCB and explosives.

There were no detections of asbestos in the zone.

One soil sample from this zone was mildy acidic, with a pH of 5.5.

In conclusion, the RZNWC area of the site is considered to have been adequately characterised for the purposes of site remediation planning, despite the usage of a larger grid spacing than for other proposed residential areas at the site.

9.5 Conservation Zone South of Rail Alignment (CZSRA)

Table 9.5 – Summary of Soil Analytical Results – CZSRA (mg/kg).

Analyte	n	Detections	Maximum	n > EPA (1994)	n > SIL Column 3 (EPA 1998)	n > SIL Column 5 (EPA 1998)
pH	17	Min-5.2	8.6	-	-	-
Arsenic	311	231	24	-	0	**1**
Cadmium	311	2	4	-	0	**1**
Total Chromium	311	311	73	-	0	**311** [1]
Chromium VI	3	0	<1	-	0	0
Copper	311	311	410	-	0	**8**
Lead	311	311	1578	**10**	**5**	**5**
Mercury (inorganic)	311	19	0.08	-	0	0
Nickel	311	311	48	-	0	0
Zinc	311	311	910	-	0	**2**
TPH (C6-C9)	89	0	<20	0	-	-
TPH (C10-C36)	89	2	80	0	-	-
BTEX	89	0	<0.5	0	-	-
Phenols	14	0	<0.5	-	0	-
VHC	19	0	<0.5	-	-	-
Total PAHs	89	8	43	-	**1**	-
Benzo(a)pyrene	89	6	5.6	-	**1**	-
OCP/ OPP	51	0	<0.1	-	0	-

Analyte	n	Detections	Maximum	n > EPA (1994)	n > SIL Column 3 (EPA 1998)	n > SIL Column 5 (EPA 1998)
PCBs	51	0	<0.1	-	0	-
Explosives	35	0	<0.5	-	-	-
Asbestos [2]	104	11	-	-	-	-

n number of samples

- No criteria available/used

1 Chromium VI criteria

2 soil and sheeting samples

Five primary samples from the Conservation Zone South of Rail Alignment exceeded the human health guideline (SIL Column 3) for lead of 600 mg/kg. The samples ranged in concentration from 620 to 1578 mg/kg compared to the guideline of 600 mg/kg. Four of these samples were of fill up to 2.7 m deep from the small arms range (TP642/2, TP646/1, TP691/4 and TP693/1) and one sample was of natural soil from within Dam 3, located downgradient to the south east of the small arms range (TP713/3, 0.3-0.5 m). A further two duplicate samples exceeded this guideline, with detections of 780 and 1000mg/kg compared to the primary sample concentrations of 440 (TP723/1) and 87mg/kg (HAAS5/2), respectively. These samples were from within the open waste trench adjacent to the small arms range area and from within the small arms range itself.

A number of metals detections also exceeded the phytotoxicity guidelines (SIL Column 5), as follows:

- Arsenic was detected in one sample (HA AS9/1, 0-0.1 m) at 24 mg/kg compared to the guideline of 20 mg/kg. This was a sample of surface fill from within the small arms range/ asbestos impact area.
- Cadmium was detected in one sample (TP723/1, 0-0.1 m) at 4 mg/kg compared to the guideline of 3 mg/kg. This was a sample of surface fill from within the open waste trench adjacent to the small arms range area.
- Copper was detected in eight primary samples exceeding the guideline of 100 mg/kg with concentrations ranging from 110 to 410 mg/kg. These were samples from a range of depths from the small arms range/ asbestos impact, waste disposal pits and Dam 3 areas. A further duplicate sample from within this area also exceeded this guideline, although the primary sample did not.
- The above lead SIL Column 3 exceedences also exceed the phytotoxicity guideline for lead which is also 600 mg/kg.
- Zinc was detected in two samples exceeding the guideline of 200 mg/kg with concentrations of 410 and 910 mg/kg. These samples were of surface fill from within the open waste trench adjacent to the small arms range area (TP723/1, 0-0.1m) and in a waste disposal pit (TP704/3, 1-1.1 m).

The above detections are unlikely to effect vegetation growth at the site due to their infrequent occurrence and common occurrence in areas that will be subject to remedial action (small arms range, waste disposal pits).

- All 311 samples analysed for Total Chromium exceeded the guideline of 1 mg/kg for Chromium VI. However, these results were well below the Chromium III guideline of 400 mg/kg, with a maximum of 73 mg/kg. Chromium VI analyses were performed on three samples containing relatively high Total Chromium concentrations and Chromium VI was not detected. Further, there is nothing in the site history to indicate the Chromium VI form would be present, therefore these detections are not considered to represent a risk to vegetation at the site.

One sample (TP599/1) exceeded the human health guidelines (SIL Column 3) for PAH with detections as follows:

- Total PAH of 43 mg/kg compared to the guideline of 40 mg/kg; and
- Benzo(a)pyrene of 5.6 mg/kg compared to the guideline of 2 mg/kg.

This sample is located at the eastern end of the waste disposal pits and was also impacted by Copper above the phytotoxicity guidelines and contained a TPH detection (see below). A further seven samples contained minor PAH detections at concentrations below the guidelines. These samples were from the two coal stockpile areas (six samples) and one sample from a drainage line near Dam 3. The occurrence of minor PAH detections in soils from around the coal stockpiles would be expected.

Heavy end TPH in the C15 to C36 range was detected in three samples at 52, 56 and 80 mg/kg, compared to the EPA guideline of 1000 mg/kg for C10 to C36. These samples were of fill from within the small arms range (BH608/1) and at the waste disposal pits (TP599/1, TP707/3).

No other organic compounds were detected in any samples from this zone, including TPH C6-C9, BTEX, Phenols, VCH, OCP, OPP, PCB and explosives.

There were 11 asbestos detections at this zone, nine in samples of sheeting suspected as containing asbestos, and two in soil from the same location as sheeting samples in the asbestos impact area. These results are discussed further in the sections below.

The sampled soils from this zone were generally mildy acidic to neutral, with a pH range of 5.2 to 7.6, and a measurement of 8.6 in TP723/1. Fill samples were generally less acidic than natural samples.

In conclusion, the CZSRA area of the site is considered to have been adequately characterised for the purposes of site remediation planning.

9.6 Small Arms Range and Lead Particulate

The original stop butt material, which contained lead particulate, was spread about the range and built into roads at the site in the 1970s. The extent of impact by lead particulate in the small arms range and track areas was delineated by digital detector survey during previous investigations by Milsearch. External limits of the impact areas were confirmed by analogue follow-up investigations with an F1A4 mine detector.

The Milsearch investigations delineated the extent of lead-impacted material at the site as follows:

- A 4.1 ha area surrounding the stop butts. Delineation was successful except for defining the exact extent in the high ground to the east. Since this area is also impacted by broken asbestos sheeting and coal dust from the stockpile, this poor definition was not considered significant since remediation of this area would already be required.
- A 0.65 ha area of the north west perimeter road.
- Two small tip truck back dumpings north west of the stop butt area, approximately 4 to 5 m^3 each pile.
- In the road formation at the Zouch Road entrance gate.

Golder identified the lead particulate material to comprise lead fragments and bullet fragments between 5 and 10mm in size. The depth of occurrence ranged from 0.1 to 4.5m BGL with an average of about 0.8m BGL, and the quantity of material was estimated by Golder as approximately 35,000m^3.

The small arms range is the source of the majority of contamination detections from within the Conservation Zone South of Rail Alignment. The five lead exceedences of the human health guideline (SIL Column 3) were within the small arms range area, and within Dam 3 which has apparently been impacted by runoff from the small arms range. Based on 86 samples from within the small arms range area, Golder calculated the 95% upper confirdence limit (UCL) on the average lead concentration as 118 mg/kg. Phytotoxicity exceedences for Arsenic, Copper and Zinc can also be attributed to activities within the small arms range area. A minor heavy end TPH detection was also made in the area, but well below the relevant guidelines.

The elevated metals detections in the small arms range were further assessed by the analysis of seven samples with the highest lead and zinc concentrations by the Toxicity Characteristics Leaching Procedure (TCLP) under acidic, saline and deionised water conditions. Findings from these tests were as follows:

- Lead and zinc were the only metals with leachable concentrations;
- Zinc was much more readily leached than lead (all samples versus only three samples).
- Even low concentrations of zinc leached under all conditions, while lead only leached under acid and deionised water conditions, not saline conditions.
- The highest leached lead concentrations were not recorded from the sample with the highest total concentration.
- The maximum leached lead concentration was 1.1 μg/L under acid conditions, total concentration 1187 mg/kg.
- The maximum leached zinc concentration was 4.7 μg/L under acid conditions, total concentration 910 mg/kg.

Golder report that based on the TCLP results and average lead concentrations, the lead impacted material would be classified as Inert Waste following the NSW EPA (1999) *"Environmental Guidelines: Assessment, Classification and Management of Liquid & Non-Liquid Wastes".* Golder also note that there is potential for leaching of lead to impact on surrounding soil and groundwater.

During reengineering of the stop butts in the 1970s, lead particulate material was distributed at some of the boundary tracks on site. The extent of this impact was delineated by geophysical techniques during previous investigations by Milsearch, however, the degree of contamination was not assessed. Total lead analyses from the tracks did not identify any lead concentrations exceeding the site assessment criteria. However, in addition to analyses for total lead and TCLP concentrations, an additional 10 samples (PSD1 to 10) were collected and subject to sieving to assess the quantity of lead particulate within the soil. These samples were collected from the track in the north (four samples), the track in the south west (one sample) and the small arms range (five samples).

Soil samples were around 15 kg (dry weight), and the weight of lead particulate was as follows:

- Northern track: average 1.7g, equivalent 0.01%
- Small arms range: average 3.4g, equivalent 0.02%

No lead particulate was recorded in the south west track sample.

The samples were selected randomly from areas where lead particulate was visible. A possible target zone of concentrated lead particulate could not be identified within the small arms range during the investigations due to the mixing of lead particulate within the fill during reengineering of the small arms range. Golder identifies that there may be areas within the stop butt of the small arms range where the quantity of lead particulate may vary significantly from the samples analysed.

9.7 Waste Disposal Trenches

Three parallel pits were delineated by Milsearch using a digital detector survey. The pits run downhill to the east away from the coal stockpile. The combined area of the pits was determined to be 0.25ha. The length of each pit was found to be (from the north), 64, 72 and 71m long. The average width was 6 m and the average depth was 2.5 m. 500mm wide trench cross sections were excavated by Milsearch to the bottom of the pits at 10m intervals. The pit contents were found to include:

- Bonded asbestos sheeting;
- Building waste (including bricks, pipes, concrete blocks, guttering, downpipes);
- Household waste (including fridges, water heaters, metal cabinets); and
- Foul water was encountered when the crust of the pits was broken through.

Golder excavated a further six test pits that encountered waste material (TP598, 704 and 706-709). Similar observations regarding the content of the pits were made by Golder, however, water was only encountered in the eastern most testpits at the end of each disposal pit. Foul water inflow occurred in these testpits (TP598, 706 and 708) with a standing water level of 0.5 m BGL.

No munitions were observed in the pits. It was determined that buildings demolished in the departure of the Infantry Centre to Singleton in the early 1990's were placed in the pits. The pits were observed to be terminated in clay. Large metal wastes were observed on the ground surface in the vicinity of the pits.

Golder identified an open trench containing scrap metal and rubbish to the south of the buried waste trenches. TP723 was excavated beneath the waste dumped here, and a further location TP612 was placed downhill to identify any impact from runoff through the waste.

Golder also identified an area of disturbed soil to the east of the trenches, where excavated soil was apparently stockpiled prior to being pushed back over to cap the buried waste. Four locations were placed to investigate this area (TP599, 705, 710 and 711). Fill remains in this area, comprising excess residual soil from excavation of the trenches.

The waste disposal trenches are another source of contamination detections from within the Conservation Zone South of Rail Alignment.

The Total PAH and Benzo(a)pyrene exceedences of the human health guidelines (SIL Column 3) were made in a sample from the eastern end of the waste disposal pits. There was no waste in this location (TP599) and the source of this detection is not clear. A Human Health exceedence for Lead and Phytotoxicity exceedences for Cadmium, Copper, Lead and Zinc can also be attributed to activities within this area, including the open waste trench to the south of the buried pits. Minor heavy end TPH detections were also made in the area, but well below the relevant guidelines.

9.8 Asbestos Impact Area

The asbestos impact area overlaps with the small arms range and is contained entirely within CZSRA. Fragmented pieces of bonded asbestos sheeting were observed scattered across the ground surface in this area. The area of impact is around 25,500 m^2, and the quantity of material was estimated by Golder as approximately 2,500 m^3.

Grid based testpits samples from this area were analysed for asbestos, and a further 12 locations (AS1 to 12) were investigated specifically to assess this area of impact. Samples of collected sheeting were analysed to confirm the presence of asbestos.

Around 30 locations from this area were analysed for asbestos. In eight locations, samples of both sheeting as well as soil were analysed. There were 11 asbestos detections at this zone, nine in samples of sheeting suspected as containing asbestos, and two in soil from the same location as sheeting samples. The findings from these analyses were as follows:

- Sheeting and soil pairs were collected from locations HA AS1, 2, 3, 4, 5, 6, 8 and 11. Further sheeting samples were collected from HA AS7 and TP723.
- Chrysotile asbestos was detected in five sheeting samples (HA AS4/1, 5/1, 8/1, 11/1, TP723/4).
- Chrysotile and amosite asbestos were detected in four sheeting samples (HA AS1/1, 2/1, 3/1, 6/1).
- One sheeting sample did not contain asbestos (HA AS7/1).
- Chrysotile asbestos was detected in soil in two samples from the sheeting and soil pairs (HA AS3 and 5). No other detections were made of asbestos from within soil from this area.

One of the board fragments confirmed as asbestos (AS6) was collected from a location outside the small arms range/ asbestos impact area. This area was logged as having yielded 8 fragments of asbestos from a 2 x 2 m area.

9.9 Stockpiles

Stockpiles occur in all areas at the site. Golder identified 16 stockpiles, as shown on Attachment 2, Appendix A. Stockpiled soils were observed to consist of silty/ gravelly clays. Numerous wastes including building rubble and asbestos were also associated with stockpiles, as described in Section 2.4.

A number of grid based test pits were located to assess stockpiled materials, and a further 13 locations (SP1 to 13) were investigated specifically to assess these materials. A large number of stockpiles were clustered in the north west corner of the site, identified by Golder as the 'waste disposal west' area.

The only contaminant detection made in stockpile samples was the detection of chrysotile asbestos in surface soil from TPSP6, located on the northern boundary of the site in RZNRA. This was the only detection of asbestos in soil at the site outside the asbestos impact area discussed above.

There are two coal stockpiles at the site, one between the small arms range and disposal pits, and one in the south east corner of the site. Both are within CZSRA. Two test pits were excavated into the main stockpile (TP702 and 703), with a maximum depth of 1.1m coal encountered. Coal was found on the groundwater surface surrounding this stockpile to depths of up to 0.4m BGL at distances of around 25 m. Three test pits were excavated into the south east stockpile (TP698 to 700), with a maximum depth of 0.5m coal encountered. Coal was not found at nearby locations. A number of low level PAH detections were associated with samples from these two stockpile areas.

9.10 Acid Sulphate Soils

Eight samples collected from low points on the site were collected and analysed for Peroxide Oxidation Combined Acidity and Sulphate (POCAS). The results indicated the presence of little or no oxidisable sulphur, however, over half of the samples exceeded the action criteria for Total Potential Acidity (TPA) due to the presence of organic acidity. The potential for Acid Sulphate Soils (ASS) to be present on site was assessed to be low due to the site elevation of 50 to 70 m AHD. Golder assessed the sampled soils to have a mild organic acid generating capacity and they were not considered as potential acid Sulphate soils (PASS).

9.11 Conclusion

In the Auditor's opinion, the soil analytical results are consistent with the site history and field observations. Minimal contaminant detections were made in the general site areas, with only limited detections exceeding human health guidelines made in known areas of contamination such as the small arms range and waste disposal pits. The Auditor is satisfied that the general site areas are free of contamination and that significant contamination detections are restricted to areas of known contamination where remedial action is proposed (refer Section 11).

10 EVALUATION OF GROUNDWATER ANALYTICAL RESULTS

10.1 Investigations Undertaken

Groundwater samples were collected from seven wells and three trenches in February and March 2005.

Groundwater samples were analysed for a variety of contaminants including heavy metals, TPH/ BTEX, PAH, OCP/ OPP, PCB, Explosives, Phenols and VHCs.

The analytical results for true groundwater are tabulated below in Table 10.1, while the perched trench water results are summarised in Table 10.2. Results from field testing for temperature, pH, electrical conductivity (Ec) and Total Dissolved Solids (TDS) are also included in these tables. Laboratory testing was conducted for pH and Ec for the groundwater wells and results were similar to the field measurements.

Groundwater well locations are shown on Attachment 3, Appendix A and sampled trench locations (TP598, 706 and 708) are shown on Attachment 4, Appendix A.

10.2 Groundwater Well Results

Table 10.1 - Evaluation of Groundwater Well Analytical Results – Summary Table.

Analyte	Units	n	Detections	Minimum	Maximum	Max Well	n >ANZECC Fresh (2000)
Temperature	°C	7	7	21.0	23.8	BH558	-
pH	-	7	7	6.8	7.2	BH675	0
Ec	µV	7	7	9 210	14 270	BH291	-
TDS	mS	7	7	4.53	7.18	BH291	-
Arsenic	mg/L	7	7	0.004	0.12	BH2	**1** [1]
Cadmium	mg/L	7	0	-	<0.0002	-	0
Total Chromium	mg/L	7	7	0.007	0.014	BH608	**7** [2]
Copper	mg/L	7	5	<0.001	0.004	BH608	**3**
Lead	mg/L	7	7	0.002	0.012	BH675	**6**
Mercury (inorganic)	mg/L	7	0	<0.0001	0.0001	BH291 (Dup)	**1** [3]
Nickel	mg/L	7	7	0.002	0.022	BH675	**4**
Zinc	mg/L	7	3	<0.001	0.07	BH291 (Dup)	**2**
TPH (C6-C9)	mg/L	7	0	-	<0.04	-	-
TPH (C10-C36)	mg/L	7	0	-	<0.5	-	-
BTEX	mg/L	7	0	-	<0.001	-	0
Phenols	µg/L	7	0	-	<0.5	-	0
VHC	µg/L	7	0	-	<5	-	0

Analyte	Units	n	Detections	Minimum	Maximum	Max Well	n >ANZECC Fresh (2000)
PAHs	µg/L	7	0	-	<0.5	-	0 [4]
OCP/ OPP	µg/L	7	0	<0.01	<0.2	-	0 [5]
PCBs	µg/L	7	0	-	<0.1	-	-
Explosives	mg/L	7	0	-	<0.005	-	-

n number of samples
- No criteria available/used
1 Arsenic III criteria
2 Chromium III criteria
3 Detection limit (0.0001 mg/L) for primary samples is above guideline (0.00006 mg/L)
4 Detection limits for some PAHs (anthracene, benzo(a)pyrene) are above guidelines
5 Detection limits for some OCP/OPP (Aldrin, Dieldrin, Chlorpyrifos) are above guidelines

Groundwater from wells at the site was found to be approximately neutral and saline.

All heavy metals except cadmium and mercury were detected at concentrations exceeding the guidelines in at least one groundwater well at the site. Heavy metal exceedences were distributed across all wells at the site. Exceedences were detected in both upgradient and downgradient wells. It is possible that the presence of heavy metals in groundwater is due to those metals naturally occurring within the rock aquifer. Elevated metals concentrations are commonly detected within Wianamatta Shale aquifer.

There is one area of the site where there is an apparent correlation between heavy metal detections and contaminant sources. The highest metals concentrations were commonly detected in wells BH608 and BH675 which are in the vicinity of the small arms range, disposal trenches and nearby Dam 3, where the majority of soil metals exceedences were detected. One of the two zinc exceedences for the site was also detected in well BH608, in the small arms range. It is possible that these activities have locally increased the heavy metal loading in groundwater, but this increase is not considered to be substantially more than the concentrations which appear to be naturally occurring at the site.

No organic compounds were detected in any of the groundwater well samples from the site, including TPH, BTEX, PAH, Phenols, VHC, OCP, OPP, PCB and explosives.

10.3 Trench Water Results

Table 10.2 - Evaluation of Trench Water Analytical Results – Summary Table.

Analyte	Units	n	Detections	Minimum	Maximum	Max Loc'n	n >ANZECC Fresh (2000)
Temperature	°C	3	3	22.6	23.1	Trench 3	-
pH	-	3	3	6.9	7.1	Trench 3	0
Ec	µV	3	3	780	1100	Trench 3	-
TDS	mS	3	3	4.68	4.9	Trench 2	-
Arsenic	mg/L	3	3	0.001	0.001	-	0
Cadmium	mg/L	3	0	-	<0.0002	-	0
Total Chromium	mg/L	3	2	0.001	0.002	Trench 1	0 [1]
Copper	mg/L	3	2	0.002	0.003	Trench 3	**2**
Lead	mg/L	3	1	<0.001	0.002	Trench 3	0
Mercury (inorganic)	mg/L	3	0	-	<0.0001	-	0 [2]
Nickel	mg/L	3	3	0.004	0.01	Trench 3	0
Zinc	mg/L	3	3	0.002	0.041	Trench 3	**2**
TPH (C6-C9)	mg/L	3	0	-	<0.04	-	-
TPH (C10-C36)	mg/L	3	0	-	<0.5	-	-
Benzene	mg/L	3	0	-	<0.001	-	0
Toluene	mg/L	3	1	<0.001	0.002	Trench 3	0
Ethylbenzene	mg/L	3	0	-	<0.001	-	0
Xylenes	mg/L	3	0	-	<0.003	-	0
Phenol	µg/L	3	2	<10	11	Trench 1,2	0
M/p-Cresol	µg/L	3	3	13	17	Trench 1	-
2-Nitrophenol	µg/L	3	1	<5	10	Trench 1	-
4-Nitrophenol	µg/L	3	1	<5	21	Trench 1	-
Other Phenols	µg/L	3	0	-	<5	-	0
PAHs	µg/L	3	0	-	<0.5	-	0 [3]
OCP/ OPP	µg/L	3	0	-	<0.2	-	0 [4]
PCBs	µg/L	3	0	-	<0.1	-	-
Explosives	mg/L	3	0	-	<0.01	-	-

n number of samples
- No criteria available/used
1 Chromium III criteria
2 Detection limit (0.0001 mg/L) is above guideline (0.00006 mg/L)
3 Detection limits for some PAHs (anthracene, benzo(a)pyrene) are above guidelines

4 Detection limits for OCP/OPP (Heptachlor, Aldrin, Dieldrin, Chlorpyrifos) are above guidelines

Trench 1 = TP598; Trench 2 = TP706; Trench 3 = TP708

The occurrence of heavy metal exceedences in the perched trench water was much less common than in the true groundwater, further suggesting that the metals are naturally occurring rather than derived from contamination at the site. The trench water had exceedences for copper and zinc only, both occurring within Trench 2 and 3 (TP706 and 708). Trench 3 (TP708) most commonly contained the highest heavy metals concentrations. It appears likely that the identified exceedences are due to contamination from the buried waste materials encountered in each location.

The BTEX compound Toluene was also detected in Trench 3, at a very low concentration close to the detection limit and well below the guideline. Four different phenol compounds were detected in the Trenches, also well below the guidelines. These low level organic detections would most likely be due to contamination from buried hydrocarbon wastes within the trenches.

No other organic compounds were detected in any of the trenches, including TPH, PAH, Phenols, VHC, OCP, OPP, PCB and explosives.

10.4 Conclusion

In the Auditor's opinion, the groundwater and trench water analytical results are consistent with the site history and field observations. There is evidence of only minor contamination of groundwater by heavy metals in the vicinity of the small arms range. The majority of heavy metals exceedences detected at the site are considered to be representative of background conditions within the shale bedrock. The Auditor is satisfied that groundwater at the site is free of levels of contamination that would negatively impact on the proposed development or the surrounding environment.

The trench water displayed low levels of contamination by copper, zinc, toluene and phenols. This contamination is likely due to leaching of contaminants from the buried waste materials encountered in each location. The perched water is considered likely to be restricted to a small area in the vicinity of the waste pits. The water was perched due to the presence of natural clay that restricted downward migration of waters. For this reason, impact on the underlying groundwater due to this contamination is unlikely. Management of the perched water in conjunction with the surrounding waste material will be required to prevent any impact on the proposed development.

11 EVALUATION OF REMEDIATION

11.1 Remediation Already Completed

Remediation of seven areas has already been undertaken with respect to munitions, as summarised in Table 11.1. Based on the works undertaken, BACTEC has provided certification that the seven remediation areas described below are free of UXO.

During the course of all munitions investigations, all SAA/ weapons fragments were collected and documented. Golder reported that all of the collected training ordnance such as 81mm mortars and anti tank mines were disposed offsite by Department of Defence personnel. Remaining items such as SAA and grenade base plugs were stockpiled on site for later disposal.

Table 11.1 – Summary of Remediation Undertaken

Impact	Area(s)	Remediation Method	Items Found *
36M grenade impact areas	REM 1 (IA1) REM 2 (IA2, excluding REM 5) REM 3 (IA3) Total 3.47ha	100% remedial searching for 36M UXO Metal detector search to 300mm depth (two man team at 1m line spacings). Collection and documentation of all items found. A water filled depression in the eastern part of REM 2 was drained to allow remediation.	No live ordnance found 54x36M grenade base plugs 100xSpent 303 SAA 428xSpent blank SAA star pickets, scrap metal, steel pipes, wire, general rubbish
36M grenade bursting zone	REM 5 (within IA2) 0.16ha	100% remedial searching for 36M UXO Metal detector search to 300mm depth (two man team at 1m line spacings). The previously proposed method of mechanical screening (in SAQP) was changed and agreed to by the Auditor. Collection and documentation of all items found.	No live ordnance found 105x36M grenade base plugs 64x36M grenade fragments 48xSpent 303 SAA 568xSpent blank SAA star pickets, scrap metal, steel pipes, wire, general rubbish
3.5" anti-tank (A-Tk) rocket warheads	REM 4 2.625ha	Aesthetic issue only, impact is inert 100% remedial searching for practice 3.5" A-Tk rockets Metal detector search to 300mm depth (two man team at 1m line spacings). Collection and documentation of all items found.	No live ordnance found 3xpractice UK M29 rocket motors and fuzes (fired) 1xpractice fuze (L5 Mk2) assembly (fired) 12xpractice rocket fragments
Inert	REM 6	100% remedial search.	No live ordnance found

Impact	Area(s)	Remediation Method	Items Found *
81mm practice mortar	1.5ha (100x150 m)	Metal detector search to 300mm depth (two man team at 1m line spacings). Collection and documentation of all items found.	9xInert 81mm practice mortars 6xSpent blank SAA
Anti-tank training mine	REM 7 0.015ha (10x15 m)	100% remedial search. Metal detector search to 300mm depth (two man team at 1m line spacings). Collection and documentation of all items found.	No live ordnance found 1xpractice British Mk5 Anti tank mine

* BACTEC reported that all items found were sporadic and not confined to a specific area within the remediation zone except for REM 2 where the majority of items were found within the grenade target area, 30m from the grenade throwing bay and REM 6 where the mortars were found in the centre of the search area.

11.2 Remediation Proposed

Golder has identified a number of areas at the site requiring remediation, defined as "Areas of Concern" (AOC). These are summarised by the Auditor in Table 11.2, below. Attachment 5, Appendix A, shows the location of the various AOC.

Table 11.2 – Summary of Proposed Remediation

Area of Concern	Description/ Location	Comments
AOC 1	Military associated objects: Concertina wire; weapons pits; former structure/ slabs; general rubbish; scrap metal; asbestos piping Located in all areas of the site	Removal of all stockpiles is also required, particularly in the northwest corner of the site (RZNWC) where numerous stockpiles are concentrated.
AOC 2	SAA in proposed residential zones (RZNRA, RZSWC and RZNWC)	Could be present in all areas not subject to searching to date (ie, not at grid locations or within remediation zones). Anticipated to be higher in concentration in previously identified areas of high metallic concentration.
AOC 3	SAA in proposed conservation zone (CZSRA)	Could be present in all areas not subject to searching to date (ie, not at grid locations or within remediation zones). Anticipated to be higher in concentration in previously identified areas of high metallic concentration.

Area of Concern	Description/ Location	Comments
AOC 4	Lead impacted material – small arms range and northern tracks (refer Section 9.5) (RZNRA, CASRA, RZNWC and RZSWC)	Remediation of south western track area not required based on laboratory analysis.
AOC 5	Area of asbestos sheeting fragments (refer Section 9.7) (CZSRA)	
AOC 6	PAH impact at TP599 (CZSRA)	The Auditor notes that the lateral extent and immediate source of impact has not been determined.
AOC 7	Waste disposal pits (CZSRA)	Excavation is considered necessary because of unknown contents and contaminated water.

The Auditor agrees with the identified AOCs requiring remediation, considering the comments made above in Table 11.2.

A Remediation Action Plan (RAP) is required to define the remedial requirements for the site.

12 CONTAMINATION MIGRATION POTENTIAL

The potential for off-site migration of munitions related contaminants is considered to be very low. No trace explosives were detected in any soil or groundwater samples from the site.

Minimal contaminant detections were made in soils and drainage sediments from the general site areas. The potential for offsite migration of contamination in surface water or groundwater from these areas is therefore very low. The potential for the generation of dust in general areas of the site would also be very low due to the heavy vegetation cover.

There were a limited number of detections exceeding human health guidelines in known areas of contamination such as the unsealed tracks impacted by lead particulate in the north of the site and the small arms range, asbestos impact area and waste disposal pits in the south of the site. These areas have less vegetation cover than general areas of the site. The potential for offsite migration of contaminants in dust or surface water from these areas is currently considered to be low to moderate. Remediation of these areas as proposed will remove the potential for generation of contaminated dusts or surface water impacts.

There is evidence of only minor contamination of groundwater by heavy metals in the vicinity of the small arms range. The majority of heavy metals exceedences detected at the site are considered to be representative of background conditions within the shale bedrock. The Auditor is satisfied that groundwater at the site is free of levels of contamination that would negatively impact on the surrounding environment.

The trench water displayed low levels of contamination due to leaching of contaminants from the surrounding buried waste materials. The perched water would be restricted to a small area in the vicinity of the waste pits, with a very low potential for impact on the underlying groundwater.

In the Auditor's opinion, there is no evidence of significant offsite migration of contamination and little potential for future migration provided the proposed remediation works are implemented.

13 ASSESSMENT OF RISK

Based on assessment of results against relevant guidelines and consideration of the overall investigation and proposed remediation, it is the Auditor's opinion that:

13.1 Munitions

- The risk of live UXO being encountered on site is very low. None has been found to date during the course of extensive investigations.
- There is a moderate risk of additional 'unexpected' inert grenade or mortar impacts to be present in general areas of the site. These items are difficult to locate due to the lack of fragmentation 'signature'. While these practice items do not present an explosive hazard, their discovery on site could be alarming to any future workers or occupants. Further remediation works are therefore required and are proposed by Golder (refer Section 11).
- There is a higher risk of such 'unexpected' impacts to be present in areas of the site that have not previously been accessed (refer Section 8.6).
- The risk of live ball ammunition being encountered on site is very low. None has been found to date during the course of extensive investigations.
- Blank expended ammunition is present on site at an estimated 700 items/ha in high intensity usage training areas and 250 items/ha in remaining areas of the site. While presenting no explosive hazard, the discovery of expended blank SAA could be alarming to site workers or occupants.
- The proportional occurrence of live blank SAA has been estimated at between 2 and 10% however a lesser proportion than this has actually been found on site. Live blank ammunition can cause injury, particularly eye damage, if detonated through tampering.
- Further remediation works are required and with respect to SAA and are proposed by Golder (refer Section 11).

13.2 Soil and Groundwater

- Low levels of soil contamination and physical waste materials including asbestos have been identified in a number of areas of the site. Contamination detections were expected in these areas and remedial action is proposed (refer Section 11). Since the site is currently unoccupied and fenced, the risk posed by these issues is low, however, the risk to human under the proposed residential or conservation landuse would be high if remediation were not undertaken.
- There is considered to be a very low risk of undetected soil contamination being present in general areas of the site outside of the known areas of contamination.
- Groundwater investigations have identified possible minor contamination by heavy metals in the vicinity of the small arms range. The majority of heavy

metals exceedences detected at the site are considered to be representative of background conditions within the shale bedrock. The Auditor considers the risk to human health, the proposed development or the surrounding environment due to groundwater contamination is very low.

- Perched water within the waste disposal trenches contains low levels of contamination by copper, zinc, toluene and phenols. The perched water is considered likely to be restricted to a small area in the vicinity of the waste pits and is unlikely to influence deeper groundwater or the environment. However, this water could pose a risk to human health if accessed by site occupants. This could occur since the perched water occurs at a depth of around 0.5m BGL. Remedial action for the waste disposal trenches is proposed (refer Section 11) and should address this issue.

14 COMPLIANCE WITH REGULATORY GUIDELINES AND DIRECTIONS

The Auditor has used guidelines currently approved by the EPA under section 105 of the NSW *Contaminated Land Management Act 1997*.

The investigation was generally reported in accordance with the EPA (1997) *Guidelines for Consultants Reporting on Contaminated Sites*. The checklist included in that document has been completed and is kept on file. The EPA's *Checklist for Site Auditors using the EPA Guidelines for the NSW Site Auditor Scheme 1998* (December 1999) has also been completed and is kept on file.

The regulatory approvals and licences obtained for works at the site included:

- Section 91 License from Department of Industry, Planning and Natural Resources (DIPNR). This did not permit disturbing vegetation within Class 1 and 2 areas (Threatened Species/ Community Classification) due to the presence of Cumberland Woodland threatened species.
- Golder (2005) does not state whether well licences were obtained from DIPNR.

15 CONCLUSIONS AND RECOMMENDATIONS

Golder considers that "The use of the site for residential and conservation land uses is considered acceptable subject to the implementation of the recommendations made below with respect to the AOC's listed above, and the limitations discussed in this report".

The Auditor considers that the investigations documented in Milsearch and Golder's reports have been adequate to identify the major contamination issues at the site for the purposes of remediation planning. Golder has identified seven AOC's requiring remedial action and the Auditor concurs with these items, with comments as noted in Section 11.2. Preparation of a RAP is now required to address these items.

APPENDIX A

ATTACHMENTS

ATTACHMENT 1: Site Location

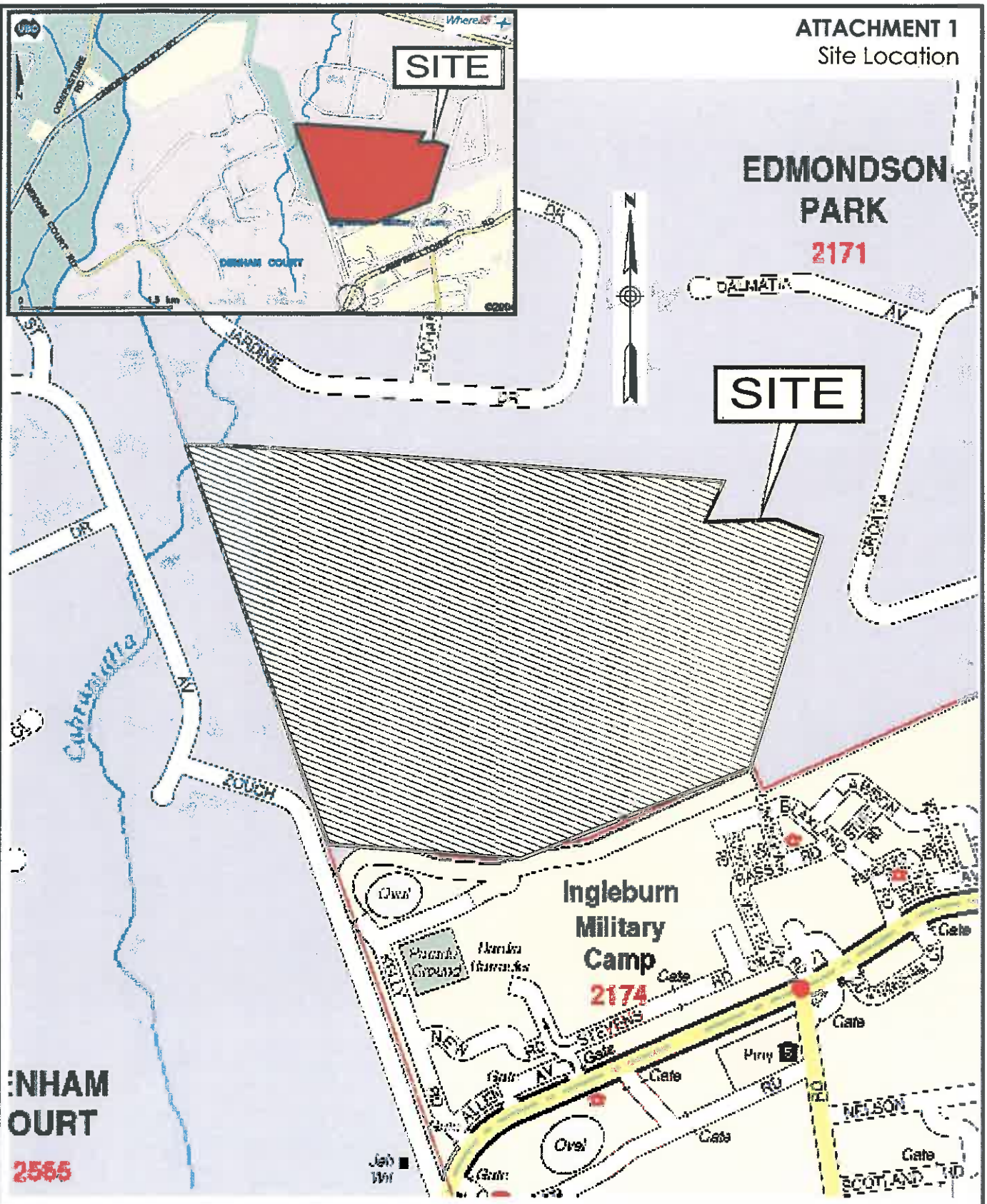
ATTACHMENT 2: Site Layout and Key Features

ATTACHMENT 3: Groundwater Contours

ATTACHMENT 4: Investigation Locations

ATTACHMENT 5: Proposed Remediation Areas

ATTACHMENT 1
Site Location



SOURCE: SYDNEY UBD AND INSET FROM WHEREIS.COM.A - WITH PERMISSION

Golder Associates	CLIENT: Landcom		PROJECT: Zouch Road Edmondson Park NSW			
	DRAWN: RT	DATE: 5 April 2005	TITLE: SITE LOCALITY PLAN			
	CHECKED	DATE				
	SCALE: NTS		PROJECT No: 04623119_12	FIGURE No: 1	REV No: 0	A4

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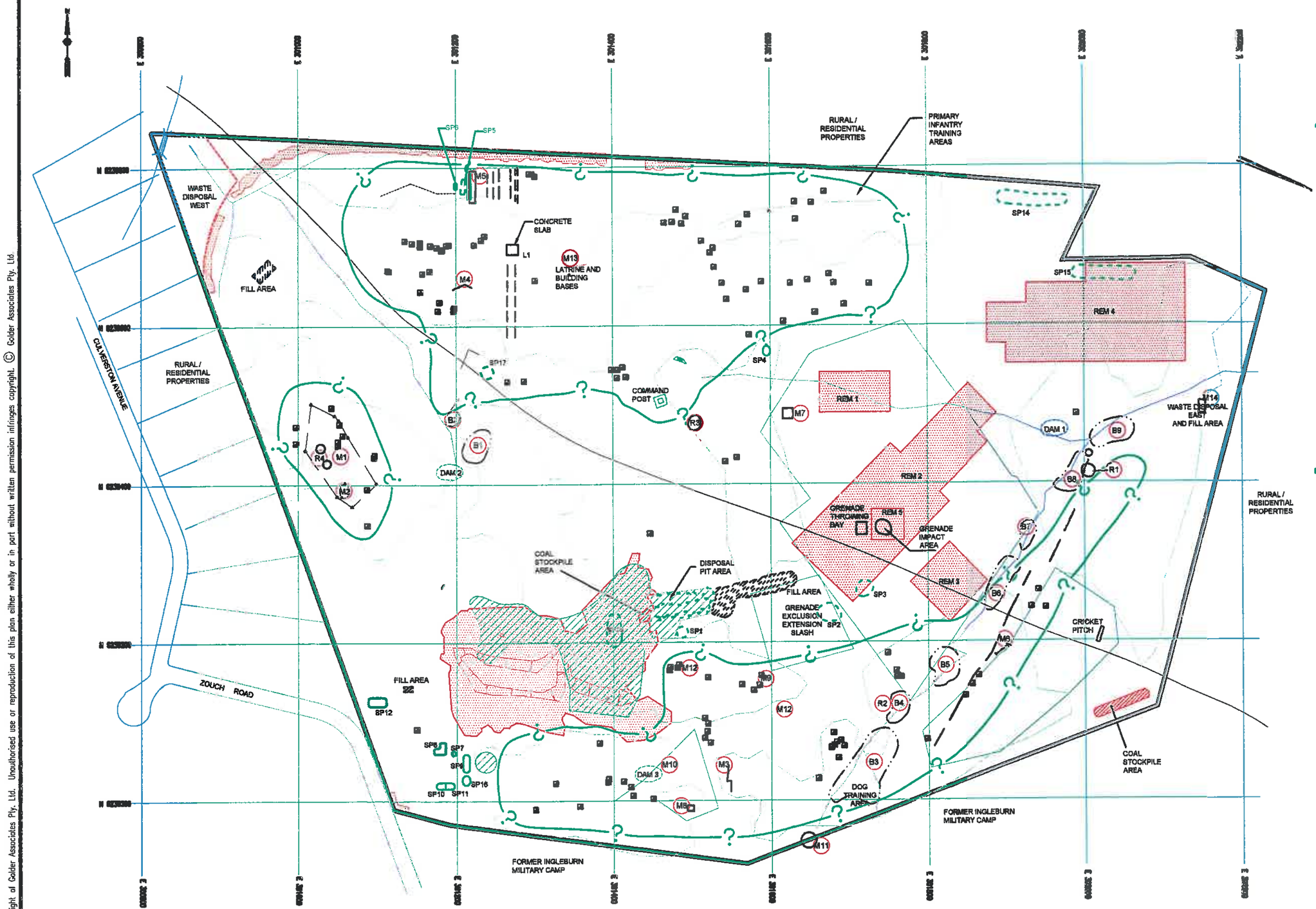
ATTACHMENT 2
Site Layout and Key Features



LEGEND

M1	CONCERTINA WIRE COMPOUND (PRISONER CAMP)
M2	STOCKPILE OF CONCERTINA WIRE
	CONCERTINA WIRE
M3	INFANTRY TRENCH
M4	INFANTRY TRENCH
M5	INFANTRY TRENCH
M6	TRAINING PITS
R1	GENERAL RUBBISH / ASBESTOS PIPES
R2	GENERAL RUBBISH (USED CAR TYRES)
M8	INFANTRY TRENCH / COMMAND POST
B1-B9	BLACKBERRY INFESTATION
M7	RAISED PLATFORM / FORMER STRUCTURE
M8	CONCRETE SLAB / FORMER STRUCTURE
M9	GENERAL RUBBISH / CAR PARTS
R3	GENERAL RUBBISH
M11	OBSTACLE COURSE
M12	OBSTACLE COURSE
M13	BUILDING FACADE
L1-L2	FORMER LATRINE
R4	GENERAL RUBBISH
M14	WATE DISPOSAL TRENCH
SP5	STOCKPILE

UXO STUDY AREA (MILSEARCH 1999 TO 2003)
UXO REMEDIATION AREA (GOLDER 2005)
LEAD PARTICULATE AREA (MILSEARCH 1999 TO 2003)
SITE BOUNDARY
REMEDIATION OF ASBESTOS AREA (AOC 5)
HEAVILY VEGITATED AREAS
WASTE BURIAL TRENCHES (MILSEARCH 1999 TO 2003)

CLIENT	Landcom	PROJECT	Zouch Road Edmondson Park NSW
DRAWN	SL	DATE 03 August 2005	TITLE SITE PLAN / SITE FEATURE
CHECKED	GJF*	DATE 04 August 2005	
SCALE	1:5000	PROJECT No 04623119/012	FIGURE No 2
			REV No 1
			A3

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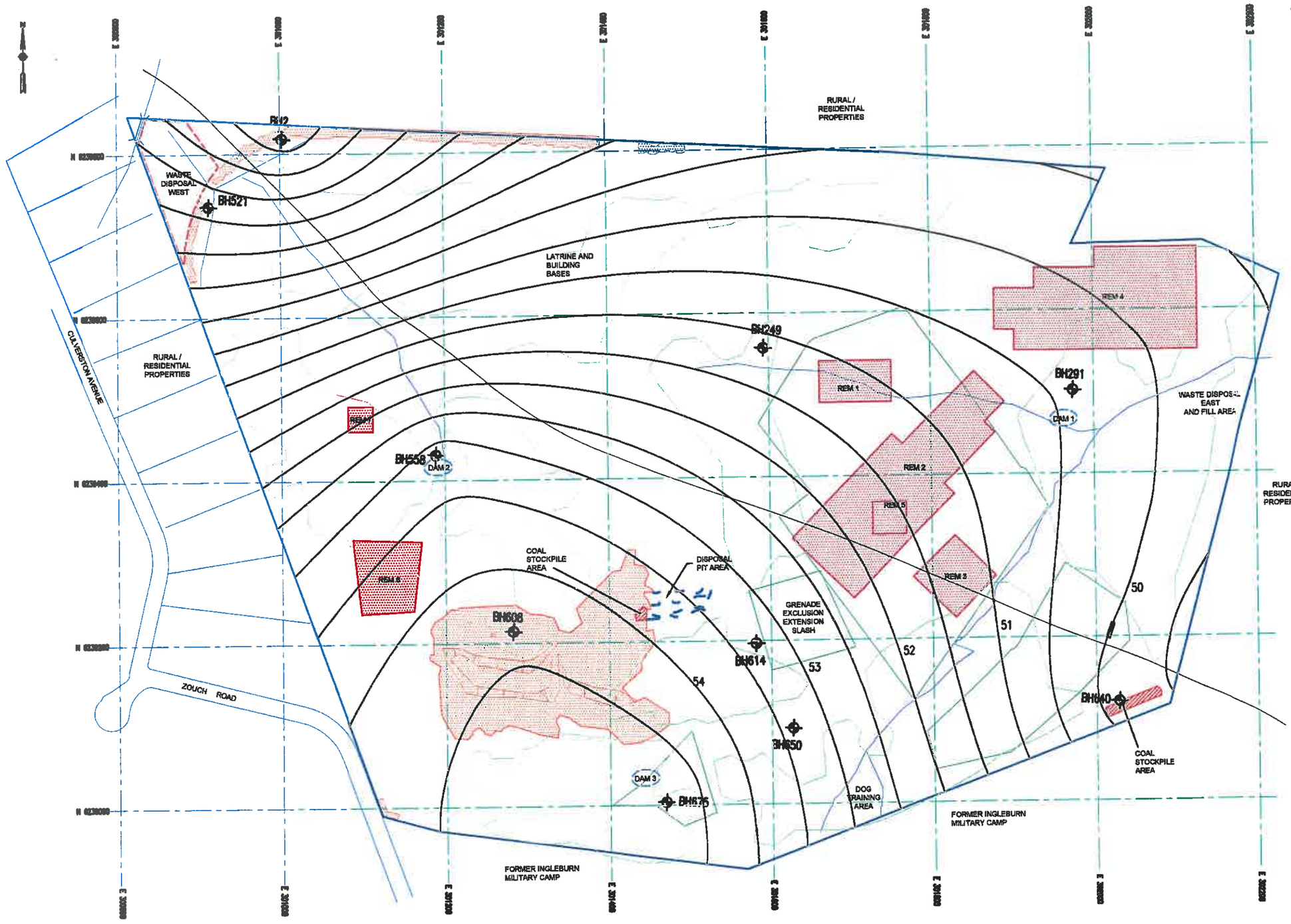
ATTACHMENT 3
Groundwater Contours



CLIENT	Landcom	PROJECT	Zouch Road Edmondson Park NSW
DRAWN SL	DATE 03 August 2005	TITLE	GROUND WATER CONTOURS
CHECKED GJF*	DATE 04 August 2005		
SCALE 1:5000		PROJECT No 04623119/012	FIGURE No 5 · REV No 1 · A3

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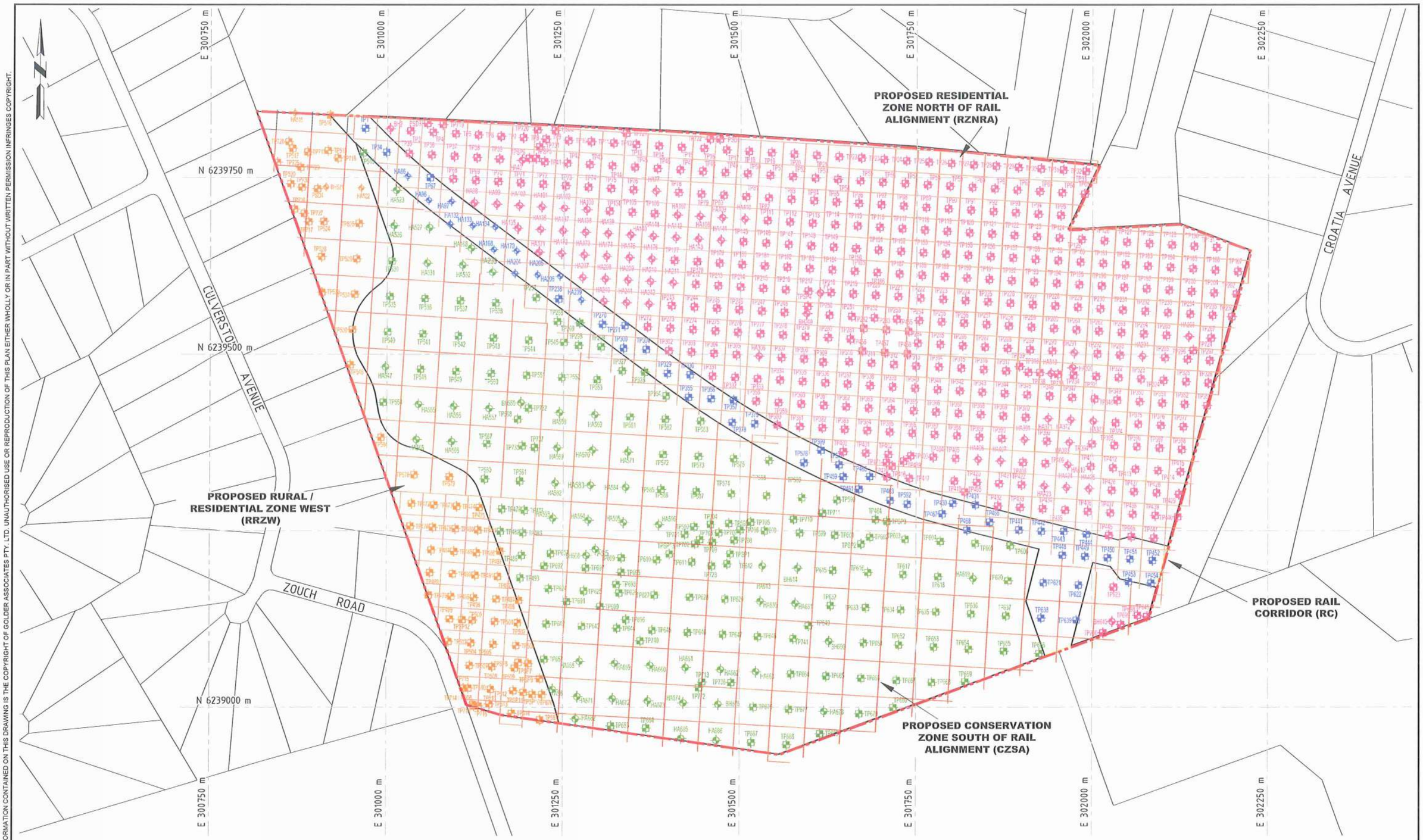

LEGEND

- SITE BOUNDARY
- BOREHOLE AND TEST PIT LOCATIONS, 2005 [PROPOSED RURAL / RESIDENTIAL ZONE WEST (RRZW)]
- BOREHOLE AND TEST PIT LOCATIONS, 2005 [PROPOSED RESIDENTIAL ZONE NORTH OF RAIL ALIGNMENT (RZNRA)]
- BOREHOLE AND TEST PIT LOCATIONS, 2005 [PROPOSED RAIL CORRIDOR (RC)]
- BOREHOLE AND TEST PIT LOCATIONS, 2005 [CONSERVATION ZONE SOUTH OF RAIL ALIGNMENT (CZSA)]
- SAMPLING GRID @ 32 x 32m
- SAMPLING GRID @ 50 x 50m

1:5,000

0 100 200 300m

ADAPTED FROM DIGITAL CADASTRE DATABASE, NSW DEPARTMENT OF LANDS, 2004, ZONE 56 MGA COORDINATES

Golder Associates

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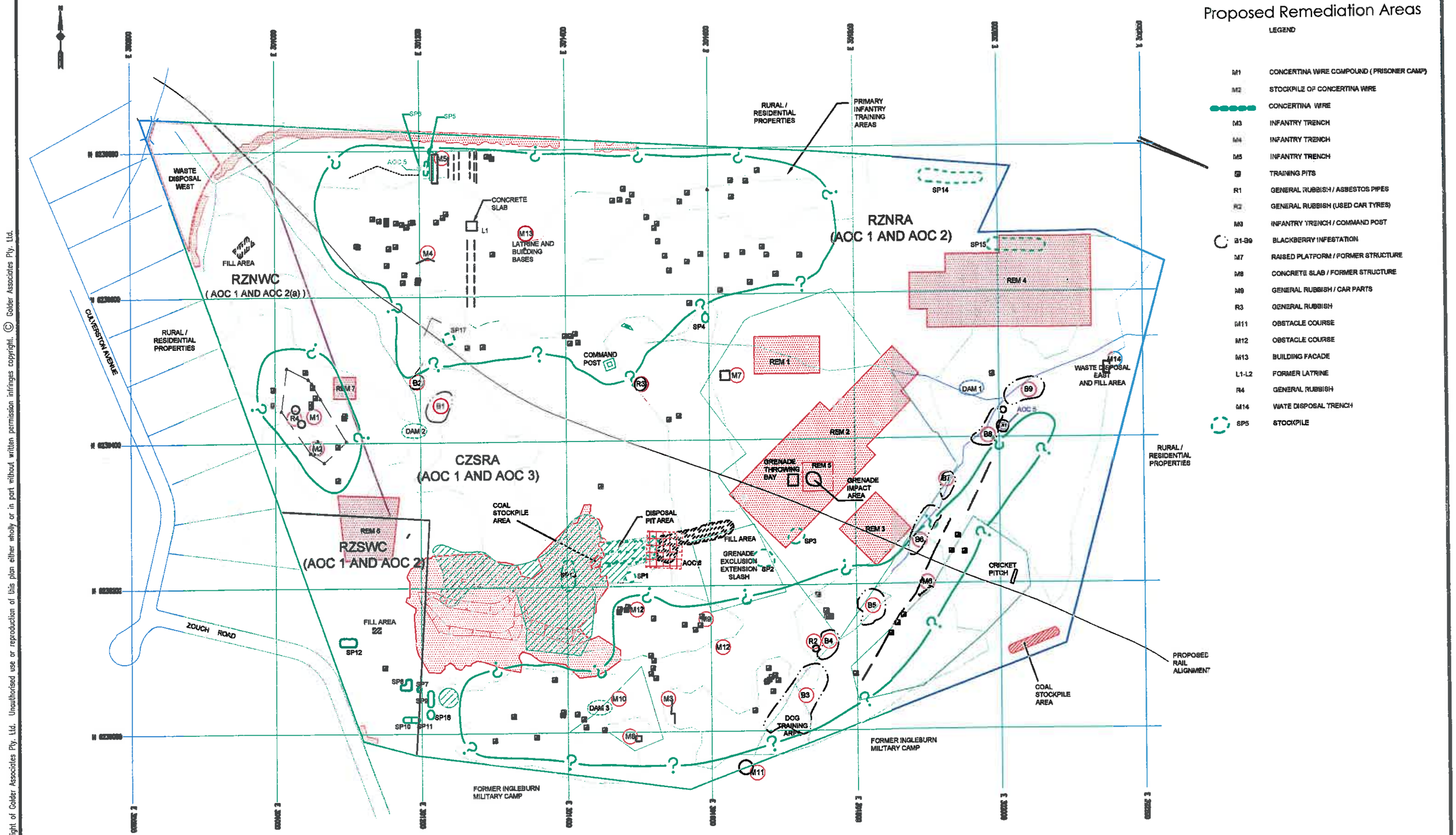
CLIENT	LANDCOM	PROJECT	REMEDIATION ACTION PLAN - ZOUCH ROAD, EDMONDSON PARK
DRAWN BY	HC	DATE	27.08.2010
CHECKED BY	GJF	DATE	12.05.2010
SCALE	1:5000	SHEET SIZE	A3
DRAWING TITLE	PREVIOUS INVESTIGATION LOCATIONS		
PROJECT No	107623047	DOC No	001
DOC TYPE	R	FIGURE No	F0004
REVISION	0		FIGURE 4

Plot Date: 27 August 2010 Time:9:38:12 AM By: Campbell, Helen Path: J:\env\2010\107623047_Landcom_Edmondson Park\Technical Doc\CADD\FIGURES - File Name:107623047_001_R_F0004_REV0.dwg
Xref: GAP_LOGO-A3.dwg;

ATTACHMENT 5
Proposed Remediation Areas



LEGEND

M1	CONCERTINA WIRE COMPOUND (PRISONER CAMP)
M2	STOCKPILE OF CONCERTINA WIRE
	CONCERTINA WIRE
M3	INFANTRY TRENCH
M4	INFANTRY TRENCH
M5	INFANTRY TRENCH
	TRAINING PITS
R1	GENERAL RUBBISH / ASBESTOS PIPES
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M6	INFANTRY TRENCH / COMMAND POST
B1-B9	BLACKBERRY INFESTATION
M7	RAISED PLATFORM / FORMER STRUCTURE
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M9	GENERAL RUBBISH / CAR PARTS
R3	GENERAL RUBBISH
M11	OBSTACLE COURSE
M12	OBSTACLE COURSE
M13	BUILDING FACADE
L1-L2	FORMER LATRINE
R4	GENERAL RUBBISH
M14	WATE DISPOSAL TRENCH
SP5	STOCKPILE

AOC 1– REMOVAL OF GENERAL WASTE (ENTIRE SITE)

AOC 2– REMEDIATION OF SAA AND POTENTIAL UXO (RESIDENTIAL ZONES)

AOC 3– REMEDIATION OF SAA AND POTENTIAL UXO (CONSERVATION ZONE)

AOC 6– REMEDIATION OF PAH IMPACTED MATERIAL

- UXO STUDY AREA (MILSEARCH 1998 TO 2003)
- UXO REMEDIATION AREA (GOLDER 2005)
- REMEDIATION OF ASBESTOS AREA (AOC 5)
- REMEDIATION OF LEAD PARTICULATE AREA (AOC 4)
- SITE BOUNDARY
- REMEDIATION OF PAH IMPACTOED MATERIAL (AOC 6)
- HEAVILY VEGITATED AREAS
- WASTE BURIAL TRENCHES (MILSEARCH 1998 TO 2003)

Golder Associates

CLIENT	Landcom	PROJECT	Zouch Road Edmondson Park NSW
DRAWN SL	DATE 03 August 2005	TITLE	SITE PLAN / AREAS OF CONCERN (REMEDIATION AREAS)
CHECKED GJF*	DATE 04 August 2005		
SCALE 1:5000		PROJECT No 04623119/012	FIGURE No 9 / REV No 1 / A3

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Appendix G:
Interim Advice #4 – Zouch Road, Edmondson Park, NSW, Remediation Action Plan. 30 January 2006, ENVIRON Australia Pty Ltd

ENVIRON

30 January 2006 Ref: 31-0163

Landcom
c/o APP Corporation Pty Ltd
Level 1, 53 Berry Street
North Sydney NSW 2060

Attn: Scott Johnston

Dear Scott,

Interim Advice #4 – Zouch Road, Edmondson Park, NSW
Remediation Action Plan

1 INTRODUCTION

A site contamination audit is being conducted for Landcom relating to property at Zouch Road, Edmondson Park, formerly occupied by the Department of Defence.

The audit is being conducted ultimately to provide an independent review of whether the land is suitable for any specified use or range of uses by an EPA Accredited Auditor i.e. an Audit under Section 47 (1) (b) (iia) of the NSW *Contaminated Land Management Act* 1997 (the CLM Act).

The Audit is being conducted in stages, with initial investigations conducted by Milsearch Pty Ltd (2000 to 2003) focusing on the military history of the site and the potential for contamination by munitions. Parsons Brinkerhoff Australia Pty Ltd (2004) then prepared a *Sampling, Analysis and Quality Plan for Detailed Site Assessment,* which covered munitions issues as well as soil and groundwater contamination issues. Golder Associates Pty Ltd (2005) undertook *Detailed Contamination Site Investigation* of the site and prepared a Remediation Action Plan (RAP) for the site. The munitions aspects of the more recent assessment were conducted by BACTEC SE Asia Pty Ltd (BACTEC).

Advice has previously been provided by the Auditor throughout the audit, as follows:

- Stage 1 - Initial Advice, 7 February 2003;
- Interim Advice #2, 8 July 2003, relating mainly to review of munitions investigations;
- Various comments on the Sampling Analysis and Quality Plan, 21 April to 19 May 2004; and
- Interim Advice #3, 8 September 2005, relating to review of detailed soil and groundwater investigations.

Consistent with Department of Environment and Conservation (DEC and formerly EPA) requirements for staged "sign off" of sites that are the subject of progressive assessment, remediation and validation, I advise that:

- This opinion letter does not constitute a Site Audit Report or Site Audit Statement.
- At the completion of the remediation and validation I will provide a Site Audit Statement and supporting documentation that will conclude as to the suitability of the site for its intended purposes.
- This interim advice will be documented in the final Site Audit Report.

The scope of work completed for this Interim Advice since the completion of the previous Interim Advice (#3) includes:

- Review of the following reports:
  - Draft Report *"Remediation Action Plan, Landcom Project No: 12619, Zouch Road, Edmondson Park, NSW",* by Golder Associates Pty Ltd (Golder), October 2005.
  - Report *"Remediation Action Plan, Landcom Project No: 12619, Zouch Road, Edmondson Park, NSW",* by Golder, December 2005.
- Discussions with the Client (Landcom) and Consultant (Golder) who prepared the RAP.

This Interim Advice provides a review of the RAP and associated issues only. The reader is referred to previous Interim Advice letters for background information and a detailed review of investigations.

2 PROPOSED DEVELOPMENT

Details of the proposed development for the site have changed slightly since the previous Interim Advice (#3). According to the RAP, key features of the proposed development include:

- A proposed rail line crossing the site from the south east corner to north west corner of the site;
- Approximately 38 ha of Conservation Zone, riparian protection park south of the proposed rail alignment;
- Approximately 47 ha of development including elements of a town centre and residential districts in the northern and south western parts of the site; and
- Approximately 8 ha of residential zone with limited development and clearing of vegetation in the north western corner of the site (known as 1D Land).

Golder note that the proposed location of the rail alignment could change during the development planning stages, however, it would only move toward the north and not encroach on the proposed open space area. If this occurred, the proposed remediation for the affected area would be conservative since it would be based on remediation criteria for a more conservative land use (residential) than that required for open space land use.

3 EVALUATION OF REMEDIATION

3.1 Remediation Already Completed

Remediation of seven areas has already been undertaken with respect to munitions, as detailed in the previous Interim Advice (#3). Based on the works undertaken, BACTEC provided certification that the seven remediation areas are free of Unexploded Ordnance (UXO).

During the course of all munitions investigations, all Small Arms Ammunition (SAA)/ weapons fragments were collected and documented. Golder reported that all of the collected training ordnance such as 81 mm mortars and anti tank mines were disposed off-site by Department of Defence personnel. Remaining items such as SAA and grenade base plugs were stockpiled on site for later disposal.

3.2 Remediation Strategy and Methodology

Golder has identified a number of areas at the site requiring remediation, defined as "Areas of Concern" (AOC). These areas and the preferred remediation method for each area is summarised in Table 3.1. The preferred remediation method defined by Golder is considered by the Auditor to be generally appropriate. Some specific comments on the RAP are provided in Section 3.3, below.

Golder divided the site into four areas for the detailed site assessment. The following codes have been used by the Auditor in Table 3.1.

- Residential zone north of rail alignment (RZNRA);
- Residential zone south west corner (RZSWC);
- Residential zone north west corner – 1D land (RZNWC); and
- Conservation zone south of rail alignment (CZSRA).

The following key issues are noted with respect to the preferred remedial options:

- All proposed remediation works require initial preparation of technical specifications.
- An ongoing Environmental Management Plan (EMP) will be required for some areas.

Table 3.1 – Summary of Proposed Remediation

Area of Concern	Description/ Location	Remediation Proposed
AOC 1	Military associated objects: Concertina wire; weapons pits; former structures/ slabs; general rubbish; scrap metal; asbestos piping Located in all areas of the site	*Collection and off-site disposal* Visual site inspection and removal of all objects Backfill where required
-	Stockpiled materials: North west corner disposal area - silty/ gravelly clay, concrete blocks, bricks, timber, general building waste (Waste Disposal West) (RZNWC). General stockpiles in all areas of the site. Soils were observed to consist of silty/ gravelly clays. Golder consider these to be clean fill with the exception of SP6 on the northern boundary (contains bricks and asbestos fibre detection). Two coal stockpiles – small arms firing range (about 200 m^3) and in the south east corner of the site (about 150 m^3) (CZSRA).	*Waste Disposal West and SP6 - Excavation and off-site disposal* Excavate impacted material Off-site disposal at approved landfill *Remaining stockpiles – Use as backfill in pits* *Coal stockpiles – Remove from site*
AOC 2	UXO/ SAA in proposed residential zones (RZNRA, RZSWC)	*Zero tolerance – 100% removal* Vegetation reduction to 0.1 m 100% UXO/ SAA shallow detector search (300mm range, Minelab F3 or similar) Searching of 1ha (100x100m) cells Two-man teams, 1 m line spacing Documentation/ removal of all contacts
AOC 2a	UXO/ SAA in proposed 1D part protected residential zone (RZNWC)	*Combination100% removal and visual clearance* *100% removal* Vegetation reduction in grassed/ non protected areas to 0.1 m 100% UXO/ SAA shallow detector search (300mm range, Minelab F3 or similar) Searching of 1ha (100x100m) cells Two-man teams, 1 m line spacing *Visual clearance* Limited/ approved vegetation reduction in protected areas Visual UXO/ SAA search in protected areas

Area of Concern	Description/ Location	Remediation Proposed
		Searching of 1ha (100x100m) cells Four to six-man teams, 5 to 10 m lane spacing Documentation/ removal of all contacts Management via SMP
AOC 3	UXO/ SAA in proposed conservation zone (CZSRA)	*Visual clearance* Visual UXO/ SAA search Searching of 1ha (100x100m) cells Four to six-man teams, 5 to 10 m lane spacing Documentation/ removal of all contacts Management via SMP
-	Areas of blackberry infestation Numerous affected areas, current area estimate 1.3 ha (CZSRA, RZSRA) No investigation for UXO/ SAA to date.	*Zero tolerance – 100% removal* Vegetation removal (qualified arborist) 100% UXO/ SAA shallow detector search (300mm range, Minelab F3 or similar) Two-man teams, 1 m line spacing Documentation/ removal of all contacts
AOC 4 AOC 5	Lead impacted material – small arms firing range and northern tracks (RZNRA, CZSRA, RZNWC and RZSWC) Area of asbestos sheeting fragments (CZSRA)	*Re-engineer and construct sealing layer to preclude access and minimise infiltration* Prepare level area to accept ACM Emu-pick ACM and place in containers in prepared area Excavate asbestos from waste disposal pits and place in prepared area Vegetation removal, S91 permit may be required Re-engineer/ re-shape the western part of the former small arms firing range to match the surrounding topography Re-locate lead particulate from the access tracks to the small arms firing range area Construct a clay sealing separation layer of 0.4m, including a marker layer Construct a layer of topsoil of nominally 0.1m and seed with native grasses Management via SMP
AOC 6	PAH impact at TP599 (CZSRA)	*Excavation and off-site disposal* Delineate extent and identify source Excavate impacted material Off-site disposal at approved landfill

Area of Concern	Description/ Location	Remediation Proposed
AOC 7	Waste disposal pits (CZSRA) Contain ACMs as well as building demolition waste, scrap metal, machine parts, furniture and foul water	*Excavation and off-site disposal* Vegetation removal Excavate ACM and waste material Sort oversize and metallic materials where possible Relocate to engineered cell at small arms firing range Collect water and dispose off site or reuse on site if quality is acceptable Backfill excavations

3.3 Evaluation of Remedial Action Plan

The Auditor has assessed the RAP by comparison with the checklist included in EPA (1997) *Guidelines for Consultants Reporting on Contaminated Sites*. The RAP was found to address the required information for most items, as detailed in Table 3.2, below.

Table 3.2 - Evaluation of Remedial Action Plan.

Remedial Action Plan	Comments
Remedial Goals	▪ *Complete remediation and validation works such that the land is rendered suitable for the proposed residential and open space (conservation) land uses.* ▪ *Verify that there are no unacceptable off-site impacts at the site during or following remediation.* ▪ *Ensure that the remediation works are conducted safely so as to protect on-site workers, and the public.* A further objective with respect to munitions is to remove "remnants of Small Arms Ammunition and Potential Unexploded Ordnance within proposed residential areas and conduct a visual clearance of contacts within proposed conservation zones". In the Auditor's opinion, these goals are considered appropriate.
Discussion of the extent of remediation required.	Remediation required for each area was discussed within the RAP (See Section 3.2, above)
Remedial Options	**AOC 1:** Collection and off-site disposal **Stockpiles:** Excavation and off-site disposal Use as backfill **AOC 2/3, blackberry infestations:** Zero tolerance – 100% removal Visual clearance **AOC 4/5:** Re-engineer and construct sealing layer Excavation and off-site disposal **AOC 6:** On-site treatment Excavation and off-site disposal **AOC 7:** Cap and cover in situ Excavation and relocation to engineered capped area Excavation and off-site disposal
Selected Preferred Option	The preferred options were discussed within the RAP (refer Section 3.2, above)

Remedial Action Plan	Comments
Rationale	The decision-making rationale was based on technical feasibility, environmental impact, relative cost benefit and ongoing maintenance requirements.
Proposed Validation Testing	**AOC 1:** None proposed for general waste/ military associated objects. Visual validation proposed for removal of coal stockpiles. Validation of soil from within excavation areas is proposed for the Waste Disposal West and SP6 stockpile. Analytes and sample density are not specified. General stockpiles proposed for reuse as backfill in pits, validation testing density is not specified. **AOC 2, 2a and 3:** Validation is proposed for all UXO/ SAA remediation by a repeat check of 10% of each 1ha (100x100m) search cell. If validation fails (i.e., a contact is found), the entire cell area (1ha) will be searched again. The 10% repeat check area within each 1ha cell should be selected to ensure it is representative of the entire cell area (1ha). It is noted that the definition of "contact" for the purposes of initiating a re-search as part of the validation process is "a metallic object of military firearm origin, greater than 25mm in length". **AOC 4/5:** Validation of placement of capping layers is proposed by detailed survey. Validation of "effectiveness" of capping is further proposed but the methodology is not defined. Capping materials will be required to meet open space land use criteria. Proposed analytes and density of sampling is not defined. **AOC 6, 7:** Validation of soil remaining on site from the PAH and waste disposal pit excavation areas. Analytes and sample density are not specified. **Imported Fill:** Analysis for a selection of heavy metals, TPH and BTEX is proposed, to meet open space land use criteria. A sampling density is not specified. These analytes may not be adequate to identify potential contaminants in imported fill. Validation should be undertaken in accordance with the density and analytes for imported fill listed in EPA (1994) *Contaminated Sites: Guidelines for Assessing Service Station Sites*. **Groundwater:** Sampling of groundwater before and after remediation. Analytes as per the detailed site investigation.
Interim Site Management Plan (before remediation)	No measures discussed in the RAP. Site is currently fenced and unoccupied.

Remedial Action Plan	Comments
Site Management Plan (operation phase) including stormwater, soil, noise, dust, odour and OH&S	The need for health and safety and environmental controls during the remediation works is identified. Golder states that the implementation of these will be the responsibility of the Site Contractor and Project Manager. The RAP states that the following plans will need to be prepared: ■ Soil and Erosion Management Plan (SEMP) ■ Site Management Plan (SMP) ■ Construction Management Plan (CMP) ■ Contractor Site Specific Health and Safety Plans (SSHSP)
Contingency Plan if Selected Remedial Strategy Fails	None specifically discussed, not likely to fail since proven methodologies.
Contingency Plans to Respond to site Incidents. Site Management Plan for the Operation Phase.	Emergency response measures are to be detailed in Site Specific Health and Safety Plans.
Remediation Schedule	Indicative project duration was given as eight months commencing November 2005.
Hours of Operation	Hours of Operation are not provided.
Licence and Approvals	Discussed in the RAP, refer Section 6 of Interim Advice
Contacts/Community Relations	No measures discussed in the RAP.
Staged Progress Reporting	No measures discussed in the RAP.
Long term site management plan	A Site Management Plan (SMP) will be required for AOC 2a, 3, 4 and 5. Golder states that the implementation of this will be the responsibility of the future landowners (private landowners for AOC 2a; DEC for AOC 3, 4 and 5). The mechanism for implementation of SMPs at individual residential block level (eg, in AOC 2a) has not been defined. An outline of the required contents of the SMP is provided in the RAP. It is stated that input in preparing the SMP will be required from a suitably qualified environmental consultant. For AOC 2a/ 3, the RAP notes that the SMP should include contingency measures for the instance where UXO/ SAA are encountered. Specific management requirements identified for AOC 4/ 5 include: Maintain integrity of sealing layer Erection of notices No planting of deep rooting plants No installation of site services Avoid erection of structures Notation via planning instrument

The RAP outlines some of the validation proposed, but does not include a detailed validation plan. For the majority of analytical validation proposed, validation sample

densities and analytes are not defined. Validation acceptance criteria are defined as the site assessment criteria for residential or open space land use which is appropriate. Reference is made in Section 8.3 of the RAP to various guideline documents, however, these documents do not specify appropriate frequencies and analytes for validation of the specific issues at the site. These include the following issues:

- Excavation area of Waste Disposal West and SP6 stockpile
- ACM/ lead particulate capping layer
- Excavation area of PAH impact at TP599
- Excavation area of Waste Disposal Pits

With regards to imported fill, validation should be undertaken in accordance with the density and analytes listed in EPA (1994) *Contaminated Sites: Guidelines for Assessing Service Station Sites*.

Stockpiles on site may be reused as backfill. Detailed characterisation of these materials has not been undertaken. The RAP proposes the reuse of these materials if they are demonstrated as suitable for use on site however the density of testing to be conducted is not specified.

The Auditor considers that if stockpiles are observed to be a consistent soil material with no evidence of contamination, reuse in the conservation zone is acceptable. However, characterisation to an appropriate density should be undertaken before re-use in the residential zones and before re-use in the conservation zone if there are any indications of contamination. If this characterisation is not undertaken to support re-use on site, the material should be disposed off-site.

It is recommended that a detailed validation plan be prepared and provided to the Auditor for review prior to commencement of the validation stage of the remediation works.

3.4 Future Remediation Items Requiring Auditor Consideration

The RAP identifies the following items that need to be approved by the Auditor during forthcoming stages of the project:

- Soil and Erosion Management Plan (SEMP) (operation phase)
- Site Management Plan (SMP) (operation phase)
- Construction Management Plan (CMP) (operation phase)
- Long term SMPs
- Any alternative remediation methodologies than those described in the RAP that are proposed to be adopted
- Location and technical specification of ACM/ lead particulate capping layer
- Agreement on program for validation of ACM/ lead particulate capping layer "effectiveness"
- Application of statistical analysis of data should validation samples fail criteria

- Consideration of imported fill validation sampling requirements if EPA (1995) *Contaminated Sites: Sampling Design Guidelines* are not followed.

3.5 Conclusion

Overall, it is considered that the remediation approach recommended by Golder is appropriate. Contamination issues raised within the previous Interim Advice letters have been addressed by the RAP. Of critical importance will be the successful implementation of EMPs for ongoing site management in certain areas of the site.

4 CONTAMINATION MIGRATION POTENTIAL

In the long term, remedial works would further reduce the low potential for off-site migration discussed in the previous Interim Advice (#3). In the short-term, however, there would be a higher potential for off-site migration due to high activity levels and disturbance of the site during remediation works. As such, an EMP is required to control environment impacts during the remediation works. This is already identified as a requirement in the RAP.

5 ASSESSMENT OF RISK

Based on assessment of results against relevant guidelines and consideration of the overall investigation and proposed remediation, the Auditor provides the following assessment of risk.

5.1 Munitions

The following are identified as the risks associated with the site in its current state:

- The risk of live UXO being encountered on site is very low. None has been found to date during the course of extensive investigations.
- The risk of live ball ammunition being encountered on site is very low. There has been no known usage at the site and none has been found to date during the course of extensive investigations. According to Golder (RAP, Section 9.7.3), it is possible that former land owners, community members or off duty soldiers with access to the site may have used live rounds over the sites history.
- There is a moderate risk of additional 'unexpected' inert grenade or mortar impacts to be present in general areas of the site. These items are difficult to locate due to the lack of fragmentation 'signature'. While these practice items do not present an explosive hazard, their discovery on site could be alarming to any future workers or occupants. There is a higher risk of such 'unexpected' impacts to be present in areas of the site that have not previously been accessed.
- Blank expended ammunition is present on site at an estimated 700 items/ha in high intensity usage training areas and 250 items/ha in remaining areas of the site. While presenting no explosive hazard, the discovery of expended blank SAA could be alarming to site workers or occupants.

- The proportional occurrence of live blank SAA has been estimated at between 2 and 10% however a lesser proportion than this has actually been found on site. Live blank ammunition can cause injury, particularly eye damage, if detonated through tampering.

The proposed 100% UXO/ SAA search in the proposed residential areas and grassed areas of the proposed 1D residential lands (AOC 2 and 2a) will reduce the likelihood of encountering the above items to minimal levels, and will reduce the associated risks to minimal levels.

The proposed visual clearance for UXO/ SAA in the protected vegetation areas of the proposed 1D residential lands and the proposed conservation zone (AOC 2a and 3) will reduce the likelihood of encountering the above items to low levels, and will reduce the associated risks to low levels. Implementation of site management controls via an EMP is required for these areas to reduce the associated risks to minimal levels.

5.2 Soil and Groundwater

- Remediation action is proposed to address the identified low levels of soil contamination and physical waste materials including asbestos in a number of areas of the site where contamination detections were largely expected. The proposed remediation works will reduce the associated risks to human health and the environment under the proposed residential or conservation land use to minimal levels.
- There is considered to be a very low risk of undetected soil contamination being present in general areas of the site outside of the known areas of contamination.
- Groundwater investigations have identified possible minor contamination by heavy metals in the vicinity of the small arms firing range. The majority of heavy metals exceedances detected at the site are considered to be representative of background conditions within the shale bedrock. The Auditor considers the risk to human health or the surrounding environment due to groundwater contamination is currently very low and would be reduced further by the proposed remediation measures.

6 COMPLIANCE WITH REGULATORY GUIDELINES AND DIRECTIONS

The Auditor has used guidelines currently approved by the EPA under section 105 of the NSW *Contaminated Land Management Act 1997*.

As discussed in Section 3, the RAP is generally in accordance with the EPA (1997) *Guidelines for Consultants Reporting on Contaminated Sites*.

The regulatory approvals and licences relevant to the proposed remediation are as follows:

- Section 91 Licence from Department of Industry, Planning and Natural Resources (DIPNR) is required for vegetation clearance aspects of remediation.
- State Environmental Planning Policy 55 (SEPP 55). Remediation is assessed by

Golder to be Category 2.

- Handling and disposal of any ACM in accordance with requirements of WorkCover NSW.
- Off-site disposal of soil/ waste/ liquids in accordance with EPA (1999) *Environmental Guidelines: Assessment, Classification and Management of Liquid and Non Liquid Waste*.
- An appropriately licensed landfill should be selected and the material tracked from the site to the landfill.
- Notation of EMP requirements will be required, for example, on the property title under Section 149(5) of the *Environmental Planning and Assessment Act 1979*.

7 CONCLUSIONS AND RECOMMENDATIONS

Golder has prepared a Remediation Action Plan outlining works required to make the site suitable for the proposed residential and conservation land uses. Seven primary Areas of Concern (AOC) requiring remediation are identified, as well as action relating to stockpiles on site and areas not previously assessed due to the presence of blackberry infestations.

The Auditor has assessed the proposed remedial action for each issue for its suitability, and overall, it is considered that the remediation approach recommended by Golder is appropriate.

Prior to commencement of remediation, preparation of technical specifications and plans controlling the remedial works are required. Preparation of Environmental Management Plans is also required for the ongoing management of certain areas of the site. A number of future remediation items are identified in the RAP as requiring consultation with, and approval by, the Auditor. These are listed in Section 3.4 of this Interim Advice.

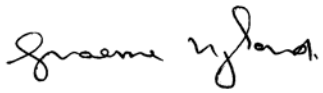
The Auditor has assessed the RAP by comparison with the checklist included in EPA (1997) *Guidelines for Consultants Reporting on Contaminated Sites*. The RAP was found to address the required information for most items. It is recommended that a detailed validation plan be prepared and provided to the Auditor for review prior to commencement of the validation stage of the remediation works.

The Auditor is satisfied that the proposed remediation described in the RAP will be able to make the site suitable for the proposed residential and conservation land uses. Of critical importance will be the successful implementation of EMPs for ongoing site management in certain areas of the site.

* * *

Please do not hesitate to contact the undersigned or Rowena Salmon if you have any questions or comments regarding the above.

Yours faithfully,
ENVIRON Australia Pty Ltd



Graeme Nyland
EPA Accredited Site Auditor 9808

Appendix H:
Interim Advice #5 – Zouch Road, Edmondson Park, NSW, Revised Remediation Action Plan. Draft, 24 February 2011, ENVIRON Australia Pty Ltd

ENVIRON

24 February 2011 Our Ref: AS120163

Landcom
Attn: David Schofield, Senior Development Manager
Level 2, 330 Church St
Parramatta NSW 2150

Dear David,

Re: Interim Advice #5 – Zouch Road, Edmondson Park, NSW, Revised Remediation Action Plan

1 Introduction

A site contamination audit is being conducted for Landcom relating to property at Zouch Road, Edmondson Park, formerly occupied by the Department of Defence.

The audit is being conducted ultimately to provide an independent review by an EPA Accredited Auditor of whether the land is suitable for any specified use or range of uses i.e. a "Site Audit" as defined in Section 4 (1) (b) (iii) of the NSW *Contaminated Land Management Act 1997* (the CLM Act).

Site assessment is being conducted in stages, with initial investigations conducted by Milsearch Pty Ltd (2000 to 2003) focusing on the military history of the site and the potential for contamination by munitions. Parsons Brinkerhoff Australia Pty Ltd (2004) then prepared a Sampling, Analysis and Quality Plan for Detailed Site Assessment, which covered munitions issues as well as soil and groundwater contamination issues. Golder Associates Pty Ltd (2005) undertook Detailed Contamination Site Investigation of the site and prepared a Remediation Action Plan (RAP) for the site. The munitions aspects of the 2005 assessment were conducted by BACTEC SE Asia Pty Ltd (BACTEC). Golder Associates Pty Ltd (2011) have now prepared a revised RAP for the site based on the revised development plan for the site which is documented in a Concept Plan, currently under assessment by the Department of Planning.

The audit commenced in 2003 and is being conducted in stages. Advice has previously been provided by the Auditor throughout the audit, as follows:

- Stage 1 - Initial Advice, 7 February 2003
- Interim Advice #2, 8 July 2003, relating mainly to review of munitions investigations;
- Various comments on the Sampling Analysis and Quality Plan, 21 April to 19 May 2004
- Interim Advice #3, 8 September 2005, relating to review of detailed soil and groundwater investigation
- Interim Advice #4, 30 January 2006, relating to review of the original RAP.

The scope of work completed for this Interim Advice since the completion of the previous Interim Advice (#4, January 2006) includes:

- Review of the following reports:
  - Report "Environmental Management Plan (EMP), Proposed Remediation Works, Regional Park Zone, Part Lot 7 and 8 in DP1127653, Edmondson Park, NSW", included as Appendix E of RAP, by Golder, 10 December 2010 (and draft dated 26 August 2010)
  - Report "Draft Site Management Plan (SMP),Conservation Zone, Part Lot 7 and 8 in DP 1127652, Edmondson Park, NSW", by Golder, 9 December 2010 (and earlier draft dated 26 August 2010)
  - Letter "Response to 14 October 2010 Auditor Comments", by Golder, 9 December 2010
  - Report "Remediation Action Plan, Landcom Project 12619 – Zouch Road, Edmondson Park, NSW", by Golder Associates Pty Ltd (Golder), 11 February 2011 (and drafts dated 26 August and 10 December 2010).
- Site visit on 8 April 2010.
- Discussions with the Client (Landcom) and Consultant (Golder) who prepared the revised RAP.

This Interim Advice provides a review of the revised RAP (referred to herein as 'the RAP') and associated issues only. The reader is referred to previous Interim Advice letters for background information and a detailed review of investigations.

2 Proposed Development

Since the previous Interim Advice (#3 and #4), the legal identification of the site has been changed to Lots 1, 2, 7 and 8 in DP 1127652, and other details of the proposed development have been changed slightly to reflect the Concept Plan. The current lot boundaries and proposed development layout are shown on Attachments 1 and 2, respectively.

According to the RAP, key features of the proposed development include:

- Approximately 6.4 ha of rail corridor crossing the site from the southeast corner to northwest corner
- Approximately 36 ha of conservation zone south of the rail corridor, to be part of the Edmondson Regional Park
- Approximately 43 ha of development primarily north of the rail corridor, including residential use, a school, public open space and mixed use development in a town centre
- Approximately 8.3 ha of rural residential zone located along the western boundary of the site.

The boundaries of these areas vary slightly from the area boundaries considered in Interim Advice #3 where the detailed investigation results were discussed and Interim Advice #4

where the previous RAP was discussed. Golder has presented a summary of the investigation data in the RAP (RAP Section 8) based on the revised area boundaries. The Auditor is satisfied that adjustment of these boundaries has not had a material affect on the interpretation of the investigation results or the remediation works required.

3 Evaluation of Remediation

3.1 Remediation Already Completed

Remediation of seven areas has already been undertaken with respect to munitions, as detailed in Interim Advice #3. Based on the works undertaken, BACTEC provided certification that the seven remediation areas are free of Unexploded Ordnance (UXO).

During the course of all munitions investigations, all Small Arms Ammunition (SAA)/ weapons fragments were collected and documented. Golder reported that all of the collected training ordnance such as 81 mm mortars and anti tank mines were disposed off-site by Department of Defence personnel. In recent correspondence (letter, 9 December 2010), Golder advised that remaining items such as SAA and grenade base plugs which were stockpiled on site for later disposal were disposed in 2006.

3.2 Remediation Strategy and Methodology

Golder has identified a number of areas at the site requiring remediation, defined as “Areas of Concern” (AOC). These areas and the preferred remediation method for each area is summarised in Table 3.1, along with the proposed validation method. Further details of proposed validation testing are provided in Table 3.3. The preferred remediation method defined by Golder is considered by the Auditor to be generally appropriate and is generally consistent with that previously proposed and reviewed in Interim Advice #4. The primary difference between the previous and current RAP is that the current (2011) RAP includes more detail regarding the containment “cap” design and further details on validation sampling.

The following area codes have been used by the Auditor in Table 3.1 based on the proposed development areas:

- Rail corridor (RC)
- Conservation zone south of the rail alignment (CZSRA)
- Residential zone north of the rail alignment (RZNRA), including a school, public open space and mixed use development, including a small portion south of the rail alignment in the east of the site
- Rural residential zone west (RRZW).

The boundaries of these areas and specific items requiring remediation are shown on Attachment 3.

The following key issues are noted with respect to the preferred remedial options:

- All proposed remediation works require initial preparation of technical specifications.
- An ongoing Site Management Plan (SMP) will be required for the Conservation Zone.

Table 3.1 – Summary of Proposed Remediation and Validation Strategy

Area of Concern	Description/ Location	Remediation Proposed		Validation Proposed
AOC 1 (Whole site – not shown on Attach-ment 3)	**Military associated objects:** Concertina wire; weapons pits; former structures/ slabs; general rubbish; scrap metal; asbestos piping Located in all areas of the site.	**Collection of objects and off-site disposal** Visual site inspection and removal of all objects Asbestos materials to be handled in accordance with NSW WorkCover requirements Backfill pits where required with imported fill or re-engineered soils from elsewhere on the site.		None specified for removal of general waste/ military associated objects Validation sampling of replacement soils, required to be suitable for the proposed land use of the relevant area
	Stockpiled materials:			
	North west corner disposal area - silty/ gravelly clay, concrete blocks, bricks, timber, general building waste (Waste Disposal West) (RRZW).	**Excavation and off-site disposal** Excavate impacted material Off-site disposal at approved landfill		Visual inspection of footprint Validation sampling of disposal area footprint
	General stockpiles in all areas of the site. Soils were observed to consist of silty/ gravelly clays. Golder consider these to be clean fill with the exception of SP6 on the northern boundary (contains asbestos fibre detection) and SP13 between the rifle range and coal stockpile (contains brick, concrete, timber and plastic but no contaminant detections).	SP6, SP13	**Excavation and off-site disposal** Excavate impacted material Off-site disposal at approved landfill	Visual inspection of footprints Validation sampling of stockpile footprints
		Remaining Stockpiles	**Use as backfill in pits** After appropriate validation for re-use	Visual inspection of footprints Validation sampling of stockpile footprints if evidence of contamination (olfactory or visual impact) Validation sampling required for reuse of stockpiles Inspection during excavation for reuse

Table 3.1 – Summary of Proposed Remediation and Validation Strategy

Area of Concern	Description/ Location	Remediation Proposed	Validation Proposed
	Two coal stockpiles – small arms firing range (about 200 m^3) and in the south east corner of the site (about 150 m^3) (CZSRA).	**Remove from site** Preferred strategy is dispose off site, possibly to an industry or community benefactor for reuse.	Visual validation of coal removal Validation sampling of stockpile footprints
AOC 2	UXO/ SAA in proposed residential zones (RZNRA, RRZW)	**Zero tolerance – 100% removal** Vegetation reduction to 0.1 m 100% UXO/ SAA shallow detector search (300mm range, Minelab F3 or similar) Searching of 1ha (100x100m) cells Two-man teams, 1 m line spacing Documentation/ removal of all contacts Contractor required to be endorsed by Department of Defence Off-site disposal at approved landfill	Repeat search of a representative 10% area of each 1ha (100x100m) search cell. If validation fails (i.e., a contact is found), the entire cell area (1ha) will be searched again. The definition of "contact" for the purposes of initiating a re-search is "a metallic object of military firearm origin, greater than 25mm in length".
AOC 3	UXO/ SAA in proposed conservation zone (CZSRA)	**Visual clearance** Visual UXO/ SAA search Searching of "workable blocks" Four to six-man teams searching within 5 to 10 m lane spacing Documentation/ removal of all contacts Contractor required to be endorsed by Department of Defence Off-site disposal at approved landfill Management via SMP	
-	Areas of blackberry infestation Numerous affected areas, current area	**Zero tolerance – 100% removal** Vegetation removal (qualified arborist)	*None specified, however, assumed to be the same as AOC*

Table 3.1 – Summary of Proposed Remediation and Validation Strategy

Area of Concern	Description/ Location	Remediation Proposed	Validation Proposed
	estimate 1.3 ha (CZSRA, RZNRA) No investigation for UXO/ SAA to date.	Remediation method as per AOC 2 or AOC 3 (depending on location of cleared infestation)	*2.*
AOC 4 AOC 5	Lead impacted material – small arms firing range and northern tracks (RZNRA, CZSRA and RRZW) Area of asbestos sheeting fragments (CZSRA)	**Re-engineer and construct sealing layer to preclude access and minimise infiltration (cap and contain)** UXO clearance Emu-pick ACM from surface and place in containers Vegetation removal, S91 permit may be required Excavate surface lead particulate and stockpile within proposed capped area footprint. Excavate burial pit (engineered cell) and stockpile excavated natural material for use as capping material Place collected ACM then first scrape of surface lead particulate into burial pit Excavate ACM from waste disposal pits and place in containers in burial pit Re-engineer/ re-shape the former small arms firing range to match the surrounding topography Cap ACM burial area, including minimum 0.2m compacted cover of lead particulate, clay sealing separation layer of 0.4m, marker layer, 0.2m topsoil and seed with native grasses Total cover over ACM burial area to comprise minimum 1m thickness Management via SMP	Visual inspection for lead particulate and ACM in excavation areas outside the capped area footprint Validation sampling of excavation faces Validation of placement of capping layers is proposed by detailed survey Validation of cap quality proposed by Construction Quality Assurance documentation Validation sampling to demonstrate capping and topsoil materials meet open space land use criteria

Table 3.1 – Summary of Proposed Remediation and Validation Strategy			
Area of Concern	**Description/ Location**	**Remediation Proposed**	**Validation Proposed**
AOC 6	PAH impact at TP599 (CZSRA)	**Excavation and off-site disposal** Delineate extent and identify source Excavate impacted material Off-site disposal at approved landfill	Visual inspection Validation sampling of excavation faces
AOC 7	Waste disposal pits (CZSRA) Contain ACMs as well as building demolition waste, scrap metal, machine parts, furniture and foul water	**Excavation and relocation for containment** Vegetation removal, S91 permit may be required Excavate ACM and waste material Place ACM in containers and relocate to burial pit (engineered cell) at small arms firing range Sort oversize and metallic materials where possible Offsite disposal/ recycling of oversize and metallic wastes Relocate remaining waste to engineered cell at small arms firing range Collect water and dispose off site or reuse on site if quality is acceptable Backfill excavations with validated material	Visual inspection Validation sampling of excavation faces

3.3 Evaluation of Remedial Action Plan

The Auditor has assessed the RAP by comparison with the checklist included in EPA (1997) 'Guidelines for Consultants Reporting on Contaminated Sites'. The RAP was found to address the required information for most items, as detailed in Table 3.2, below.

Table 3.2 - Evaluation of Remedial Action Plan

RAP Element	Details		Auditor Comments
Remedial Goals RAP s10.1 RAP s12.11	• "Complete remediation and validation works such that the land is rendered suitable for the proposed residential and open space (conservation) land uses. • Verify that there are no unacceptable off-site impacts at the site during or following remediation. • Ensure that the remediation works are conducted safely so as to protect on-site workers, and the public". A further objective with respect to munitions is to remove "remnants of Small Arms Ammunition and Potential Unexploded Ordnance within proposed residential areas and conduct a visual clearance of contacts within proposed conservation zone".		These goals are considered appropriate.
Discussion of the extent of remediation required. RAP s11	Remediation required for each area was discussed within the RAP and all areas were identified on site plans. Details are summarised in Section 3.2 of this Interim Advice and shown on Attachment 3.		Extent considered adequate, although it is noted that the extent of PAH impact at TP599 and current extent of blackberry infestations is not yet determined.
Remedial Options RAP s12	AOC 1, WDW, SP6, AOC 4/5, AOC 6	On site re-engineering and sealing Collection and off-site disposal Soil treatment	Remedial options discussed are considered appropriate
	"Clean" stockpiles	Excavation and off-site disposal Reuse on site as backfill	
	AOC 2/3, blackberry infestations	Zero tolerance – 100% removal Visual clearance	
	AOC 7	Cap and cover in situ Excavation and relocation to engineered capped area Excavation and off-site disposal	

Table 3.2 - Evaluation of Remedial Action Plan

RAP Element	Details	Auditor Comments
Selected Preferred Option RAP s12	The preferred options were discussed within the RAP (refer Section 3.2, above)	Selected preferred options are considered appropriate
Rationale RAP s10.2	The decision-making rationale was based on technical feasibility, environmental impact, relative cost benefit and ongoing maintenance requirements. a decision-making matrix was presented for each issue.	Adequate presentation of rationale
Proposed Validation Testing RAP s14 RAP s16	Validation sampling is discussed in the RAP (RAP s14.2) and is summarised in Table 3.3, following. Details of additional validation methods proposed are summarised in Table 3.1, above. The proposed validation criteria are discussed in the RAP (RAP s14.3). The validation criteria are defined as the site assessment criteria for the two primary land uses, ie: • Environmental investigation levels, equivalent to DEC (2006) SIL 5 provisional phytotoxicity-based criteria • Health-based investigation levels, equivalent to DEC (2006) SIL 1 and SIL 3, for residential usage and recreational open space, respectively. Statistical validation is proposed (95% UCL approach) when considering the Health-based investigation levels. Groundwater is to be assessed at the Site before and after remediation to ensure no impacts occur from the remedial works at the Site. Groundwater is to be assessed for the parameters, and against the criteria, used in the detailed site investigation. The RAP includes a discussion of data quality objectives (DQOs) developed in accordance with AS4482.1-2005. Quality assurance/ quality control (QA/QC) samples to be taken and quantitative data quality objectives (DQOs) are defined. Analysis of trip spike and trip blank samples is only proposed for areas with volatile contamination, currently only PAH and TPH impact in AOC 7.	Validation sampling is considered generally appropriate, however, if importation of large quantities of material from multiple sources is expected, it is recommended that more detailed guidance be prepared for classification and acceptance of VENM/ ENM/ topsoil. Validation criteria are considered appropriate. Statistical validation for Health-based investigation levels is considered acceptable. Approach to groundwater validation is considered acceptable. The identified DQOs and QA/QC samples outlined are considered acceptable.
Interim Site Management Plan (before remediation)	No measures discussed in the RAP. Site is currently fenced and unoccupied.	Maintenance of site security is the only interim site management required

Table 3.2 - Evaluation of Remedial Action Plan

RAP Element	Details	Auditor Comments
Site Management Plan (operation phase) including stormwater, soil, noise, dust, odour and OH&S RAP s15	The need for health and safety and environmental controls during the remediation works is identified in the RAP. Golder states that the implementation of these will be the responsibility of the Site Contractor and Project Manager. The RAP states that the following plans will need to be prepared for the remediation works: • Environmental Management Plan (EMP) • Site Management Plan, incorporating Landcom requirements • Construction Safety and Environmental Management Plan • Sub-contractor Site Specific Health and Safety Plans	Preparation of detailed, specific plans is considered appropriate.
EMP	Golder has prepared a draft EMP for management of environmental issues during the implementation of remediation works, including in the rail corridor. The EMP describes the following: • environmental management structure and responsibilities • approvals and licensing requirements • environmental training • emergency contacts • environmental management activities and controls (management plans) for: o critical habitat o soil o unexploded ordnance o air quality o fire o noise o conservation, spoil and waste o safety and hazards o onsite maintenance o community liaison • environmental incident response • monitoring and review, including a range of inspection schedules (initial, daily, weekly and post-remediation)	The level of detail provided and the issues covered in the EMP are considered adequate. The issues identified and management measures proposed in the EMP appear appropriate, although a detailed consideration of operational management issues is beyond the scope of this review.

Table 3.2 - Evaluation of Remedial Action Plan		
RAP Element	**Details**	**Auditor Comments**
Contingency Plans to Respond to site Incidents. RAP s15.6 EMP	As noted above, the EMP includes a section on Environmental Incident Response as well as stand alone appendices on Spill Control Procedure and Environmental Incident Management. The EMP includes forms for Environmental Incident Register, Environmental Incident Report and Environmental Incident Investigation. The RAP also states that emergency response measures are to be detailed in Site Specific Health and Safety Plans.	The level of detail provided and the issues covered in the EMP appear adequate.
Contingency Plan if Selected Remedial Strategy Fails	None specifically discussed in the RAP.	Remedial options considered could be implemented as alternatives. Cap and contain remediation not likely to fail since proven methodology. 100% UXO search has limited depth penetration (0.3m), therefore implementation of an unexpected finds protocol (UFP) during redevelopment earthworks is recommended to account for any deeper buried items that may be unearthed.

Table 3.2 - Evaluation of Remedial Action Plan

RAP Element	Details	Auditor Comments
Remediation Schedule RAP s6.1 RAP s12.13	A staged remediation schedule is proposed to coincide with the development schedule, as follows: **Stage 1** Development of RRZW, commencement of filling in the proposed town centre, excavation of lead particulate from the access roadway in the RZNRA and construction works within the proposed rail corridor. **Stage 2** Progressive development of the RZNRA and town centre area. **Stage 3** Establishment of the conservation zone The RAP states that "The timing and scheduling of the individual stages is subject to approvals and discussions with relevant approval bodies". The RAP requires the following with respect to the proposed staging of works: • "Prior to filling works or development of areas, a Site Audit Statement (SAS) will be required. • To facilitate the provision of a SAS for discrete areas, remediation works should be carried out where possible along existing lot and DP boundaries or proposed boundaries… • The sequence of staged UXO/SAA clearance and validation will consider compatibility with adjacent unremediated areas, landuses and potential for recontamination. • Prior to the commencement of remedial works a more detailed remediation and validation schedule should be prepared by the environmental consultant and provided to the SA [Site Auditor] for approval."	The identified controls around staging of works are considered appropriate. The timeframe for remediation is not specified.
Hours of Operation EMP	Hours of operation are specified in the EMP.	Adequate information provided
Licence and Approvals RAP s17	Discussed in the RAP, as outlined in Section 7 of this Interim Advice.	The licences and approvals identified appear appropriate, although the Auditor has not performed a detailed review of environmental planning requirements or requirements for disposal of specialised wastes (from UXO/ SAA clearance).

Table 3.2 - Evaluation of Remedial Action Plan

RAP Element	Details	Auditor Comments
Contacts/ Community Relations EMP	Community liaison is addressed in the EMP. The EMP includes a complaints register and a complaints hotline will reportedly be established.	Adequate information provided
Validation Reporting/ Staged Progress Reporting RAP s14.4	Validation reporting is discussed in the RAP (s14.4). Reporting is proposed in accordance with EPA (1997) 'Guidelines for Consultants Reporting on Contaminated Sites'. Staged UXO/SAA clearance certification and validation reporting is proposed to facilitate staged Auditor sign-off (s14.4, s6.1).	Considered appropriate.
Long term site management plan RAP s12.12 RAP s15, 15.8 RAP s17.5 SMP	A long term Site Management Plan (SMP) will be required for AOC 3, 4 and 5. Golder has prepared a draft SMP, discussed in Section 4.1 of this Interim Advice.	Refer Table 4.1 for SMP comments. In addition to the SMP, it is recommended that a UFP be implemented during redevelopment earthworks at RZNRA, discussed in Section 4.2.

Table 3.3 - Summary of Proposed Validation Testing

Area of Concern	Validation Item	Proposed Sampling	Proposed Analytes
General	Backfill pits/excavations with imported fill (VENM or ENM), or use in landscaping (topsoil) VENM as defined in POEO Act 1997 ENM as defined in NSW DECCW ENM Exemption (2009) Topsoil in accordance with NPWS requirements	Pre acceptance (by the environmental consultant and site auditor) and evaluation of all imported materials will be undertaken, including review of source site, historical land use, results of sampling and analysis (prior to importation) Additional sampling will be undertaken at 1/250m^3 or 1 sample per source/ batch (whichever is greater)	TPH, BTEX, PAH, metals, Selected samples for OCP, OPP, PCB and asbestos
	Backfill pits/ excavations with on site soils (VENM)	Inspect source area for obvious signs of contamination Review existing data Additional sampling at 1/250m^3	TPH, BTEX, PAH, metals and OCP

Table 3.3 - Summary of Proposed Validation Testing

Area of Concern	Validation Item	Proposed Sampling	Proposed Analytes
	Backfill pits/ excavations with "clean" stockpile soils	Inspect source area for obvious signs of contamination Review existing data Additional sampling at 1/stockpile	Asbestos, TPH, BTEX, PAH, metals and OCP
	Groundwater	Sampling of groundwater before and after remediation. Method as per detailed site investigation.	Analytes as per detailed site investigation.
Waste Disposal West, SP13, stockpiles with building waste	Validation of disposal area/ stockpile footprints	Minimum 1/100m^2	Metals, TPH, BTEX, PAH and asbestos
SP6	Validation sampling of stockpile footprint	One sample	Metals, TPH, BTEX, PAH and asbestos
Coal stockpiles	Validation sampling of stockpile footprint	3 samples per stockpile	Metals, TPH, BTEX, PAH and asbestos
Other stockpiles	Validation sampling of stockpile footprints if evidence of contamination (visual/ olfactory)	Minimum one sample	Metals, TPH, BTEX, PAH and asbestos
AOC 4	Validation sampling of excavation faces (walls and base)	10m grid	Lead
AOC 5	Validation sampling of excavation faces (walls and base)	10m grid	Asbestos
AOC 6	Delineation sampling	Test pits or boreholes on 5-10m grid Soil samples at near surface and depth intervals to maximum 1mBGL	TPH and BTEX
	Validation sampling of excavation faces (walls and base)	5m grid	TPH and BTEX
AOC 7	Validation sampling of excavation faces (walls and base)	10m grid	All - metals, TPH, BTEX, PAH and asbestos 1/6 – OCP, PCB

3.4 Conclusion

Overall, it is considered that the remediation approach recommended by Golder is appropriate. Contamination issues raised within the previous Interim Advice letters have been addressed by the RAP. The EMP for the operations phase has been reviewed at a high level and appears to cover the required items. The RAP identifies the need for Auditor review of a Construction Safety and Environmental Management Plan, however, this is not essential for completion of the audit. The long term SMP, for ongoing management of the conservation zone after remediation, has been reviewed and is discussed in the following section.

4 Ongoing Site Management

4.1 Conservation Zone SMP

A long term Site Management Plan (SMP) will be required for AOC 3, 4 and 5. Golder has prepared a draft SMP to cover the relevant areas, which occupy the proposed Conservation Zone (CZSRA). The SMP has been prepared in draft form for consideration at this stage. I note that the final SMP needs to reflect the post-remediation condition of the site, therefore the SMP will not be able to be finalised until after completion of the remedial works.

The Auditor has assessed the draft SMP by considering the requirements for EMPs in DEC (2006) 'Contaminated Sites: Guidelines for the NSW Site Auditor Scheme (2nd Ed.)'. Table 4.1 presents the Auditor's evaluation of the draft SMP.

Table 4.1: Evaluation of Draft SMP

SMP Item	Details	Auditor Comments
Site Specific stand alone document s1.1, 1.2	The SMP is a stand alone document. The legal property description and a site plan are provided. Summary background information is provided.	The information provided and level of detail is considered appropriate for the purpose of the SMP.
Plan Objectives s1, 1.3	The purpose of the SMP is identified as *"…to manage the potential human health and environment risks associated with the encapsulation structure and unexpected finds within the future Regional Park"*. The objectives of the SMP are identified as: • *Inform the Site users including contractors, owners and occupiers about the Site conditions;* • *Supplement the National Parks and Wildlife Services (NPWS) plan for the management of the Edmondson Regional Park;* • *Describe control mechanisms for the management of known and potential*	The purpose and objectives of the SMP are considered appropriate.

Table 4.1: Evaluation of Draft SMP

SMP Item	Details	Auditor Comments
	human health and environmental impacts; and • *Outline responsibilities for implementing the SMP.*	
Responsibilities s3	The RAP and the SMP identify the overall responsibility for implementation of environmental control measures to be with the site owner, who will be the National Parks and Wildlife Services (NPWS), a division of the NSW Department of Environment, Climate Change and Water (DECCW). The SMP outlines the environmental management structure and responsibilities. Roles identified include: • Site owner (DECCW NPWS division) • Environmental management representative (EMR) • Site contractors • NPWS environmental personnel/ environmental consultant The SMP will be incorporated into the NPWS management plan for the larger Regional Park.	The roles and responsibilities identified are considered appropriate.
When does the SMP apply?	The SMP will be finalised at the completion of remediation.	The SMP will apply from the completion of remediation.
Contamination Issues s1.1, 1,3 s2	A summary of the contamination issues are provided in the SMP. The RAP notes that the final SMP will include a summary of the remediation undertaken and the final site status with respect to contamination. A brief discussion of potential risks is provided.	The level of detail provided to describe the contamination issues is considered adequate. Further discussion on human health exposure pathways and potential toxic/ health effects of lead and asbestos is recommended for the final SMP.
Off-site migration	The SMP does not address the potential risk of off-site migration of contamination.	The Auditor has considered this in Section 5, below.
Extent of Capping and Specification of the Cap s4.1	The extent of the capped areas will be identified in the final SMP on Figures and by coordinates. The cap is specified as follows: *"The encapsulation structure is required to maintain a minimum cap thickness of 0.6m*	Detail of cap extent and cap specification is considered adequate.

Table 4.1: Evaluation of Draft SMP

SMP Item	Details	Auditor Comments
	made up of 0.4m of clay and 0.2m of growing medium other than in the vicinity of the ACM buried waste where a minimum total cover to be maintained is 1.0m which can include lead particulate impacted material up to base of the cap".	
Management Measures s4.1	The SMP identifies the following management measures for the capped area (encapsulation structure) • Maintain cap • Maintain shallow rooted vegetation cover • Erect warning signs • Control of excavations.	The cap management measures are considered appropriate.
s5.3.1	Maintenance essentially comprises corrective action in response to annual inspection (see below). In addition, the capping system is required to be reinstated in the event that any works are undertaken that cause damage to the cap.	The corrective action process and identified timeframes are considered appropriate.
s4.2.1	An annual inspection process is described, focussing on the capped area, with checklist items identified to supplement the annual inspection included in the NPWS plan of management for the Edmondson Regional Park (the Conservation Zone).	The inspection frequency and checklist items are considered appropriate.
s4.3, 4.4, 4.5, 4.6	Other management measures outlined, that apply to the whole of the Conservation Zone, include: • Work assessment and planning process, requiring review by the EMR and preparation of a task specific SMP for all work in the Conservation Zone, including vegetation clearing. This includes requirements for UXO and asbestos clearance to protect workers • Management of unexpected finds • Opportunistic clearance of UXO and SAA where events such as bushfires, 'back-burning' or construction activities for the establishment of the Regional Park lead to the thinning or clearing of vegetation.	The additional management measures are considered appropriate.
Records, audit and review s4.2.2, 4.2.3, 4.6	The SMP requires records to be kept such as records of inspection, documentation of any areas subject to opportunistic UXO/ SAA clearance, site induction and training and any	Template forms such as registers, incident reports and checklists are required in the final SMP.

Table 4.1: Evaluation of Draft SMP		
SMP Item	**Details**	**Auditor Comments**
s5.1, 5.3	corrective action requests and follow up actions. Audits of implementation of the SMP are proposed every two years, with findings to be documented in an Environmental Compliance Report. Review of the SMP is proposed on an annual basis following reporting on the annual inspection process. Management considerations are also to be reviewed on an ongoing basis.	
Compliant with Relevant Documentation? s3.1.1	The SMP notes the need for further consultation to confirm who is responsible for approving the SMP and to confirm the standing for the SMP in relation to the NPWS management plan for the Regional Park.	The need for further clarification is noted.
Occupational Health and Safety (OH&S) s4.5.5, 4.5.6	The SMP states that: *"All contractors and consultants working on the Site should design and implement appropriate work practices to protect the health and safety of Site workers and the general public during Site works. Managers, contractors and subcontractors who work on the Site remain responsible for all health and safety issues associated with their activities. An Occupational Health & Safety Plan should be prepared for works on the Site with the involvement of an environmental consultant. The plan should consider potential risks posed by the known contaminants".* Outline contents of the required OH&S plans are provided in the SMP. Minimum personnel protective equipment (PPE) requirements are outlined in the event of intrusive works.	The identified responsibilities and level of detail with respect to occupational health and safety are considered adequate.
Public notification mechanisms s3.1.1	The SMP states that *"The existence of this document will be required to be noted within Liverpool City Council (Council) Section 149 (2) Planning Certificate data base issued under the Environmental Planning and Assessment Act (EP&A). In addition consideration should be given to a similar notation within the dial before you dig underground asset database to alert potential utility and service providers"*.	Given the location of the capped area within a managed regional park, on-selling of the site is not likely and the proposed public notification is considered adequate.
Will be or can reasonably be made to be legally	The SMP notes the need for further consultation to confirm an appropriate mechanism to document the SMP and management requirements and to confirm the standing of the	The need for further clarification regarding enforceability is noted. If the SMP is included in the

Table 4.1: Evaluation of Draft SMP		
SMP Item	**Details**	**Auditor Comments**
enforceable? s3.1.1	SMP in relation to the management plan for the Regional Park.	management plan for the Regional Park it is likely it would be enforceable.
Are the Council in agreement with the SMP? s3.1.1	The SMP notes the need for further consultation to confirm who has overall responsibility to approve the SMP.	The need for further clarification regarding approval responsibility is noted.

For future review of the final SMP and to allow endorsement by the Auditor, the appropriate conditions for the implementation of an EMP stated under Section 3.4.6 of DEC (2006) 'Contaminated Sites: Guidelines for the NSW Site Auditor Scheme (2nd Ed.)' will need to be met, namely:

a. The EMP has been reviewed by the Auditor
b. The provisions of the EMP can reasonably be made to be legally enforceable
c. There will be appropriate public notification of any restrictions applying to the site
d. The remnant contamination is not considered to pose an unacceptable risk to onsite or offsite environments.

Based on the review documented above, the Auditor considers that the Draft SMP is likely to provide an adequate framework for the management of the remnant contamination issues in the conservation zone, although further review of the Final SMP following site remediation and verification of the above items is required to confirm this.

4.2 Residential Zone Redevelopment

Since the 100% UXO/ SAA search has limited depth penetration (0.3m), there is potential for items buried at greater depth to remain undetected. The site is not understood to have undergone any broad scale modifications that might have resulted in burial of UXO/ SAA, however, burial pits and trenches are present. There is potential for deeper buried items to be uncovered during earthworks to prepare the RZNRA area for residential, commercial or parkland development. It is recommended that an unexpected finds protocol (UFP) be implemented during these works to ensure appropriate identification and management of any such items.

5 Contamination Migration Potential

In the long term, remedial works would further reduce the already low potential for off-site migration discussed in Interim Advice #3. In the short-term, however, there would be a higher potential for off-site migration due to high activity levels and disturbance of the site during remediation works. As such, an EMP is required to control environment impacts during the remediation works. The Auditor has provided comments on the EMP in Table 3.2.

6 Assessment of Risk

Based on assessment of results against relevant guidelines and consideration of the overall investigation and proposed remediation, the Auditor provides the following assessment of risk.

6.1 Munitions

The following are identified as the risks associated with the site in its current state:

- The risk of live UXO being encountered on site is very low. There has been no known usage at the site and none has been found to date during the course of extensive investigations reviewed during the course of this audit. However, it is understood that one item was found during recent UXO clearance works in the Rail Corridor (not reviewed) indicating that the risk of such finds is not negligible.
- The risk of live ball ammunition being encountered on site is very low. There has been no known usage at the site and none has been found to date during the course of extensive investigations. According to Golder (RAP, Section 9.7.3), it is possible that former land owners, community members or off duty soldiers with access to the site may have used live rounds over the sites history.
- There is a moderate risk of additional 'unexpected' inert grenade or mortar impacts to be present in general areas of the site. These items are difficult to locate due to the lack of fragmentation 'signature'. While these practice items do not present an explosive hazard, their discovery on site could be alarming to any future workers or occupants. There is a higher risk of such 'unexpected' impacts to be present in areas of the site that have not previously been accessed.
- Blank expended ammunition is present on site at an estimated 700 items/ha in high intensity usage training areas and 250 items/ha in remaining areas of the site. While presenting no explosive hazard, the discovery of expended blank SAA could be alarming to site workers or occupants.
- The proportional occurrence of live blank SAA has been estimated at between 2 and 10% however a lesser proportion than this has actually been found on site. Live blank ammunition can cause injury, particularly eye damage, if detonated through tampering.

The proposed 100% UXO/ SAA search in the proposed residential area (AOC 2) and implementation of a UFP during redevelopment earthworks will reduce the likelihood of encountering the above items to minimal levels, and will reduce the associated risks to minimal levels.

The proposed visual clearance for UXO/ SAA in the proposed conservation zone (AOC 3) will reduce the likelihood of encountering the above items to low levels, and will reduce the associated risks to low levels. Implementation of site management controls via an EMP is required for this area to reduce the associated risks to minimal levels.

6.2 Soil and Groundwater

- Remediation action is proposed to address the identified low levels of soil contamination and physical waste materials including asbestos in a number of areas of

the site where contamination detections were largely expected. The proposed remediation works will reduce the associated risks to human health and the environment under the proposed residential or conservation land use to minimal levels.

- There is considered to be a very low risk of undetected soil contamination being present in general areas of the site outside of the known areas of contamination.
- Groundwater investigations have identified possible minor contamination by heavy metals in the vicinity of the small arms firing range. The majority of heavy metals exceedances detected at the site are considered to be representative of background conditions within the shale bedrock. The Auditor considers the risk to human health or the surrounding environment due to groundwater contamination is currently very low and would be reduced further by the proposed remediation measures.

7 Compliance with Regulatory Guidelines and Directions

The Auditor has used guidelines currently approved by the EPA under section 105 of the NSW Contaminated Land Management Act 1997 in reviewing the RAP. As discussed in Section 3, the RAP is generally in accordance with the EPA (1997) 'Guidelines for Consultants Reporting on Contaminated Sites'.

The regulatory approvals and licences identified in the RAP (RAP s17) as relevant to the proposed remediation are as follows:

- Section 91 Licence under the *Threatened Species Conservation Act 1995* from Department of Environment, Climate Change and Water (DECCW) is required for vegetation clearance aspects of remediation in the conservation zone.
- State Environmental Planning Policy 55 (SEPP 55). Remediation is assessed by Golder to be Category 1 since the works are proposed on land identified as critical habitat under the *Threatened Species Conservation Act 1995*.
- Handling and disposal of any ACM is required in accordance with requirements of WorkCover NSW.
- Any waste generated during remediation works which is to be disposed offsite (including liquid wastes such as accumulated surface water) will be classified in accordance with the DECC (2009) 'Waste Classification Guidelines'. Coal may be disposed offsite in accordance with the Natural Immobilisation Approval Number 1999/05 for Coal and Ash impacted material.
- Imported fill will be assessed as VENM as defined in *Protection of the Environment Operations Act 1997* or as ENM as defined in NSW DECCW ENM Exemption (2009).
- Management of waste from the UXO/ SAA clearance works is identified as follows:
  - any live ordnance found would be handed over to the appropriate authorities (Department of Defence personnel)
  - all Free From Explosive (FFE) and Explosive Ordnance Waste (EOW) would be appropriately disposed by the UXO clearance contractor.

The EMP includes a further discussion relating to environmental approvals and licensing requirements for the works. As these largely relate to environmental planning issues, the Auditor has not reviewed these requirements in detail.

8 Conclusions and Recommendations

Golder has prepared a Remediation Action Plan (RAP) outlining works required to make the site suitable for the proposed residential and conservation land uses. Seven primary Areas of Concern (AOC) requiring remediation are identified, as well as action relating to stockpiles on site and areas not previously assessed due to the presence of blackberry infestations.

The Auditor has assessed the proposed remedial action for each issue for its suitability, and overall, it is considered that the remediation approach recommended by Golder is appropriate. The Auditor has assessed the RAP by comparison with the checklist included in EPA (1997) 'Guidelines for Consultants Reporting on Contaminated Sites'. The RAP was found to adequately address the required information.

Prior to commencement of remediation, preparation of technical specifications and plans controlling the remedial works are required. The Auditor has reviewed at a high level an Environmental Management Plan (EMP) to be implemented during remediation and it was found to cover the required items. The RAP identifies the need for Auditor review of a Construction Safety and Environmental Management Plan, however, this is not essential for completion of the audit.

Following remediation, ongoing management of the Conservation Zone will be required under a long term Site Management Plan (SMP). The Auditor has reviewed a draft SMP, which will need to be finalised after completion of the remedial works so it can reflect the post-remediation condition of the site. The Auditor considers that the Draft SMP is likely to provide an adequate framework for the management of the remnant contamination issues in the conservation zone, although further review of the Final SMP following site remediation, and clarification of some items will be required to confirm this.

Following remediation, and during redevelopment earthworks in the RZNRA area, it is recommended that an unexpected finds protocol (UFP) be implemented to allow for appropriate identification and management of any deeper buried UXO/ SAA items that may be uncovered.

The Auditor is satisfied that the proposed remediation described in the RAP will be able to make the site suitable for the proposed residential and conservation land uses. Of critical importance will be the successful implementation of the SMP for ongoing site management in the Conservation Zone.

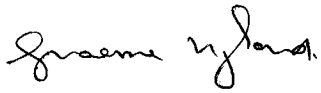
* * *

Consistent with Department of Environment, Climate Change and Water (DECCW and formerly NSW EPA) requirements for staged "signoff" of sites that are the subject of progressive assessment, remediation and validation, I advise that:

- This advice letter does not constitute a Site Audit Report or Site Audit Statement.
- At the completion of the remediation and validation I will provide a Site Audit Statement and supporting documentation.
- This interim advice will be documented in the Site Audit Report.

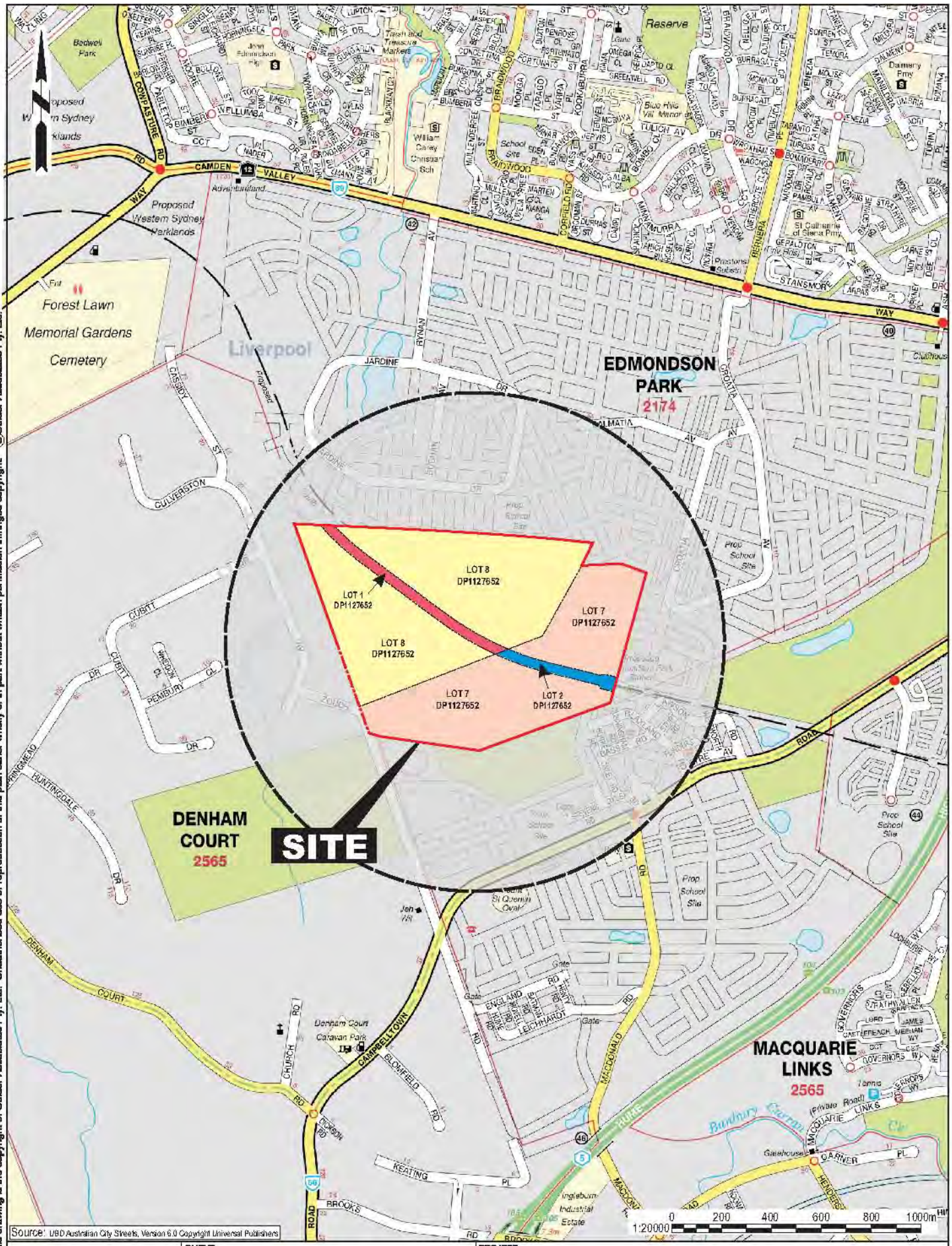
Please do not hesitate to contact the undersigned or Rowena Salmon if you have any questions or comments regarding the above.

Yours faithfully
ENVIRON Australia Pty Ltd



Graeme Nyland
EPA Accredited Site Auditor 9808

Enc:
Attachment 1 Lot Layout
Attachment 2 Proposed Development Layout
Attachment 3 Site Features and Remediation Areas



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Golder Associates www.golder.com GOLDER ASSOCIATES PTY LTD	CLIENT: LANDCOM		PROJECT: REMEDIATION ACTION PLAN - ZOUCH ROAD, EDMONDSON PARK					
	DRAWN: HC	DATE: 20.04.2010	TITLE: SITE LOCALITY PLAN					
	CHECKED: GJF	DATE: 27.08.2010						
	SCALE: 1:20,000 A4		PROJECT No: 107623047	DOC No: 001	DOC TYPE: R	FIGURE No: F0001	REV No: 0	FIGURE 1

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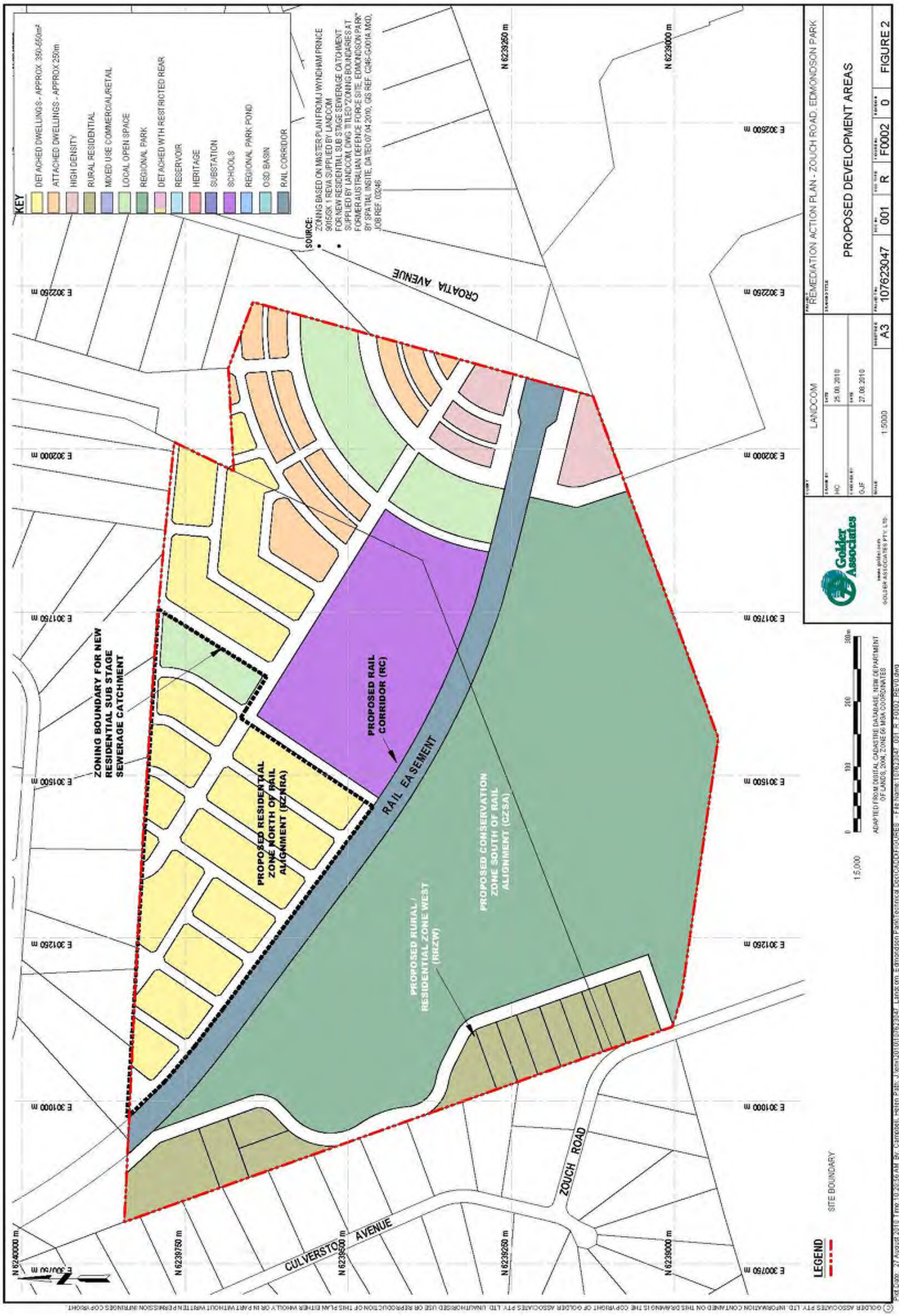
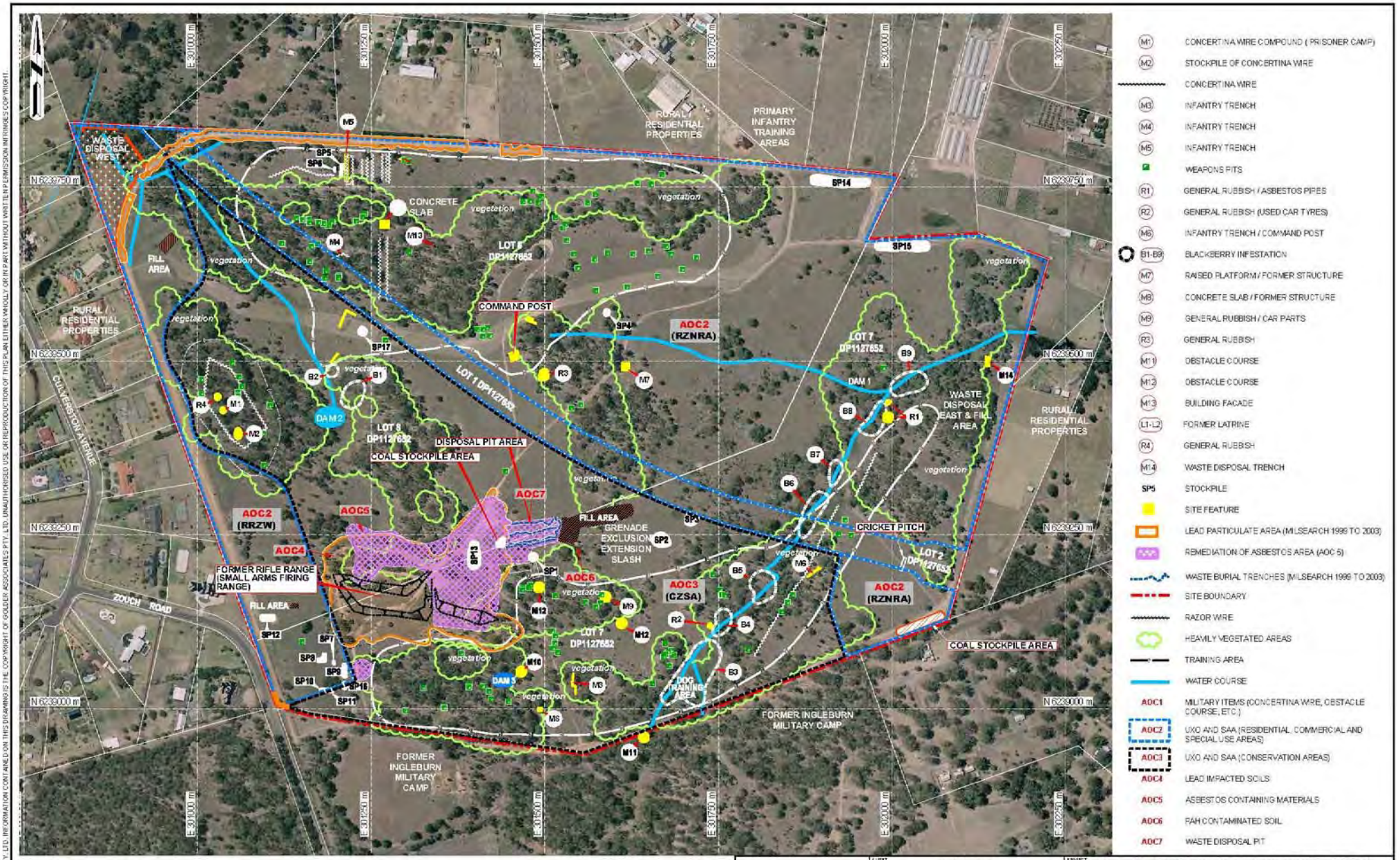
Attachment 2 Proposed Development Layout





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SOURCE: AERIAL PHOTOGRAPH SUPPLIED BY LANDCOM

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CLIENT	LANDCOM	PROJECT	REMEDIATION ACTION PLAN - ZOUCH ROAD, EDMONDSON PARK
DRAWN BY	HC	DATE	22.04.2010
CHECKED BY	GJF	DATE	24.02.2011
SCALE	1:5000	PAPER SIZE	A3
DRAWING TITLE	AREAS OF ENVIRONMENTAL CONCERN (AOC1 TO AOC7)		
PROJECT No.	107623047	DOC No.	001
DOC TYPE	R	FIGURE No.	F0005
REVISION	1		FIGURE 5

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Xref: GAP_LOGO-A3.dwg; m630162389010S-Edmondson-Park (1)_24595.png;

Attachment 3 Site Features and Remediation Areas

Appendix I: "Urban Growth, Public Open Space, Site Environmental Management Plan, Residential Zone North of Rail Alignment, Zouch Road, Edmondson Park, NSW". 2 September 2013, JBS&G (NSW & WA) Pty Ltd

UrbanGrowth NSW
Public Open Space
Site Environmental Management Plan

Residential Zone North of Rail Alignment
Zouch Road, Edmondson Park, NSW

2 September 2013
41945 – 55351 (Rev 0)
JBS&G

www.jbsg.com.au

UrbanGrowth NSW
Public Open Space
Site Environmental Management Plan

Residential Zone North of Rail Alignment
Zouch Road, Edmondson Park, NSW

2 September 2013
41945 – 55351 (Rev 0)
JBS&G

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Appendices

Appendix A: Examples of Types of UXO/SAA/EOW

Appendix B: Edmondson Park Conservation Agreement Plan

List of Abbreviations

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

ACM	Asbestos Containing Material
Contact	A metallic object of military firearm origin, greater than 25 mm in length
DPI	NSW Department of Planning and Infrastructure
DP	Deposited Plan
EMP	Environmental Management Plan
EOW	Explosive Ordnance Waste
EPA	New South Wales Environment Protection Authority
FFE	Free From Explosives
ha	Hectare
NEPM	National Environmental Protection (Assessment of Site Contamination) Measure
OEH	Office of Environment and Heritage
QA/QC	Quality Assurance/Quality Control
RAP	Remediation Action Plan
RZNRA	Residential Zone North Rail Alignment
SA	Site Auditor
SAA	Small Arms Ammunition
SAQP	Sampling Analysis Quality Plan
SAR	Site Audit Report
SAS	Site Audit Statement
SEPP	State Environmental Planning Policy
SEMP	Site Environmental Management Plan
UXO	Unexploded Ordnance

1 Introduction

1.1 Background

JBS&G (NSW & WA) Pty Ltd (JBS&G) was engaged by UrbanGrowth NSW to act as remediation consultant during redevelopment of the land known as Landcom Project 12619 located at Zouch Road, Edmondson Park, NSW. The entire parcel is formally identified as part Lot 7 and Lot 8 DP1127652 as shown in **Figure 1**, noting that Lots 1 and 2 DP1127652 comprises a railway corridor that has been excluded from the contract. It is noted that the railway corridor has been remediated under a separate contract to facilitate construction of the South West Rail Link ahead of the Landcom site remediation timeframe.

For the purposes of the remediation contract, the project site has been divided into a number of development areas as shown in **Figure 2,** including a parcel of approximately 43 ha known as the Residential Zone North of the Railway Alignment (RZNRA) located in the northern portion of the project site. Previous remediation works within the RZNRA portion, as documented separately in JBS&G (2013[1]), concluded that the RZNRA site is suitable for the proposed residential use with accessible soils contingent upon application of a a site environmental management plan (SEMP) to address the residual potential for buried unexploded ordnance (UXO) and small arms ammunition (SAA) risks with the proposed local public open space areas of the RZNRA site. The extent of the proposed public open space areas are shown in **Figure 3**.

This document comprises a SEMP to address residual potential UXO/SAA concerns within the proposed public open space footprints following the completion of site remediation works.

1.2 SEMP Objectives and Purpose

This EMP provides procedures, controls and monitoring activities that will be implemented in an ongoing manner during development and use of the proposed public open space areas of the site to minimise the potential for unacceptable site exposure risks to current and future site users, occupants of surrounding properties and to the surrounding environment.

This EMP is in no way intended to replace or supersede existing or proposed open space operational management plans and/or work health and safety (WHS) plans for site maintenance personnel. This EMP should be considered as a supplement report to such documentation and targets issues unique to potential risks from potential residual concerns at the site.

[1] *Validation Report, Residential Zone North Rail Alignment, Landcom Project 12619, Zouch Road, Edmondson Park, NSW*. JBS&G, August 2013 (JBS&G 2013)

2 SEMP Implementation and Responsibilities

The SEMP will apply indefinitely during future Site operations as well as during any future Site development.

2.1 Site Identification

The Site details are summarised in **Table 2.1** and shown in **Figures 1, 2** and **3**. It is noted that this SEMP applies only to those proposed public open space areas as shown in **Figure 3** and also conservation areas as shown in the plan included as **Appendix B**.

Table 2.1 Summary Site Details

Lot/DP	Part Lot 7 and Lot 8 in DP1127652 (formerly Lot 1 in DP807460 and Lot 2 in DP807461)
Public Open Spaces Site Area	Total of approximately 4.6 ha (45 6640 m^3) for area shown in Figure 3
Local Government Authority:	Liverpool City Council
Current Zoning:	RE1 – Public Recreation (SEPP Major Projects 2005[2] as shown in LCC 2008) The area as shown in **Appendix B** is also the subject of a Conservation Agreement as discussed in section 2.3.
Previous use:	Former military training area and bushland
Current use:	Bushland
Proposed use:	Public open space

2.2 Summary of Historical Site Activities

The project site was part of an initial crown grant to Mr Henry Kitchen in 1819 and is likely that the area was part of broader agricultural/grazing holding until 1939 when the Department of Defence (DoD) occupied the project site and land extending to the south. During World War II a large army camp known as the Ingleburn Army Camp was built for infantry training purposes, with the land subsequently purchased by the Commonwealth of Australia in 1953. During the Korean War (1951 – 1954) and Vietnam War (1962 – 1975) periods training facilities including grenade throwing ranges, obstacle courses, war games infrastructure (command posts, field latrines, weapons pits, etc) and a rifle range were constructed within parts of the project site. Training in the use of grenades, small arms, etc is anticipated to have occurred across the whole of the project site.

During the mid to late 1980s the DoD ceased use of the project site and in 1989 ownership was transferred from the Commonwealth to the NSW Land and Housing Corporation (Landcom). It is understood that the land has been largely vacant since this period.

In 2011 Landcom sought NSW Government approval for a concept plan that would result in approximately 413 hectares, incorporating the project site and land to the south being developed for new residential uses; a new Edmondson Park town centre; and a regional parkland conservation zone. The concept plan approval, including provision for the completion of site remediation works to address contamination issues associated with historical DoD site use was granted on 18 August 2011 (PAC 2011[3]). Proposed land uses within various portions of the proposed project site are presented in **Figure 2**.

Remediation works completed in accordance with an approved RAP (Golder, 2005b[4] and updated as 2011[5]) comprised the removal from the RZNRA site of:

[2] State Environmental Planning Policy (Major Development) 2005, http://www.legislation.nsw.gov.au/maintop/view/inforce/epi+194+2005+cd+0+N

[3] *Concept Plan Approval, Edmondson Park MP10_0118.* The Planning and Assessment Commission (NSW), 18 August 2011 (PAC 2011)

[4] *Remediation Action Plan, Landcom Project No: 12619, Zouch Road, Edmondson Park, NSW*. Golder Associates Pty Ltd (Golder 2005b)

- residual military items, including concertina wire, star pickets, sheet metals, training pits, former building remnants, demolition waste, etc identified on the ground surface and in buried waste pits across the entire RZNRA site;
- instrument identified surface and subsurface SAA and UXO, including all free from explosive (FFE) and explosive ordnance waste (EOW) from the proposed future residential and commercial land portions of the RZNRA site;
- visually identified surface SAA and UXO from the current ground surface from within the proposed public open space portions of the site where vegetation retention requirements limited the scope of site clearance activities able to be achieved;
- lead particulate impacted soils previously used as fill material underlying a road in the north-west portion of the RZNRA site; and
- asbestos containing materials (ACM), including stockpiled former construction materials, an ACM impacted soil stockpile and buried ACM waste from the RZNRA site.

The remediation and associated validation assessment outcomes are documented separately as JBS&G (2013).

2.3 Site Status

The vegetation retention requirements for the proposed public open space areas located as shown in **Figure 3** resulted in clearance of the residual military items, including UXO/SAA, being limited to removal of visually identifiable items on the ground surface at the time of remediation works during 2012. This generally comprised removal of items of 25 mm or larger in size apparent on the ground surface when assessed by teams of qualified technicians completing survey methods using 1 m width transects within the vegetated areas.

Based on the remedial works observations completed across the broader RZNRA site, it is anticipated that there is a low to moderate potential for items remaining buried below the ground surface, or obscured by current vegetation, including parts of or whole mortar shells, parts of or whole grenades, trip flare components, rocket components, blanks and small arms ammunition cartridge case projectiles.

Given the adopted survey methods completed within the public open space areas, there is considered a low probability that residual former weapons pits and/or small waste burial pits may remain within these areas of the site. Such features may include buried timber, scrap metals, star pickets, camouflage netting, barbed wire, ACM and similar materials.

Future management of the proposed local open space areas and associated vegetation will require to be cognisant of the potential for such materials to remain below the current ground surface.

The SEMP applies to two areas as shown in **Figure 3**, comprising a local park in the central northern portion of the site and a vegetated riparian zone including the Maxwell's Creek tributary in the eastern section of the site. In addition to the Public Open Space zoning, the riparian zone corridor is also required to be managed for conservation objectives in accordance with the Edmondson Park Precinct Conservation Agreement[6]. The extent of the site falling within this classification is shown in the plan included in **Appendix B**.

[5] *Landcom Project 12619 – Zouch Road, Edmondson Park, NSW, Remediation Action Plan*. Golder Associates Pty Ltd (Golder 2011)
[6] Details of the Edmondson Park Precinct Conservation Agreement, including in force variations can be found at the Australian Government Department of Sustainability, Environment, Water, Population and Communities website: http://www.environment.gov.au/epbc/about/conservation-agreements.html

3 SEMP Implementation

3.1 Site Activities to which this SEMP Applies

This SEMP has been designed to ensure, via the implementation of a number of ongoing management measures, that:

- The risk to current and future proposed site users from subsurface buried items is appropriately managed; and
- Contingency actions are available to be implemented where potential risk to human users, site workers or ecological receptors occurs.

This SEMP will apply indefinitely. Should vegetation retention/management requirements cease to be applicable, such that site vegetation can be completely removed to complete a full instrumental UXO/SAA clearance, the requirements for removing the SEMP are provided as part of this document.

The requirements of the SEMP are intended to apply to all activities at the Site which could involve disturbance/penetration of the existing ground surface and so result in the potential exposure of site users, site workers and/or sensitive receptors to subsurface buried items of concern including UXO/SAA. These activities have been identified as, but are not limited to:

- Vehicle/plant movement within areas of the site;
- Placement, removal and/or movement of existing vegetation;
- Installation of infrastructure including drainage, fencing, lighting, signage, walkways/paths, etc associated with use as public open space;
- Amendment of existing surface treatments, including removal of weed and/or excessive vegetation growth and/or surface water management; or
- Geotechnical, environmental or any other subsurface investigations.

3.2 Key Stakeholders to whom this SEMP applies

This SEMP is intended to apply to a range of key site stakeholders who may be involved, or otherwise responsible for various site activities as outlined in **Table 2.1** below.

Table 2.1 Stakeholder Responsibilities

Stakeholder	Responsibilities
Land Owner or relevant appointed Site Manager	1. Inform the relevant planning and regulatory authorities, including but not limited to NSW Department of Planning and Liverpool City Council, of the existence of this SEMP. 2. Provide the SEMP to the current and future managers of the site. 3. Ensure that Site personnel or contractors that must conduct intrusive works at the site are provided a copy of and inducted into the SEMP and are aware of their responsibilities with regard to health and safety and protection of the environment. 4. Ensure the requirements of the SEMP are successfully implemented. 5. Provide management services as appropriate to address any reported finds of UXO or other materials. 6. Inform the Police of the discovery of any suspected UXO immediately and manage appropriate actions to ensure removal of the UXO, including site access during the period until the items are cleared. . 7. Maintain records and co-ordinate inspections as required to ensure the requirements of this SEMP are appropriately demonstrated.
Site Workers	1. Ensure operations and intrusive works on the site are conducted in accordance with the requirements of this SEMP and other relevant statutory requirements including current Work Health & Safety (WHS) legislation. 2. Ensure that any persons or sub-contractors, who are engaged on the site, are inducted into the SEMP and are aware of their responsibilities in relation to potential UXO/SAA or asbestos finds. 3. Promptly implement temporary management requirements in the event of a UXO or other material find and report the occurrence to the Land owner or the appointed site manager.
Liverpool City Council	As specified in Section 3.4.6 of the *Guidelines for the NSW Site Auditor Scheme* (2006), the responsibilities of council, in the future role of consent authority: a) Public notification of the existence of the SEMP on appropriate property records (i.e. planning certificates prepared for the site as created under s.149 of the Environmental Planning and Assessment Act 1979); and b) Enforcement of the SEMP as a condition in any future development consent for additions or alterations to the development that may involve disturbance of soil at the site.

4 Management Strategy / Procedures

Various management procedures as required to address site issues are discussed in detail in the following sections.

The procedures provided below are based on site conditions as discussed in **Section 1.2** and key stakeholder responsibilities as identified above.

4.1 Worker Training / Public Awareness Arrangements

The land owner, or relevant appointed site manager, will be responsible for the development of an appropriate induction/training package for all site workers, including public open space maintenance personnel, such that they have adequate skills to appropriately manage the situation should a suspected item of UXO/SAA be identified. The UXO awareness training should be developed by appropriately trained and experienced personnel such as a member of the Defence UXO Panel. It is anticipated that awareness training will include the use of photographs/videos etc of examples of types of UXO/SAA similar to that presented as **Appendix A** to this SEMP.

Records of induction/training should be maintained by the land owner/appointed manager for the period of implementation of the SEMP.

In addition, the land owner, or appointed site manager will implement appropriate public awareness arrangements reflective of potential land use scenarios to provide potential open space users with information such that suspected UXO/SAA finds are appropriately managed and reported by members of the public such that the site manager can appropriately manage removal of the items. The public awareness arrangements may include, but not necessary be limited to installation of public signage at public open space access points with pictorial examples of UXO/SAA similar to those presented in **Appendix A** of this SEMP.

4.2 Routine Daily Operations – Non-intrusive Works

Maintenance of the public open space areas should be completed in a manner so as to minimise the potential for erosion or other ground cover disturbance such that formerly buried materials may be exposed at the ground surface.

Minor works, involving activities such as litter removal, weeding and general maintenance do not require specific controls provided the minor works:

- Maintain the existing vegetation cover; and
- Prevent surface soil erosion.

In addition, site workers should maintain general surveillance of the ground surface for items of potential concern.

4.3 Non - Routine Operations – Intrusive Works

In the event that intrusive works are required to be completed that will disturb the ground cover or otherwise result in disturbance of the subsurface profile (ie. horizontal boring, installation of fencing, walkways/paths, infrastructure, lighting, vegetation clearance/planting activities, etc), the following management measures will be required to be implemented and associated documented retained by the site owner or appointed site manager for the duration of the EMP:

- Prior to any intrusive work commencing the appointed works manager will commission the services of an appropriately qualified and experienced UXO consultant to complete

a risk assessment and prepare a management strategy specific to the proposed disturbance works;

- Where the works will require the removal of vegetation such that an appropriate visual and instrumental clearance can be implemented, this should be completed and appropriate clearance documentation subsequently appended to this SEMP;
- Where the works will not include substantial vegetation clearance such that a UXO/SAA clearance cannot be completed, the following is anticipated to be required, dependent upon specific assessment by the UXO consultant:
    - Site worker(s) will be inducted by the UXO consultant with respect to the proposed works and associated risks prior to the commencement of works;
    - The Site Worker(s) must ensure that, where possible, only hand tools are used to minimise the potential risk of disturbance of suspected UXO/SAA; and
    - Surveillance for the presence of suspected UXO/SAA should be completed during site activities associated with disturbance and where identified, items should be managed in accordance with protocols established by the UXO consultant, with consideration to the requirements as discussed in the following section.

4.4 Emergency Preparedness and Response

The following procedure will be followed in the event that the suspected UXO/SAA are identified by site workers during daily operations or by site users who subsequently report the occurrence to the land owner and/or appointed site manager. This procedure should be considered by the appointed UXO consultant in preparation of management procedures for non-routine works.

Further information on the potential types of materials which may occur at the site is provided below:

Small Arms Ammunition (SAA)

SAA comprises ammunition used for hand weapons including rifles, shot guns, hand guns etc with a diameter of less than 20 mm in calibre. Two types of SAA have typically been identified at the site:

- blanks, normally made of plastic or brass without a projectile and with a crimped end; and
- 'live' SAA made of brass, with an obvious projectile in the end, or projectile fragments.

Once fired, 'live' SAA has an open end to the case and the corresponding projectile, or associated fragments of projectiles. Neither fired blanks, nor fired projectiles or their associated casing represent a potential risk if identified in-situ.

Unfired 'live' or blank SAA does not represent a potential risk provided that the items are not inappropriately handled (placed over a heat source, cut open, crushed, or via striking the percussion cap with a sharp object).

Examples of SAA images are included in **Appendix A**.

Unexploded Ordnance (UXO)

UXO comprises all items which previously contained explosives, fission and fusion materials and chemical and biological agents. Basically UXO comprises all items that contain explosives other than SAA. Based on historical information of site activities, the following types of UXO may potentially occur at the site: mortar shells, hand grenades, flares (smoke or illumination), mines, etc. If identified, suspected UXO should be left untouched in situ and handled only by trained personnel.

Images of examples of UXO are included in **Appendix A**.

Explosive Ordnance Waste (EOW)

EOW comprises inert material remnant from the initiation or functioning of UXO. EOW is anticipated to include the remnants of exploded bombs, mortars, grenades, flares, mines, munitions packaging, etc.

As per the SAA, EOW having already been fired does not typically pose a threat if uncovered, however it is recommended that material be left in situ and handled only by trained personnel.

Images of examples of UXO are included in **Appendix A**.

Further information is also available from the Department of Defence via www.defence.gov.au/uxo/.

4.4.1 Site Identification of UXO

Where suspected items of UXO are identified by site workers, the find should be managed as per the following:

- The surrounding area should be immediately evacuated of all workers to a distance of at least 50 m and where possible, the area isolated from members of the public.
- The Police should be contacted as soon as practicable via the emergency services number, 000, to report the find's location. Details of the location, a description of the shape, colour, material and approximate dimensions of the item should be provided where possible (without touching the item).
- Contact the site owner and/or appointed manager to report the location of the find and provide a Police reference number.
- The Police will arrange for appropriately trained military explosives personnel to attend site and remove it.
- Works should not recommence until such time as the Police or defence personnel have provided the all clear to return to the area.

Following the occurrence, records of the nature of the UXO and location, and actions taken, should be maintained by the site owner/appointed manager.

Where suspected items of UXO are identified by members of the public, the Police should be notified as soon as practicable via 000. The suspected UXO item(s) should not be touched and the public should move well away (at least 50 m) from the object. It is anticipated that the Police will establish a safe exclusion zone and arrange for the removal of the items in liaison with the site owner/appointed manager.

4.4.2 Site Identification of SAA and EOW Waste

The vast majority of items removed during RZNRA remediation works comprised SAA/EOW waste. Given the low potential risk associated with these items, the location should be recorded upon identification and reported to the site owner/appointed manager. The items should then be removed by an appropriately qualified contractor at intervals as appropriate with respect to the frequency of finds. In the event that a large find (ie. box of buried SAA is identified), or where there is uncertainty as to whether the item comprises SAA/EOW or UXO, the items should be assumed to be UXO and treated as such.

4.5 Revision of the SEMP

Dependent upon site activities and the conditions of the Public Open Space, it may, from time to time, be necessary to revise the SEMP to reflect corrective actions, changes to

legislation, changes of ownership/management and/or changes on site. Revision of the SEMP should be undertaken by an appropriately qualified and experienced environmental consultant. Copies of the revised SEMP should be provided to the site auditor for approval prior to distribution to current stakeholders in the Site for ongoing implementation.

5 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.

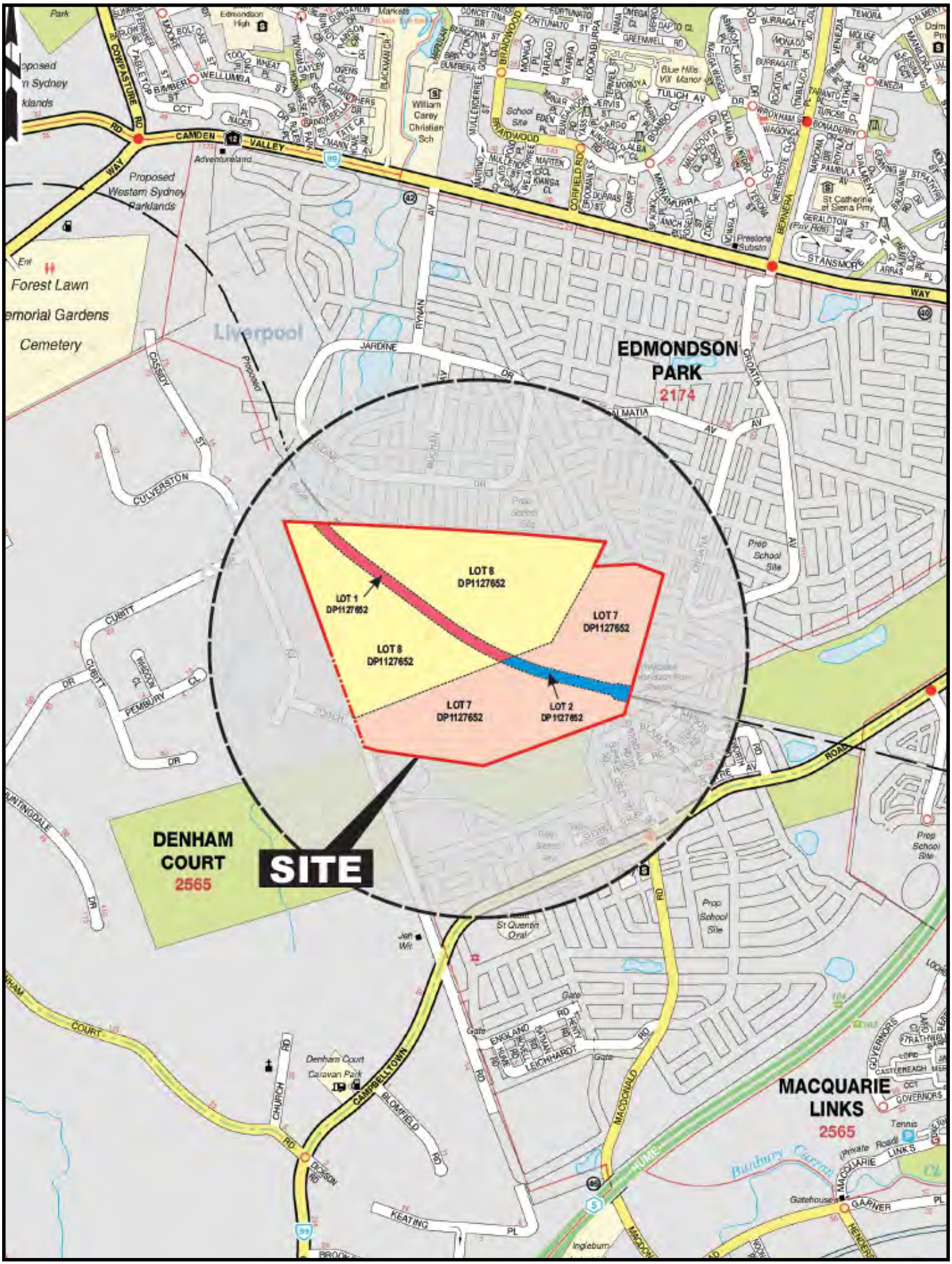
The advice herein relates only to this project and all results conclusions and recommendations made should be reviewed by a competent person with experience in environmental investigations, before being used for any other purpose. This report should not be reproduced without prior approval by the client, 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: © Golder Associates Pty Ltd, Project No 107623047, Doc No 001, Figure No F0001, Rev No 0, 27-08-2010

© 2013 JBS&G

0 200 400 800 m

Scale: Approximate

Datum: MGA94 Zone 56 - AHD

Legend:
Approximate Site Boundary

Rev	Description	Drn.	Date
A4			
A	Original Issue - R05	SE	20-08-2013

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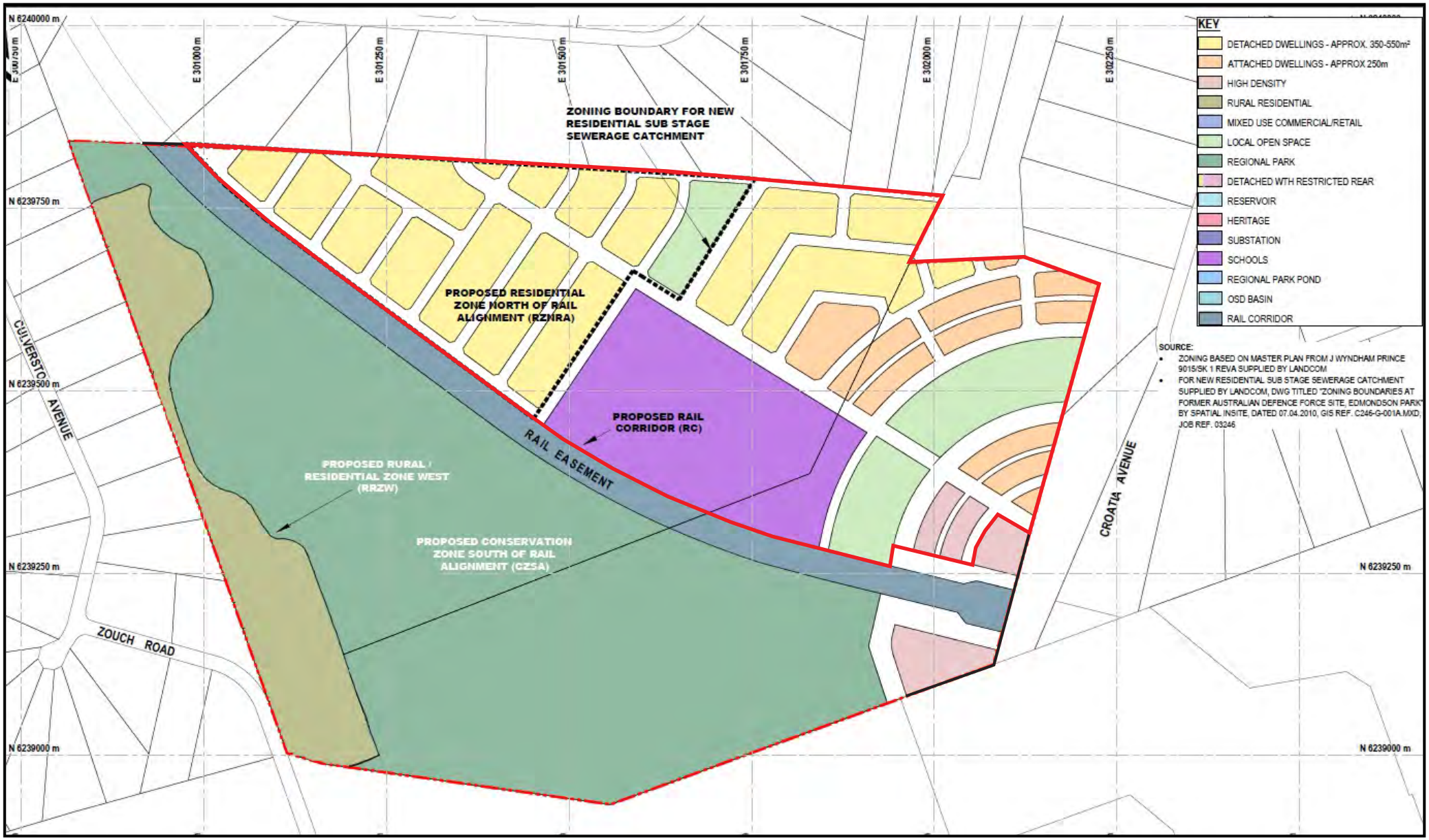
Figure 1: Site Location and Current Cadastral Boundaries

Client: UrbanGrowth NSW

Project: Edmondson Park, Local Open Space SEMP

Job No: 41945 File Name: 41945_01



Source: Base Image - © Golder Associates Pty Ltd, Project No 107623047, Doc No 001, Figure No F0002, Rev No 0, 27-08-2010

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0 75 150 300 m

Scale: Approximate

Datum: MGA94 Zone 56 - AHD

Rev	Description	Drn.	Date
A4			
A	Original Issue - R05	SE	20-08-2013

Legend:

- Approximate Site Boundary (RZNRA)

JBS ENVIRONMENTAL

Figure 2: Proposed Site Layout and Development Areas

Client: UrbanGrowth NSW

Project: Edmondson Park, Local Open Space SEMP

Job No: 41945 File Name: 41945_02

Source: Base Image - © NearMap 23-10-2011

© 2013 JBS&G

0 50 100 200 m

Scale: 1:5,000

Datum: GDA 1994 MGA Zone 56 - AHD

Rev	Description	Drn.	Date:
A4			
A	Original Issue - R05	SE	20-08-2013

Legend:

- Approximate RZNRA Boundary
- Public Open Space Area

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Figure 3: Local Open Space Locations

Client: UrbanGrowth NSW

Project: Edmondson Park, Local Open Space SEMP

Job No: 41945 File Name: 41945_03

Appendix A: Examples of UXO / EOW / SAA

SAA Examples

Plastic Blank Casing

Lead Shell Tip

2 PR Artillery Shell

18 PR Artillery Shell

EOW Examples

Examples of EOW (grenade, mortar etc components) removed from the Edmondson Park Site During Works

UXO Examples

No. 69 Grenade

36M Grenades

Uncovered 36M Grenade

Range of 60 mm Unfired Mortars

2" Mortar Shells

105 mm Howitzer Artillery Shell

Retreived 81mm M43 Mortar

Source: G-Tek 2013 and www.defence.gov.au/uxo

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Datum: MGA94 Zone 56 - AHD

Rev	Description	Drn.	Date
A4			
A	Original Issue - R05	JR	20-08-2013

Abbreviations:
UXO - Unexploded Ordinance
EOW - Explosive Ordinance Waste
SAA - Small Arms Ammunition

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Appendix A: Examples of Various Types of UXO/EOW/SAA

Client: UrbanGrowth NSW

Project: Edmondson Park, Local Open Space SEMP

Job No: 41945 File Name: 41945_AppA

Appendix B: Edmondson Park Precinct Conservation Area Extent

Edmondson Park Precinct

Edmondson Park Precinct

Land Use

- Regional Park (1)
- Open Space Private (1)
- Open Space Public (1)
- Open Space Public (for Conservation) (2)
- Regional Park (3)
- Open Space Public (4)
- Railway
- Town Centre

CPW

- EPBC Listed
- Additional CPW - Rehabilitation & Restoration

Area to Which this SEMP Applies

0 500 1,000
Metres

1. Identified in the draft State Environmental Planning Policy (Major Development) Amendment (Edmondson Park South) 2010 and Liverpool Environmental Plan 2008
2. Identified in the draft State Environmental Planning Policy (Major Development) Amendment (Edmondson Park South) 2010 and Liverpool Local Environmental Plan 2008 and proposed in the Agreement as areas to be managed for CPW values.
3. Identified in the draft State Environmental Planning Policy (Major Development) Amendment (Edmondson Park South) 2010 and proposed to be included in the Regional Park
4. Identified in the draft State Environmental Planning Policy (Major Development) Amendment (Edmondson Park South) 2010

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Rev No.	Author	Reviewer	Approved for Issue		
		Name	Name	Signature	Date
A	Joanne Rosner	Matthew Bennett	Issued for Client Review		21/08/2013
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Our Ref: PSM3750-006L

14 February 2019

School Infrastructure NSW (SINSW)
c/-APP
Level 7, 116 Miller Street
NORTH SYDNEY NSW 2060

Attention: Satya Mandalika
By email: Satya.Mandalika@app.com.au

Dear Satya

RE: SCHOOL INFRASTRUCTRE NSW (SINSW)
RESULTS OF GEOTECHNICAL INVESTIGATION ON LANDCOM 6.0 HA LAND

1. Introduction

This letter presents the results of geotechnical investigation undertaken by Pells Sullivan Meynink (PSM) at Lot 375 Edmondson Park. The work has been undertaken in accordance with the PSM proposal PSM3750-002L dated 4 December 2018. The land size for geotechnical investigation was changed from 8.06 ha to 6.0 ha based on Satya Mandalika (APP)'s email on 7 January 2019.

2. Background

To assist in the geotechnical investigation, we were provided with and reviewed the following documents:

- A plan showing the proposed 6.0 ha subdivision of the site, drawing no. 17104PS, provided in an email by Satya Mandalika on 7 January 2019
- A survey plan with areal imagery for the subject site, drawing no. *23916-DETAIL1,* dated 17 January 2019

We understand that SINSW's proposed development for this stage may comprise a 6 to 9 storey building. There is currently a large stockpile (approximately 30,000 m^3 and 9 m high) on the western portion of the property that is planned to be removed prior to the development. Details of the proposed development (eg. basement, finish surface levels, building loads, earthworks, etc.) are not known to PSM at this stage. We assume no basement is proposed.

3. Geotechnical Investigation

As requested by APP, PSM have completed a geotechnical investigation for the area.

3.1 Field Work

The fielwork was undertaken on 21 and 22 January 2019 under the full-time supervision of a PSM geotechnical engineer, who undertook the following tasks:

- Directing the testing locations and drilling
- Preparing engineering logs of the material encountered
- Collection of disturbed soil samples for further testing

The test locations were recorded with a hand-held GPS unit with a horizontal accuracy of approximately +/- 5 m. Figure 1 presents the test locations.

Prior to testing, on-site service location “scans” were undertaken by a service locator in the presence of a PSM geotechnical engineer to asses if the test locations were free from buried utilities.

A total of five (5) boreholes (BH01 to BH05) were drilled using a 6.5 tonne track mounted drill rig. Augering through soil was undertaken using a V-bit to refusal depth and continued with a TC-bit in rock until refusal. Bulk soil samples were taken directly from the auger and from areas immediately adjacent to the borehole using a shovel when necessary. Furthermore, BH01 and BH03 were cored in rock from the depth of TC-bit refusal to final depths of 8.5 m and 7.4 m respectively. Two standpipe peizometers (monitoring wells) were installed in BH01 and BH03. The standpipe peizometer at BH01 also contains a water level logger which records the water level at regular intervals of 30 minutes. Attachment A presents geotechnical engineering borehole logs.

At the completion of the fieldwork, the boreholes were backilled with excavated spoil and lightly tamped with a shovel. Figures 2 and 3 presents selected photos of this fieldwork.

3.2 Geotechnial Laboratory Results

3.2.1 Point load Testing

Point load tests on the core were performed at approximately one metre intervals. Results are tabulated in Attachment B.

3.2.2 California Bearing Ratio (CBR)

Three (3) bulk soil samples were recovered for the California Bearing Ration (CBR) testing.

The following sample preparation was undertaken prior to CBR testing:

- Compact to 98% standard MDD, at optimum moisture content (OMC);
- Four (4) day soaked sample; and
- 4.5 kg surcharge.

Table 1 - CBR Test Results

presents a summary of the CBR test results. The test results are included as Attachment C.

Table 1 - CBR Test Results

Sample ID (depth)	Material Description	Soaked CBR (%)	OMC (%)	Standard Maximum Dry Density (t/m^3)	Swell (%)
BH01 (0.1 - 1.5m)	CLAY	0.5*	17.8	1.70	5.5
BH03 (0.1 - 1.5m)	CLAY	2.0*	20.0	1.67	1.0
BH05 (0.1 -1.5m)	CLAY	3.0*	21.1	1.58	1.5

Note: * Indicates Soaked CBR value at 2.5mm penetration

3.2.3 Atterberg Limit Test

Three (3) soil samples in total were recovered from BH01, BH03 and BH04 ranging from depths of 0.2 m to 2.5 m for Atterberg limit tests. Table 2 presents a summary of the test results.

Table 2 - Atterberg Limits Test Results

Sample Description	Atterberg Limits		
	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)
Red, Grey Silty CLAY	41	16	25
Grey Brown, Silty CLAY with gravel	27	14	13
Brown Silty CLAY	34	15	19

Figure 4 presents the test results plotted on the plasticity chart. All the geotechnical test results are included as Attachment D.

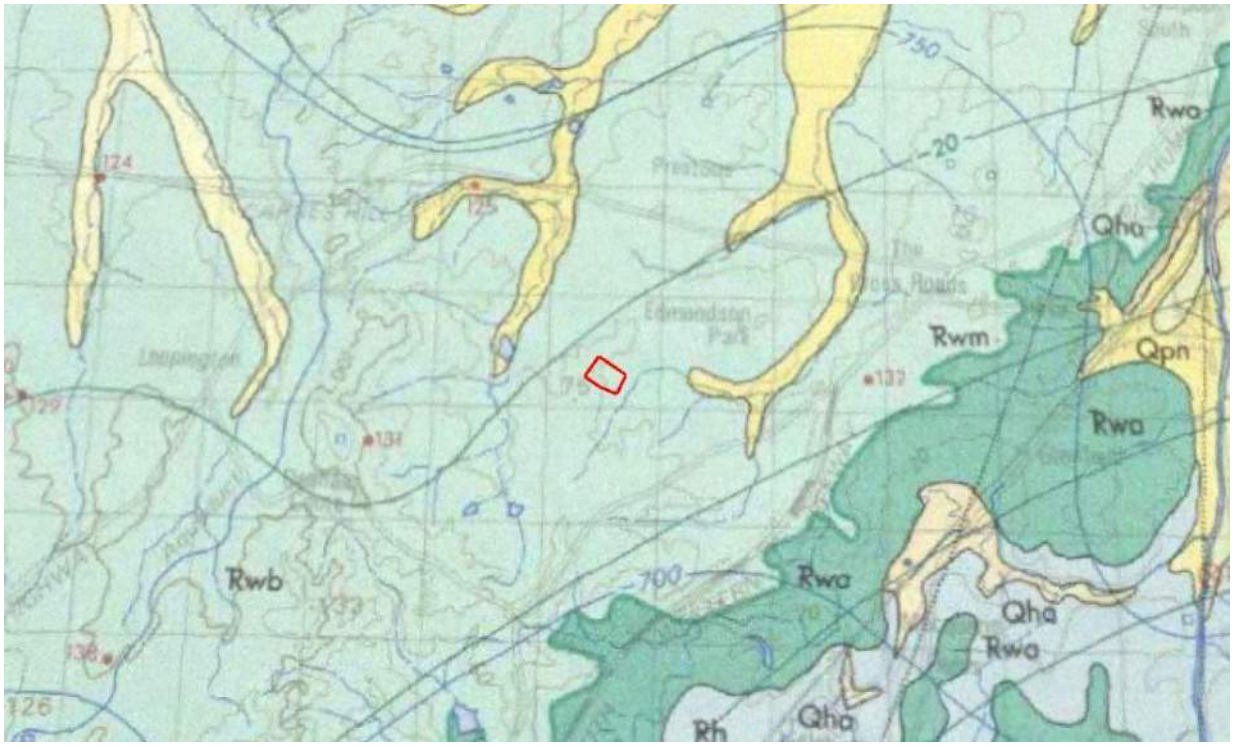
4. Site Conditions

4.1 Geological Setting

The 1:100,000 Geological Map for Penrith indicates that the site is underlain by the following units:

- (Rwb) Bringelly Shale of the Wianamatta Group consisting of shale, carbonaceous claystone, claystone, laminite, fine to medium-grained lithic sandstone, rare coal and tuff.

Inset 1 presents the geological map of the site.



Inset 1: 1:100,000 Geological Map for Penrith (red rectangle marks the approximate site location)

4.2 Surface Conditions

The site is located at Lot 375, Edmondson Park. The site is approximately 6.0 ha in area, and it is bounded by Faulkner Way to the west, railway lines to the south and rural land to the north and east.

The ground is generally sloping towards the east and has a large 9.0 m high stock pile located in the southwest corner. The majority of the ground surface was grassed with tall bushes and trees covering the central, southern and eastern portions of the site. There are a few dirt roads previously used by trucks.

At the time of fieldwork, the surface was wet from rain that had occurred on the previous day and during the fieldwork.

Inset 2: Nearmap aerial photograph of site condition on 28 December 2018

4.3 Subsurface Conditions

Table 3 shows the approximate depth to the top of the inferred geotechnical units encountered at the test locations.

Table 3 - Summary of inferred subsurface conditions encountered in test locations

Inferred Unit	Inferred top of unit depth below ground surface (m)	Description
TOPSOIL	0.0	Silty CLAY; trace of gravel; low plasticity, pale to dark brown, coarse grained sand, firm to stiff consistency, dry to moist. Roots, rootlets and grasses observed throughout.
FILL	0.0 to 0.1	CLAY; generally low plasticity, pale brown and orange, stiff to very stiff consistency, dry. Occasional roots and rootlets observed.
NATURAL SOIL	0.1 to 1.5	CLAY and Silty CLAY; low to medium plasticity, pale brown, red, orange and grey, stiff to very stiff consistency, stiffness increases with depth reaching hard consistency in some areas, mostly dry.
BEDROCK	2.0 to 4.9	SILTSTONE: Orange and brown, distinct fine-grained sandstone laminations and well developed, extremely low to low strength. LAMINITE: dark grey and grey 50%-70% sandstone and 30% - 50% shale, fine grained, rock fabric visible, developed bedding, very low to high strength.

The subsurface conditions encountered within the test locations are summarised in Table 4

Table 4 - Elevation to top of inferred geotechnical units encountered in test locations

Test ID	Elevation to top of inferred geotechnical units (RL m AHD)				
	Topsoil	Fill	Natural Soil	Bedrock	EOH
BH01	60.0	N/E	59.9	55.1	51.5
BH02	57.0	N/E	56.8	54.0	52.9
BH03	59.0	N/E	58.9	56.0	51.6
BH04	N/E	60.5	60.3	58.5	57.1
BH05	60.5	0.1	59.0	57.8	57.5

Note: EOH = End of Hole
N/E = Not Encountered

4.4 Groundwater

No groundwater seepage was observed during the borehole drilling (augering), though it is noted that the drilling water used in the cored boreholes (BH01 and BH03) would have prevented any groundwater from being observed. Standpipe piezometers (monitoring wells) were installed in BH01 and BH03. A water logger was installed in BH01 to measure water levels at regular 30 minute intervals. Attachement E includes the piezometer construction records. Water was observed in the wells immediately after wells were completed.

A PSM geotechnical engineer visited the site on 12 February 2019 to take measurements of the water levels in BH01 and BH03. The monitoring data from the well is presented in Figure 5. The water level in BH03 was measured using a tape measure with a water whistle attached at the end. From these measurements the water level elevation is between between RL 54.9 m and RL 55.8 m, i.e 5.1 m and 3.2 m depth below the existing surface in BH01 and BH03 respectively. We note this may be affected by the water introduced during drilling / coring that potentially still remains in the monitoring wells, eg. not actual ground water. PSM should be requested to return to site to re-measure the groundwater level and download the data from the logger.

5. Soil Salinity and Aggressivity Investigation

A total of eight (8) disturbed soil samples were collected by a PSM Geotechnical Engineer for testing in an environmental laboratory.

5.1 Laboratory Results

The disturbed soil samples were sent to a NATA accredited environmental laboratory and the following tests were undertaken:

- Cation Exchange Capacity (CEC) of calcium, magnesium, potassium and sodium
- Exchange sodium percentage
- Salinity (EC 1:5, one part soil to five parts water)
- Soil pH
- Chlorides
- Sulphates
- Resistivty
- Moisture content

Table 5 presents a summary of the results. The laboratory reports are presented in Attachment F.

Table 5 - Laboratory Testing Results

Sample ID	pH	Electrical Conductivity [µS/cm]	Moisture Content [%]	Resistivity at 25 °C [ohm.cm]	Chloride By Discrete Analyser [mg/kg]	Soluble Sulfate by ICPAES [mg/kg]	Exchangeable Cations [meq/100g]					ESP [%]
							Ca	Mg	K	Na	CEC	
BH05-1.5m	5.5	216	9.3	4630	230	150	<0.1	7.2	0.3	3.0	10.5	28.6
BH05-3.0m	5.8	300	8.0	3330	280	230	0.1	7.4	0.5	3.2	11.2	28.8
BH03-2.0m	5.8	142	5.8	7040	160	30	<0.1	3.9	0.2	1.8	6.0	30.7
BH04-0.5m	5.5	94	12.1	10600	80	80	0.8	4.6	0.2	1.0	6.6	15.0
BH01-2.0m	5.2	553	11.8	1810	660	180	<0.1	7.9	0.2	4.0	12.2	33.4
BH03-1.5m	5.8	145	6.3	6900	120	90	<0.1	4.6	0.3	1.8	6.8	26.7
BH02-4.0m	7.1	82	14.4	12200	70	20	0.8	5.6	0.4	3.6	10.3	34.4
BH01-1.0m	4.9	526	13.7	1900	410	290	<0.1	4.7	0.1	1.9	6.8	28.4

5.1.1 Soil chemistry

The salinity test results, summarised in Table 5 indicate the following:

- pH of the soil samples analysed was in the range of 4.9 to 7.1, with an average of 5.7
- The 1:5 soil to water extraction and subsequent electrical conductivity ($EC_{1:5}$) of the soil samples analysed to be in the range of 82 µS/cm to 553 µS/cm
- Resistivity of samples at 25 °C analysed was in the range of 1810 ohm.cm to 12200 ohm.cm
- Concentrations of chlorides in samples analysed was in the range of 70 mg/kg to 660 mg/kg
- Concentrations of soluble sulfate in samples analysed was in the range of 20 mg/kg to 290 mg/kg
- Cation Exchange Capacity (CEC) in samples analysed was in the range 6.0 meq/100g to 12.2 meq/100g
- Exchange Sodium Percentage (ESP) in samples analysed was in the range of 15.0% to 34.4%.

6. Salinity Assessment

6.1 Salinity

Site Investigations for Urban Salinity (DLWC 2002) classify soil salinity based on electrical conductivity (ECe). The method of conversion from EC1:5 to ECe (electrical conductivity of saturated extract) is based on DLWC (2002) and given by ECe = EC1:5 x M, where M is the multiplication factor based on "Soil Texture Group".

The "Soil Texture Group" of the samples tested were assessed during our investigation. The salinity classification for the soil samples that were tested are presented in Table 6.

Table 6 - Salinity Classification

Sample ID	$EC_{1:5}$ (dS/m)	Soil Type	M	EC_e (dS/m)	Salinity Class
BH05 - 1.5m	0.216	Heavy Clay	6	1.296	Non-saline
BH05 - 3.0m	0.300	Light Medium Clay	8	2.400	Slightly saline
BH03 - 2.0m	0.142	Medium Clay	7	0.994	Non-saline
BH04 - 0.5m	0.094	Heavy Clay	6	0.564	Non-saline
BH01 - 2.0m	0.553	Clay Loam	9	4.977	Moderately Saline
BH03 - 1.5m	0.145	Light Medium Clay	8	1.160	Non-saline
BH02-4.0m	0.082	Light Medium Clay	8	0.656	Non-saline
BH01-1.0m	0.526	Light Medium Clay	8	4.208	Moderately Saline

It is assessed that the majority of the soils on site are classified as "non-saline to moderately saline". We have referred to Clause 4.8.2 of Australian Standard AS3600-2009 "Concrete Structures" and note that the assessed soil electrical conductivity (EC_e) is less than the upper limit of the "A2" exposure classification.

6.2 Corrosivity / Aggressivity

Table 4.8.1 of AS3600-2009 “Concrete Structures” provides criteria for exposure classification for concrete in sulphate soils based on sulphates in soil and groundwater, and pH of soil. On the basis of the sulphate and pH testing completed we assess the exposure classification for concrete in sulphate soils to be “A2”.

Table 6.4.2(C) of Australian Standard AS2159:2009, Piling – Design and Installation provides criteria for exposure classification for concrete piles based on sulfates in the soil and groundwater, soil and groundwater pH, and chlorides in groundwater. On the basis of the soil sulfates and pH testing completed we assess the exposure classification for concrete piles in the soil to be mild.

Table 6.5.2(C) of Australian Standard AS2159:2009, Piling – Design and Installation provides criteria for exposure classification for steel piles based on resistivity, soil and groundwater pH, and chlorides in soil and groundwater. On the basis of soil chlorides, resistivity and pH testing completed we assess the exposure classification for steel piles in the soil to be mild.

6.3 Sodicity

Sodicity provides a measure of the likely dispersion on wetting and to shrink/swell properties of a soil. Soil sodicity is classified based on the Exchangeable Sodium Percentage (ESP) which is the amount of exchangeable sodium as a percentage of the Cation Exchange Capacity (DLWC, 2002).

The Exchangeable Sodium Percentages calculated from these laboratory results, ranging from 15.0% to 34.4%, indicates that the soils on site are highly sodic when compared to criteria listed in “Site Investigations for Urban Salinity”, DLWC (2002).

7. Discussion

7.1 Excavation Conditions

Excavation in the Topsoil, Fill, and Natural Soil units is expected to be achievable using conventional earth moving equipment. Excavation in Bedrock unit may require some rock breaking. It is our experience that excavatability is heavily dependent on both the operator and the plant used. Any earthworks contractor should satisfy itself with regard to excavatability especially in the bedrock unit.

Please note that the 6.5 tonne drill rig encountered TC bit practical refusal (or slow advance) in all broeholes at depths ranging form 3.0 m to 4.9 m.

Although aerial imagey of the site shows there is a dam towards the northern boundary of the site, we did not observe the dam at the time of the fieldwork.

Inset 3: Location of backfilled dam

7.2 Earthworks

Due to previous site activities, we consider the existing fill (including the stockpiles) on site may not be engineered / controlled fill. Thus, we consider it shall be removed and replaced. Any structures should not be founded on the existing fill.

At this stage we are not aware if any earthworks will be required for the proposed development. We consider that topsoil is not suited for reuse as engineered fill. It may be reused for landscaping purposes. It is our opinion that most of the remaining cut material would be suitable for reuse on the site as engineered fill.

We envisage that the earthworks proposed at the site will require the preparation of a detailed fill specification developed following the guidelines in AS 3798 (2007), "*Guidelines on earthworks for commercial and residential developments*". Preparation of this fill specification is outside the scope of this report. We consider, however, that the fill specification should address at least the following:

1. Subgrade preparation and base geometry requirements.
2. Material requirements, including a clear definition of:
   a. Suitable and unsuitable material.
   b. Grading or maximum particle size requirements. We note that a conservative definition of maximum particle size may result in some of the materials on site being excluded from reuse as engineered fill. It is our opinion that this restriction may not significantly benefit fill performance.
3. Fill placement requirements, including a clear definition of compacted layer thickness, we suggest 300 mm.
4. Compaction requirements. We suggest that a minimum and maximum density ratio be adopted to control any potential shrink swell of the clayey fill material and to limit the effect of fill material variability on the fill performance, we suggest 98 to 102 % standard.
5. Moisture control requirements. We consider that control on placement moisture variation should be adopted to control any potential shrink swell of the clayey fill material, we suggest moisture variation of +- 2%.

6. Inspection and testing requirements, including a clear definition of:
   a. Level of control testing, e.g. Level 1 as per AS3798.
   b. Lot testing, this is an important aspect of earthworks control but often ignored in acceptance of the works.
   c. Testing methodology.
   d. Testing frequency.
7. Responsibilities of the contractor. We envisage that such responsibilities would include:
   a. Undertake the earthworks in accordance with fill specification.
   b. Seek approvals by the GITA as required by the fill specification, in particular prior to placing any new fill.
   c. Responsibilities of the Geotechnical Inspection and Testing Authority (GITA). The fill specification should define:
   d. The inspection and testing responsibilities of the GITA.
   e. The reporting responsibilities of the GITA.

The final certification responsibilities of the GITA. We note that the specification should require the GITA to certify that "all the earthworks have been documented and have been undertaken in accordance with the relevant fill specification". It is not adequate just to refer to AS3798 Level 1.

7.3 Permanent and Temporary Batters

The batter slope angles shown in Table 7 are recommended for the design of batters up to 5 m height subject to the following recommendations:

- The batters shall be protected from erosion. Permanent batters will need face support such as vegetation or shotcrete
- Permanent batters shall be drained for a distance behind the faces at least equal to the height.
- Temporary batters shall not be left unsupported for more than a month without further advice, and inspection by a geotechnical engineer should be undertaken following significant rain events
- No buildings, loads or services should be located within 1 batter height of the crest.

If the conditions above cannot be met, further advice should be sought.

Where Fill is not engineered/controlled fill, batter slope angles should be assessed by a geotechnical engineer.

Table 7 - Batter Slope Angles

Unit	Temporary	Permanent
ENGINEERED FILL	1.5H : 1V	2H : 1V
NATURAL SOIL	1.5H : 1V	2H : 1V
BEDROCK*	1H : 1V	1.5H : 1V

Note: *: See the requirements below regarding inspections.

The batters should be inspected by an experienced geotechnical engineer or engineering geologist during excavation to confirm the batter advice provided and assess the need for localised support, such as rock bolting to control the adverse jointing and mesh and/or shotcreting for overall face support.

Proper and suitable safe work method statements and OHS documents need to be developed for works to be undertaken in the vicinity of the crest and toe of batters, including temporaty batters for the Bedrock unit.

Steeper batters may be possibly subject to further advice, probably including inspection during construction and possible shortcreting, spot bolting etc.

7.4 Retaining Walls

Cuts in the Fill, Natural Soil and Bedrock units steeper than the recommended permanent batter slopes in Table 7 will need to be supported by some form of retaining structure or ground reinforcements.

The selection of the appropriate retention system is a matter of design. The designer should consider the following factors in making its selection:

- Technical factors
  - Performance
  - Ground conditions (this is addressed below with the design parameters)
  - Surcharge loading and
  - Proximity of structures, buildings and roads, etc.
- Non- technical factors
  - Cost (to build and to maintain)
  - Other constraints such as real estate, neighbouring site / boundary, aesthetics, legislation, etc.

The design of these structures should be based on the following geotechnical properties:

- Effective soil strength parameters in Table 8
- A lateral pressure of 10 kPa for vertical cuts in the BEDROCK units. This is to allow for blocks and rock wedges formed due to adverse defects that may exist within the unit.
- Water pressure (depending on the type of structure).

Note that design of retention systems may be based on either K_a or K_o earth pressures. Design using active earth pressures provides the minimum lateral earth pressure that must be supported to avoid failure and requires a wall that can rotate or translate to allow the pressures to reduce to these values (vertical and lateral movements up to 2% of height may occur, typical movements will be much less).

Where the design is based on K_o pressures, construction should be carefully controlled to avoid unwanted effects. It should be noted that designing for K_o pressures do not, of themselves, ensure that movement does not occur. Movements are controlled by the construction method, especially sequence.

Both surface and sub-surface drainage needs to be designed and constructed properly to prevent pore water pressures from building up behind the retaining walls or appropriate water pressures must be included in the design.

Table 8 - Engineering Parameters of Inferred Geotechnical Units

Inferred Unit	Bulk Unit Weight (kN/m^3)	Soil Effective Strength Parameters		Ultimate Bearing Pressure under Vertical Centric Loading (kPa)	Allowable Bearing Pressure under Vertical Centric Loading (kPa)	Ultimate Shaft Adhesion (kPa)	Elastic Parameters	
		c' (kPa)	*Φ'* (deg)				Young's Modulus (MPa)	Poisson's Ratio
Engineered Fill	18	0	30	400[1]	150[1]	N.A.	10	0.3
Natural Soil	18	0	30	400[1]	150[1]	N.A.	10	0.3
Bedrock	22	N.A.	N.A.	3000[2]	1000[3]	50	100	0.25

Note: 1. Minimum plan dimension of 1.0 m and a minimum embedment depth of 0.5 m.
2. Ultimate bearing pressure for bedrock assumes a settlement of approximately 5% of the least footing dimension for footings in rock.
3. Allowable bearing pressure assumes a settlement of approximately 1% of the least footing dimension for footings in rock.

7.5 Foundations

7.5.1 Shallow Footings

Pad footings can be proportioned on the basis of an allowable bearing pressure (ABP) for centric vertical loads provided in Table 8.

We note that an allowable bearing pressure (ABP) is not a soil property. It depends on many factors such as the size of the footings, the embedment depth, the load direction and eccentricity, the stiffness of the footing, the adopted factor of safety (FOS), as well as the soil properties. As footings get bigger or deeper the capacity increases rapidly, as the load gains eccentricity or becomes inclined, the capacity reduces rapidly.

Settlements in the Natural Soil unit can be estimated using the elastic moduli provided in Table 8. When assessing the settlement of the shallow footings, the designer needs to consider the additional ground settlement due to the total building load on both shallow and deeper units. The differential settlement due to the building load shall also be assessed.

Foundations conditions at the proposed shallow pad footings locations should be inspected by a suitable qualified geotechnical engineer prior to the pouring of concrete.

7.5.2 Piles

We envisage that piles would be founded within the Bedrock unit.

Piles should be designed in accordance with the requirements in AS 2159 (2009), Piling – Design and Installation. The parameters provided in Table 8 may be adopted in the design of piles founded in Bedrock unit.

The designer should note the following with regards to the pile design:

- The ABP needs to be confirmed by a geotechnical engineer during a pile inspection
- Under permanent load, the contribution of side adhesion for soils including Fill and Natural Soil should be ignored
- Deflection needs to be checked using the recommended elastic parameters in Table 8.

The bearing capacities provided are contingent on piles or footings being vertically and centrally loaded. Further advice should be sought if the footings are not vertically centrically loaded. Should higher bearing capacities be required in Bedrock, this may be available subject to further advice.

With regards to the pile design we recommend that:

- A geotechnical strength reduction factor, Φ_g = 0.60 (AS2159 CL. 4.3.2) be adopted for a high redundancy system for an assessed average risk rating (ARR) between 2.5 and 3.0. This should be reviewed to suit the specific design and appropriate pile testing proposed by the structural designers in accord with the requirements of AS2159
- It may be possible to increase the pile reduction factors, if the details of the proposed pile installation procedures indicate a high level of quality control with regards to concrete placement, base cleanliness, etc.
- If a geotechnical strength reduction factor, Φ_g = 0.40 is adopted then no pile testing will be required (AS2159 Clause 8.2.4 (b)).

7.6 Pavements

Subgrade CBR for pavement design depends on the material at the finished subgrade levels. The CBR tests undertaken by PSM (refer to Table 1) indicates a CBR value between 0.5% and 3%. Based on the testing, we recommend a design subgrade value of 2.0% be adopted.

We note that one of the samples tested has a very low CBR associated with a very high swell; this indicates a potential problem subgrade and it is not easy, and may be impossible, to visually distinguish this soil at subgrade level from other less problematic soils. We recommend that specific CBR testing be undertaken at finished subgrade level when pavement layouts are finalised.

8. General

If at any time, the conditions are found to vary from those decribed in this report, further advice should be sought.

Should there be any queries, do not hesitate to contact the undersigned

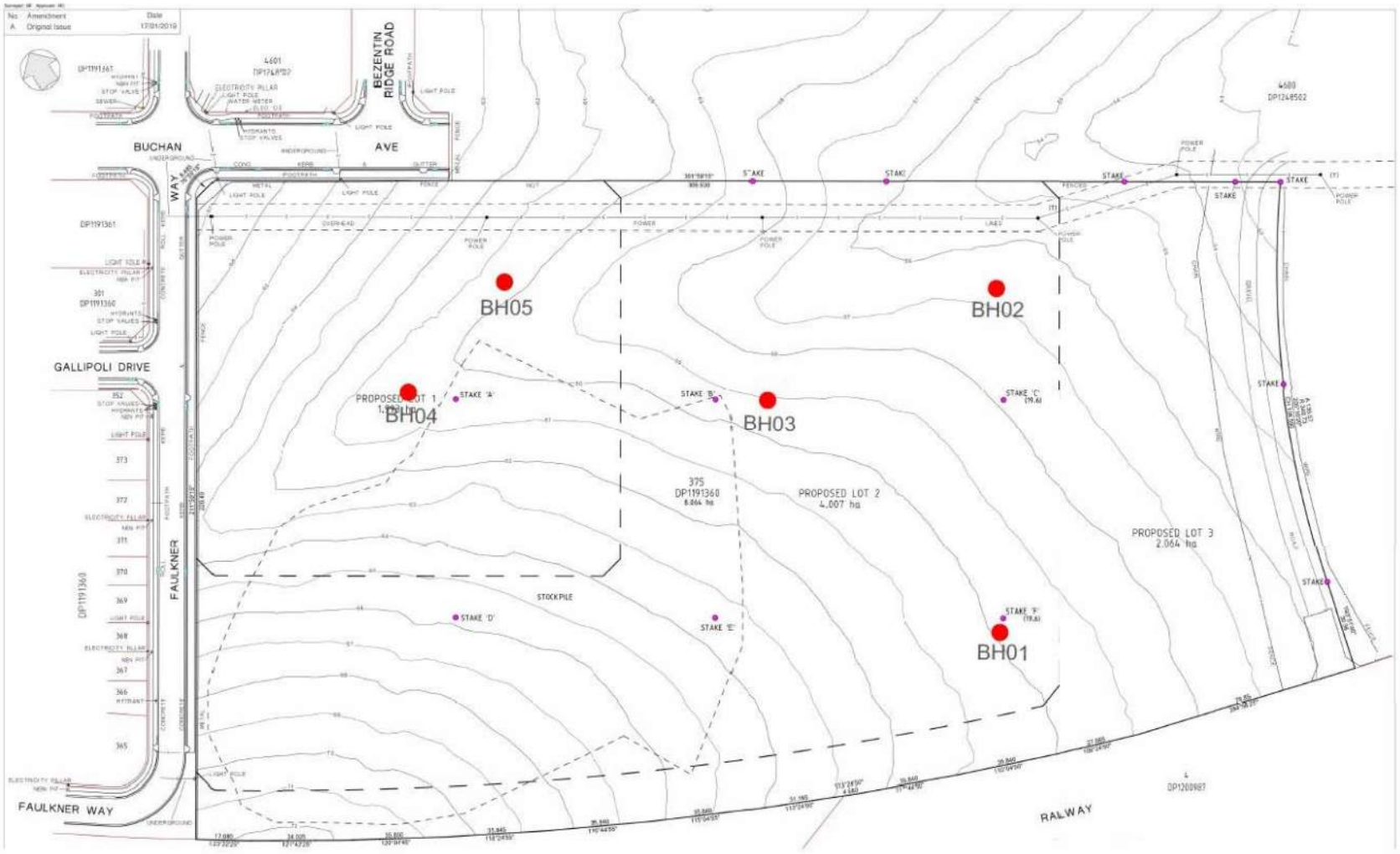
For and on behalf of
PELLS SULLIVAN MEYNINK

MATIAS BRAGA
GEOTECHNICAL ENGINEER

AGUSTRIA SALIM
PRINCIPAL

Encl.

Figure 1	Test Locations
Figure 2	Selected Photos (1 of 2)
Figure 3	Selected Photos (2 of 2)
Figure 4	Atterberg Limits Graph
Figure 5	Water Monitoring Results
Attachment A	Geotechnical Engineering Borehole Logs
Attachment B	Point Load Test Results
Attachment C	CBR Testing Results
Attachment D	Atterberg Limit Test Results
Attachment E	Piezometer Construction Records
Attachment F	Environmental Testing Results



LEGEND

PSM borehole

NOTES:

1. Borehole locations are approximate.

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Lot 375 Edmondson Park, NSW

LOCALITY PLAN & BOREHOLE LOCATIONS

PSM3750-006L	Figure 1

Photo 1 - General site conditions facing south at the strockpile

Photo 2 - General site conditions at the Western side of the site

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Lot 375 Edmonson Park, NSW

SELECTED SITE PHOTOGRAPHS

[1 OF 2]

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PSM3750-006L	**Figure 2**

Photo 1 - Typical drill rig setup during augering (BH01)

Photo 2 - Typical Standpipe piezometer (monitoring well) setup (BH03)

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Lot 375 Edmonson Park, NSW

SELECTED SITE PHOTOGRAPHS

[2 OF 2]

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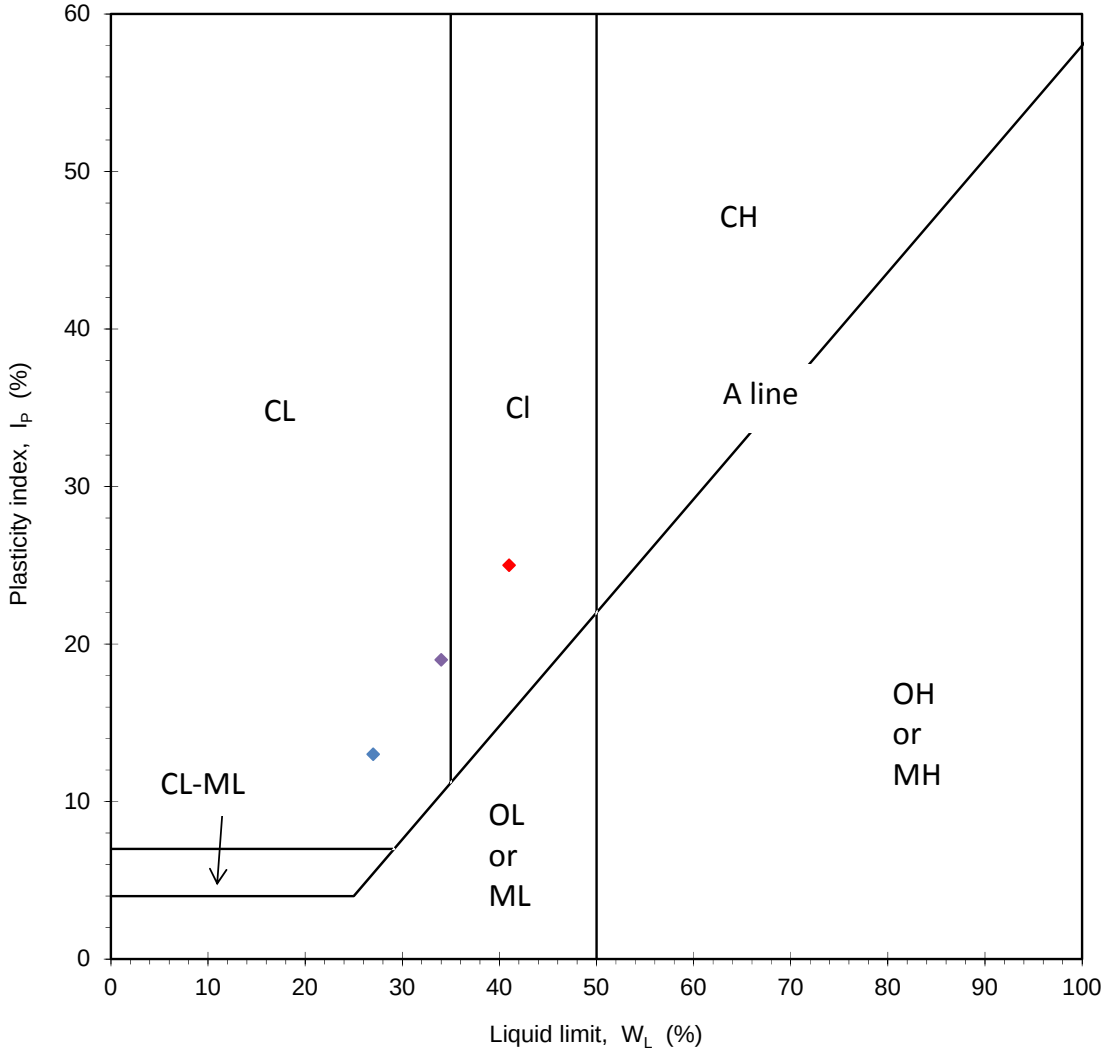
PSM3750-006L	Figure 3



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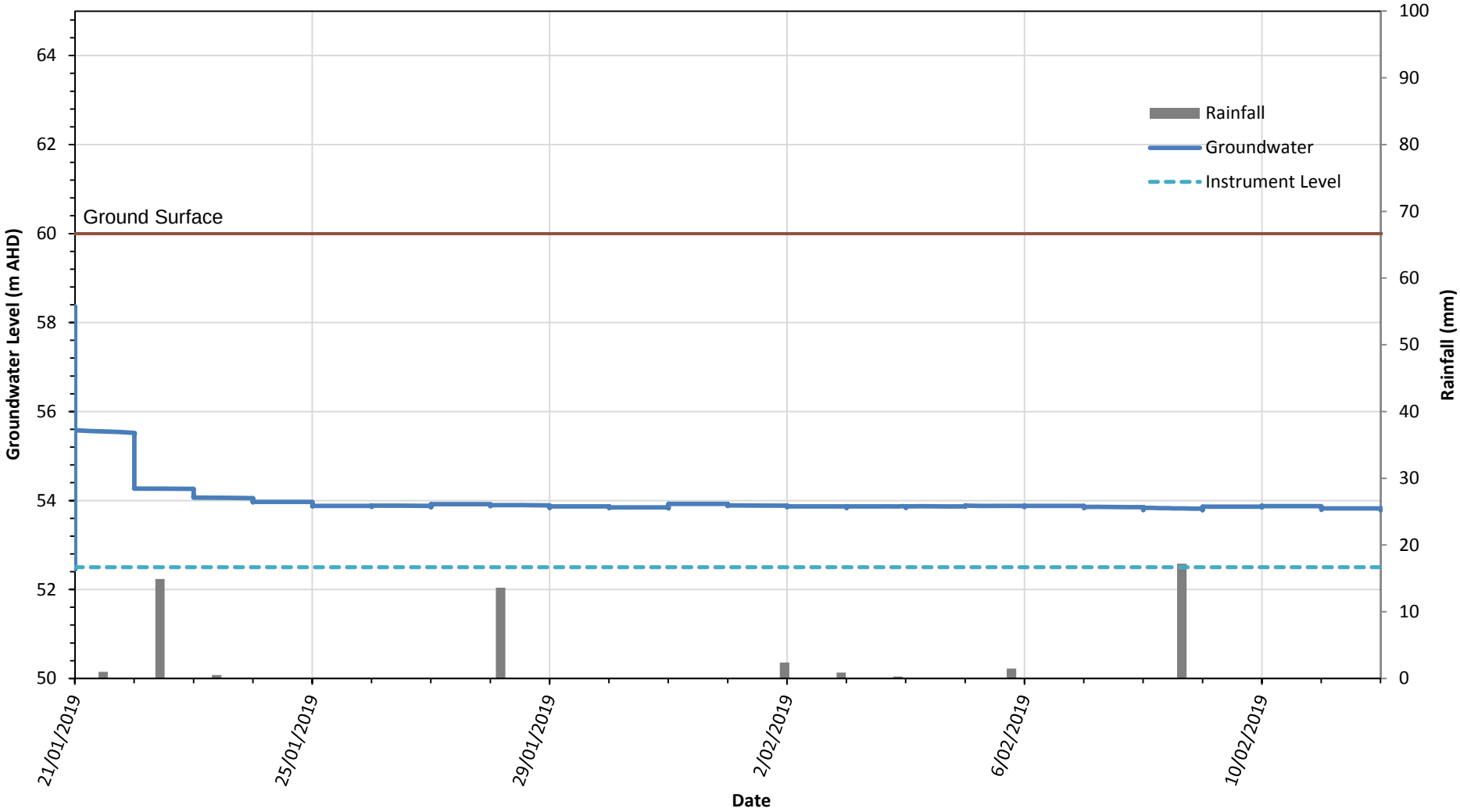
ATTERBERG LIMITS
PLASTICITY CHART

Pells Sullivan Meynink	**PSM3750-006L**	**Figure 4**



Notes:

1. Instrument depth (m AHD): 52.5
2. Rainfall data source: Bureau of Meteorology, Penrith Lakes AWS (station number: 067097)

   Measured water level on 12/02/2019.
4. Data logger installed on 21/01/2019.
5. RL's taken from Plan No: 23916-Detail 1

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Lot 375 Edmondson Park, NSW
GROUNDWATER MONITORING
BH01

PSM3750-006L	Figure 5

Attachment A
Geotechnical Engineering Borehole Logs

Borehole ID

BH01

Page 1 of 3

Engineering Log - Non Cored Borehole

Project No.: PSM3750

Client:	SINSW	Commenced:	21/01/2019
Project Name:	Geotechnical Investigation on Landcom 6.0 Ha Land	Completed:	21/01/2019
Hole Location:	Lot 375 Edmondson Park	Logged By:	MB
Hole Position:	301756.0 m E 6239364.0 m N	Checked By:	YB

Drill Model and Mounting:	Hanjin Track Mounted	Inclination:	-90°	RL Surface:	60.00 m		
Hole Diameter:	110 mm	Bearing:		Datum:	AHD	Operator:	B&G Drilling

Drilling Information								Soil Description					Observations
Method	Penetration	Support	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description SOIL NAME: Colour, structure, plasticity, additional	Moisture Condition	Consistency / Relative Density	Hand Penetrometer UCS (kPa) 100 200 300 400 500	Structure and Additional Observations
AD/V		N	Not Observed	CBR 0.00-1.50 m					CL-ML / CI	SILTY CLAY: pale brown and orange, low plasticity, trace sand coarse grained up to 2mm, roots and rootlets observed.		F		0.00: Topsoil 0.10: Inferred Natural Soil
										CLAY: mottled red, orange and grey, low plasticity		F to St		
				ES 1.00 m PP 1.00 m =300 kPa		59.0	1						×	
									CL	SANDY CLAY: red and grey, low plasticity, sand fine grained.				
		N		ES 2.00 m PP 2.00 m =300 kPa		58.0	2						×	
				Atterberg 2.50 m						Becomes medium to coarse grained at 2.5 m.	D	St		
						57.0	3		CL-ML	SILTY CLAY: dark brown, medium plasticity				3.50: Shale fragments observed
AD/T		N				56.0	4			Becomes pale brown at 4.5 m.		VSt		4.00: V-bit refusal
										Continued on cored borehole sheet				4.89: TC-bit refusal

Method
AD/T - Auger drilling TC bit
AD/V - Auger drilling V bit
WB - Washbore
SPT - Standard penetration test
PT - Push tube
AS - Auger Screwing

Penetration
No resistance through to refusal

Water
Inflow
Partial Loss
Complete Loss

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
ES - Environmental Sample
TW - Thin Walled
LB - Large Disturbed Sample

Classification symbols and soil descriptions based on Unified Soil Classification System

Moisture Condition
D - Dry
M - Moist
W - Wet

Consistency/Relative Density
VS - Very soft
S - Soft
F - Firm
St - Stiff
VSt - Very stiff
H - Hard
VL - Very loose
L - Loose
MD - Medium dense
D - Dense
VD - Very dense
Ce - Cemented
C - Compact

See Explanatory Notes for details of abbreviations and basis of descriptions.

PSM 3.00.2 LIB V2.GLB Log IS_AU_NONCORE_BH_NZ_AU PSM3750 GINT LOGS.GPJ <<DrawingFile>> 08/02/2019 15:46 8.30.003 Datgel Lab and In Situ Tool - DGD [Lib: PSM 3.00.2 2015-10-23 Prj: PSM 2.01 2015-04-07

Engineering Log - Cored Borehole

Project No.: PSM3750

Client:	SINSW	Commenced:	21/01/2019
Project Name:	Geotechnical Investigation on Landcom 6.0 Ha Land	Completed:	21/01/2019
Hole Location:	Lot 375 Edmondson Park	Logged By:	MB
Hole Position:	301756.0 m E 6239364.0 m N	Checked By:	YB

Drill Model and Mounting:	Hanjin Track Mounted	Inclination:	-90°	RL Surface:	60.00 m		
Barrel Type and Length:	Triple Tube 100mm	Bearing:		Datum:	AHD	Operator:	B&G Drilling

Drilling Information							Rock Substance																		Rock Mass Defects		
Method	Water	TCR (%)	RQD (%)	SAMPLES & FIELD TESTS	RL (m)	Depth (m)	Graphic Log	Material Description ROCK TYPE: Colour, grain size, structure (texture, fabric, mineral composition, hardness, alteration, cementation, etc as applicable)	Weathering					Strength Is(50) ● - Axial ○ - Diametral								Defect Spacing (mm)					Defect Descriptions / Comments Description, alpha/beta, infilling or coating, shape, roughness, thickness, other
									EW	HW	MW	SW	F	EL	<0.03	VL	0.1	L	0.3	M	1	H	3	VH	10	EH	<20	60	200	600	1000	
					59.0	1																									
					58.0	2																									
					57.0	3																									
					56.0	4																									
			90					Continued from non-cored borehole sheet																							

Method
AD/T - Auger drilling TC bit
AD/V - Auger drilling V bit
WB - Washbore
HQ3- Wireline core (63.5 mm)
PQ3- Wireline core (85.0 mm)
SPT- Standard penetration test
PT - Push tube

Water
Inflow
Partial Loss
Complete Loss

Graphic Log/Core Loss
Core recovered (hatching indicates material)
No core recovery

Weathering
EW - Extremely Weathered
HW - Highly Weathered
MW - Moderately Weathered
SW - Slightly Weathered
F - Fresh

Strength
EL - Extremely Low
VL - Very Low
L - Low
M - Medium
H - High
VH - Very High
EH - Extremely High

Defect Type
FT - Fault
SS - Shear Surface
SZ - Shear Zone
BP - Bedding parting
SM - Seam
IS - Infilled Seam
JT - Joint
CO - Contact
CZ - Crushed Zone
VN - Vein
FZ - Fracture Zone
BSH - Bedding Shear
DB - Drilling Break

Infilling/Coating
CN - Clean
SN - Stain
VN - Veneer
CO - Coating
RF - Rock fragments
G - Gravel
S - Sand
Z - Silt
CA - Calcite
CL - Clay
FE - Iron
QZ - Quartz
X - Carbonaceous

Roughness
SL - Slickensided
POL - Polished
S - Smooth
RF - Rough
VR - Very Rough

Shape
PR - Planar
CU - Curved
UN - Undulating
ST - Stepped
IR - Irregular

See Explanatory Notes for details of abbreviations and basis of descriptions.

PSM 3.00.2 LIB V2.GLB Log IS_AU_CORE_BH_PSM PSM3750 GINT LOGS.GPJ <<DrawingFile>> 08/02/2019 15:45 8.30.003 Datgel Lab and In Situ Tool - DGD | Lib: PSM 3.00.2 2015-10-23 Prj: PSM 2.01 2015-04-07

Engineering Log - Cored Borehole

Project No.: PSM3750

Client:	SINSW	Commenced:	21/01/2019
Project Name:	Geotechnical Investigation on Landcom 6.0 Ha Land	Completed:	21/01/2019
Hole Location:	Lot 375 Edmondson Park	Logged By:	MB
Hole Position:	301756.0 m E 6239364.0 m N	Checked By:	YB

Drill Model and Mounting:	Hanjin Track Mounted	Inclination:	-90°	RL Surface:	60.00 m		
Barrel Type and Length:	Triple Tube 100mm	Bearing:		Datum:	AHD	Operator:	B&G Drilling

Drilling Information							Rock Substance				Rock Mass Defects	
Method	Water	TCR (%)	RQD (%)	SAMPLES & FIELD TESTS	RL (m)	Depth (m)	Graphic Log	Material Description ROCK TYPE: Colour, grain size, structure (texture, fabric, mineral composition, hardness, alteration, cementation, etc as applicable)	Weathering EW HW MW SW F	Strength Is(50) ● - Axial ○ - Diametral EL <0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH	Defect Spacing (mm) <20 60 200 600 1000	Defect Descriptions / Comments Description, alpha/beta, infilling or coating, shape, roughness, thickness, other
NMLC	Not Observed	100	90	5.36m Is(50) d=3.92 a=10.64 MPa	54.0	6		SILTSTONE: Orange and brown, varying from extremely weathered rock to hard clay.*(continued)* Becomes black and grey, fine-grained and well developed.				BP 15° CL VN UN RF BP 5° CL CO UN RF 2 mm BP 0° FE SN CU RF
								Becomes orange and grey, rock fabric visible, developed laminations.				SM 0° CL CU S 20 mm BP 0° CL CO PR RF 2 mm BP 5° CL VN PR RF 1 mm SM 0° CL CO ST RF 10 mm
				6.40m Is(50) d=0.46 a=2.37 MPa								BP 0° CL VN PR RF BP 0° CL VN PR RF BP 2° CN PR RF 6.72: DB 6.84: DB 6.90: DB
		100	97	7.51m Is(50) d=0.05 a=0.65 MPa	53.0	7		Becomes dark grey and grey, rock fabric visible, well developed laminations.				SM 15° CL UN S 10 mm JT 40° CL CO UN RF 5 mm JT 60° CN PR RF BP 0° CL VN CU RF BP 15° CN ST RF 7.50: HOBO water monitoring device installed
				8.45m Is(50) d=0.13 a=0.23 MPa	52.0	8						
					51.0	9		Hole Terminated at 8.50 m Standpipe installed				

Method
AD/T - Auger drilling TC bit
AD/V - Auger drilling V bit
WB - Washbore
HQ3- Wireline core (63.5 mm)
PQ3- Wireline core (85.0 mm)
SPT- Standard penetration test
PT - Push tube

Water
Inflow
Partial Loss
Complete Loss

Graphic Log/Core Loss
Core recovered (hatching indicates material)
No core recovery

Weathering
EW - Extremely Weathered
HW - Highly Weathered
MW - Moderately Weathered
SW - Slightly Weathered
F - Fresh

Strength
EL - Extremely Low
VL - Very Low
L - Low
M - Medium
H - High
VH - Very High
EH - Extremely High

Defect Type
FT - Fault
SS - Shear Surface
SZ - Shear Zone
BP - Bedding parting
SM - Seam
IS - Infilled Seam
JT - Joint
CO - Contact
CZ - Crushed Zone
VN - Vein
FZ - Fracture Zone
BSH - Bedding Shear
DB - Drilling Break

Infilling/Coating
CN - Clean
SN - Stain
VN - Veneer
CO - Coating
RF - Rock fragments
G - Gravel
S - Sand
Z - Silt
CA - Calcite
CL - Clay
FE - Iron
QZ - Quartz
X - Carbonaceous

Roughness
SL - Slickensided
POL - Polished
S - Smooth
RF - Rough
VR - Very Rough

Shape
PR - Planar
CU - Curved
UN - Undulating
ST - Stepped
IR - Irregular

See Explanatory Notes for details of abbreviations and basis of descriptions.

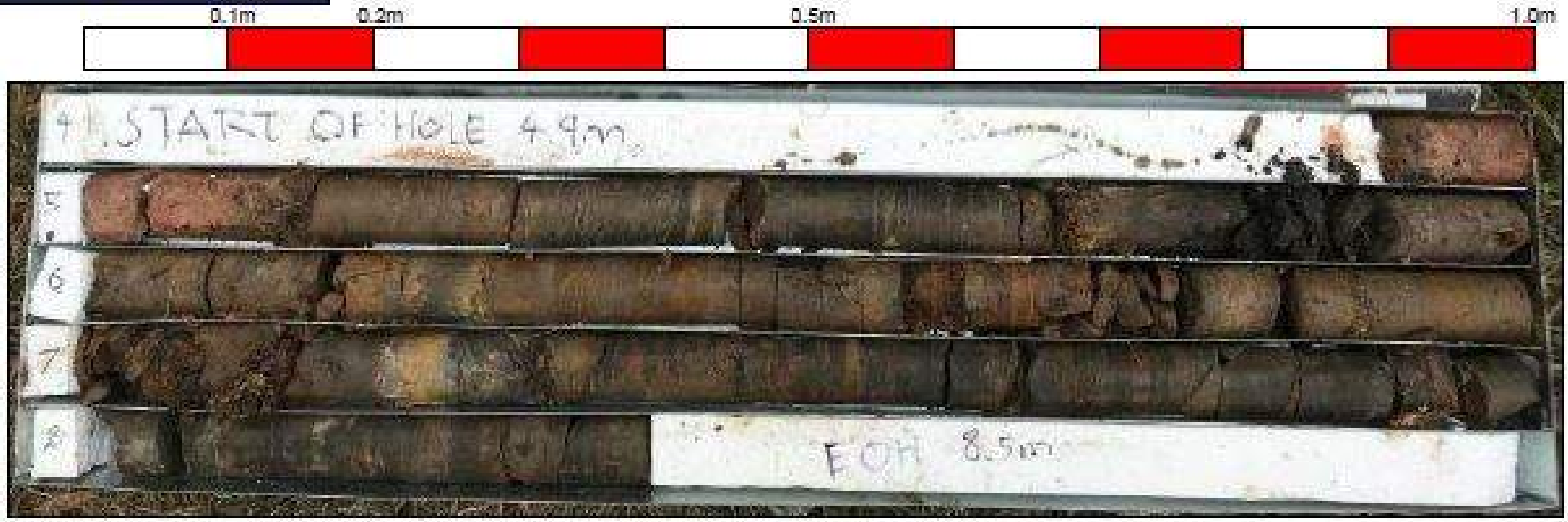
PSM 3.00.2 LIB V2.GLB Log IS_AU_CORE_BH_PSM PSM3750 GINT LOGS.GPJ <<DrawingFile>> 08/02/2019 15:45 8.30.003 Datgel Lab and In Situ Tool - DGD | Lib: PSM 3.00.2 2015-10-23 Prj: PSM 2.01 2015-04-07

JOB No.: PSM 3750 BH ID: BH 01

PROJECT: Landcom 6.0 HA Land

LOCATION: Lot 375 Edmondson Park

FROM: 4.9m TO: 8.5m DATE: 21/1/19



APP Corportation

School Infrastructure NSW

Lot 375 Edmondson Park, NSW

CORE PHOTO BH01 - 4.9m to 8.5m

Pells Sullivan Meynink | PSM3750-006L Attachment A | Figure 1

Borehole ID

BH02

Page 1 of 1

Engineering Log - Non Cored Borehole

Project No.: PSM3750

Client:	SINSW	Commenced:	22/01/2019
Project Name:	Geotechnical Investigation on Landcom 6.0 Ha Land	Completed:	22/01/2019
Hole Location:	Lot 375 Edmondson Park	Logged By:	MB
Hole Position:	301776.0 m E 6239489.0 m N	Checked By:	YB

Drill Model and Mounting:	Hanjin Track Mounted	Inclination:	-90°	RL Surface:	57.00 m		
Hole Diameter:	110 mm	Bearing:		Datum:	AHD	Operator:	B&G Drilling

Drilling Information							Soil Description					Observations
Method	Penetration	Support	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description SOIL NAME: Colour, structure, plasticity, additional	Moisture Condition	Consistency / Relative Density	Hand Penetrometer UCS (kPa)	Structure and Additional Observations
AD/V		N	Not Observed	SPT 1.00 - 1.45 m 4, 7, 10 N = 17 PP 1.00 m =300 kPa		56.0	1		CL	SILTY CLAY: dark brown, low to no plasticity.	M	S		0.00: Topsoil - roots and rootlets observed.
									CL	CLAY: orange, brown and grey, low plasticity.		F to St	×	0.20: Inferred Natural Soil. 1.00: SPT recovered: 0.45 m
				PP 2.00 m =400 kPa		55.0	2		CH	CLAY: red and grey, medium to high plasticity.		VSt	×	1.70: Drill resistance increases. 1.90: V-bit refusal.
AD/T		N		SPT 2.50 - 2.95 m 8, 11, 17 N = 28		54.0	3			SILTSTONE: Pale brown, extremely weathered, extremely low strength.	D			2.50: SPT recovered: 0.45 m 2.70: Extremely weathered shale fragments observed, up to 5mm. 3.00: Inferred Bedrock, strength and weathering inferred from cuttings.
				ES 4.00 m SPT 4.00 - 4.10 m Refusal		53.0	4							4.00: TC-bit refusal SPT recovered: 0.10m
										Hole Terminated at 4.10 m Refusal				

Method
AD/T - Auger drilling TC bit
AD/V - Auger drilling V bit
WB - Washbore
SPT - Standard penetration test
PT - Push tube
AS - Auger Screwing

Penetration
No resistance through to refusal

Water
Inflow
Partial Loss
Complete Loss

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
ES - Environmental Sample
TW - Thin Walled
LB - Large Disturbed Sample

Classification symbols and soil descriptions based on Unified Soil Classification System

Moisture Condition
D - Dry
M - Moist
W - Wet

Consistency/Relative Density
VS - Very soft
S - Soft
F - Firm
St - Stiff
VSt - Very stiff
H - Hard
VL - Very loose
L - Loose
MD - Medium dense
D - Dense
VD - Very dense
Ce - Cemented
C - Compact

See Explanatory Notes for details of abbreviations and basis of descriptions.

PSM 3.00.2 LIB V2.GLB Log IS_AU_NONCORE_BH_NZ_AU PSM3750 GINT LOGS.GPJ <<DrawingFile>> 08/02/2019 15:46 8.30.003 Datgel Lab and In Situ Tool - DGD | Lib: PSM 3.00.2 2015-10-23 Prj: PSM 2.01 2015-04-07

Borehole ID

BH03

Engineering Log - Non Cored Borehole

Project No.: PSM3750

Client:	SINSW	Commenced:	21/01/2019
Project Name:	Geotechnical Investigation on Landcom 6.0 Ha Land	Completed:	21/01/2019
Hole Location:	Lot 375 Edmondson Park	Logged By:	MB
Hole Position:	301718.0 m E 6239491.0 m N	Checked By:	YB

Drill Model and Mounting:	Hanjin Track Mounted	Inclination:	-90°	RL Surface:	59.00 m		
Hole Diameter:	110 mm	Bearing:		Datum:	AHD	Operator:	B&G Drilling

Drilling Information							Soil Description					Observations
Method	Penetration	Support	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description SOIL NAME: Colour, structure, plasticity, additional	Moisture Condition	Consistency / Relative Density	Hand Penetrometer UCS (kPa) 100 200 300 400 500	Structure and Additional Observations
AD/V		N	Not Observed	CBR 0.00-1.50 m		58.0	1		CL CL	SILTY CLAY: pale brown, low plasticity, trace sand coarse grained up to 1mm, roots and rootlets observed. CLAY: red and grey, low plasticity.		F St to VSt	×	0.00: Topsoil 0.10: Inferred Natural Soil.
				PP 1.20 m =350 kPa										
AD/T		N		ES 1.50 m Atterberg 1.50-2.00 m					CL	SILTY CLAY: pale brown, medium plasticity, trace gravel sub-rounded to sub-angular up to 5mm.	D			1.50: V-bit refusal.
				ES 2.00 m		57.0	2			Becomes red and very stiff to hard at 2.0 m.		VSt		
						56.0	3			LAMINITE: black, orange and red, extremely low strength, extremely weathered.				3.00: Inferred Bedrock - strength and weathering inferred from cuttings.
										Continued on cored borehole sheet				3.29: TC-bit refusal.
						55.0	4							

Method
AD/T - Auger drilling TC bit
AD/V - Auger drilling V bit
WB - Washbore
SPT - Standard penetration test
PT - Push tube
AS - Auger Screwing

Penetration
No resistance through to refusal

Water
Inflow
Partial Loss
Complete Loss

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
ES - Environmental Sample
TW - Thin Walled
LB - Large Disturbed Sample

Classification symbols and soil descriptions based on Unified Soil Classification System

Moisture Condition
D - Dry
M - Moist
W - Wet

Consistency/Relative Density
VS - Very soft
S - Soft
F - Firm
St - Stiff
VSt - Very stiff
H - Hard
VL - Very loose
L - Loose
MD - Medium dense
D - Dense
VD - Very dense
Ce - Cemented
C - Compact

See Explanatory Notes for details of abbreviations and basis of descriptions.

PSM 3.00.2 LIB V2.GLB Log IS_AU_NONCORE_BH_NZ_AU PSM3750 GINT LOGS.GPJ <<DrawingFile>> 08/02/2019 15:46 8.30.003 Datgel Lab and In Situ Tool - DGD | Lib: PSM 3.00.2 2015-10-23 Prj: PSM 2.01 2015-04-07

Engineering Log - Cored Borehole

Project No.: PSM3750

Client:	SINSW	Commenced:	21/01/2019
Project Name:	Geotechnical Investigation on Landcom 6.0 Ha Land	Completed:	21/01/2019
Hole Location:	Lot 375 Edmondson Park	Logged By:	MB
Hole Position:	301718.0 m E 6239491.0 m N	Checked By:	YB

Drill Model and Mounting:	Hanjin Track Mounted	Inclination:	-90°	RL Surface:	59.00 m		
Barrel Type and Length:	Triple Tube 100mm	Bearing:		Datum:	AHD	Operator:	B&G Drilling

Drilling Information							Rock Substance																Rock Mass Defects		
Method	Water	TCR (%)	RQD (%)	SAMPLES & FIELD TESTS	RL (m)	Depth (m)	Graphic Log	Material Description ROCK TYPE: Colour, grain size, structure (texture, fabric, mineral composition, hardness, alteration, cementation, etc as applicable)	Weathering					Strength Is(50) ● - Axial ○ - Diametral									Defect Spacing (mm)					Defect Descriptions / Comments Description, alpha/beta, infilling or coating, shape, roughness, thickness, other
									EW	HW	MW	SW	F	EL	VL	L	M	H	VH	EH	<20	60	200	600	1000	
					58.0	1																				
					57.0	2																				
					56.0	3		Continued from non-cored borehole sheet																		
NMLC	Not Observed	100	92	3.65m Is(50) d=0.1 a=1.06 MPa	55.0	4		LAMINITE: Orange, black and grey, parent rock fabric faint, some hard clay.																		BP 1° CL VN UN S BP 5° Fe Clay VN PR RF 1 mm BP 2° CL VN PR RF 1 mm
								Becoming grey, 70% sandstone and 30% shale, fine to medium grained, rock fabric visble, developed bedding.																	BP 0° CL VN PR RF 1 mm
				4.51m Is(50) d=1.73 a=1.28 MPa				Becoming dark grey and grey 50% sandstone and 50% shale, fine grained, rock fabric visble, developed bedding.																	BP 0° CL CO PR RF 2 mm
																									BP 7° CL VN PR RF 1 mm

Method
AD/T - Auger drilling TC bit
AD/V - Auger drilling V bit
WB - Washbore
HQ3- Wireline core (63.5 mm)
PQ3- Wireline core (85.0 mm)
SPT- Standard penetration test
PT - Push tube

Water
Inflow
Partial Loss
Complete Loss

Graphic Log/Core Loss
Core recovered (hatching indicates material)
No core recovery

Weathering
EW - Extremely Weathered
HW - Highly Weathered
MW - Moderately Weathered
SW - Slightly Weathered
F - Fresh

Strength
EL - Extremely Low
VL - Very Low
L - Low
M - Medium
H - High
VH - Very High
EH - Extremely High

Defect Type
FT - Fault
SS - Shear Surface
SZ - Shear Zone
BP - Bedding parting
SM - Seam
IS - Infilled Seam
JT - Joint
CO - Contact
CZ - Crushed Zone
VN - Vein
FZ - Fracture Zone
BSH - Bedding Shear
DB - Drilling Break

Infilling/Coating
CN - Clean
SN - Stain
VN - Veneer
CO - Coating
RF - Rock fragments
G - Gravel
S - Sand
Z - Silt
CA - Calcite
CL - Clay
FE - Iron
QZ - Quartz
X - Carbonaceous

Roughness
SL - Slickensided
POL - Polished
S - Smooth
RF - Rough
VR - Very Rough

Shape
PR - Planar
CU - Curved
UN - Undulating
ST - Stepped
IR - Irregular

See Explanatory Notes for details of abbreviations and basis of descriptions.

PSM 3.00.2 LIB V2.GLB Log IS_AU_CORE_BH_PSM PSM3750 GINT LOGS.GPJ <<DrawingFile>> 08/02/2019 15:45 8.30.003 Datgel Lab and In Situ Tool - DGD | Lib: PSM 3.00.2 2015-10-23 Prj: PSM 2.01 2015-04-07

Engineering Log - Cored Borehole

Project No.: PSM3750

Client:	SINSW	Commenced:	21/01/2019
Project Name:	Geotechnical Investigation on Landcom 6.0 Ha Land	Completed:	21/01/2019
Hole Location:	Lot 375 Edmondson Park	Logged By:	MB
Hole Position:	301718.0 m E 6239491.0 m N	Checked By:	YB

Drill Model and Mounting:	Hanjin Track Mounted	Inclination:	-90°	RL Surface:	59.00 m		
Barrel Type and Length:	Triple Tube 100mm	Bearing:		Datum:	AHD	Operator:	B&G Drilling

Drilling Information							Rock Substance					Rock Mass Defects	
Method	Water	TCR (%)	RQD (%)	SAMPLES & FIELD TESTS	RL (m)	Depth (m)	Graphic Log	Material Description ROCK TYPE: Colour, grain size, structure (texture, fabric, mineral composition, hardness, alteration, cementation, etc as applicable)	Weathering EW HW MW SW F	Strength Is(50) ● - Axial ○ - Diametral EL <0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH	Defect Spacing (mm) <20 60 200 600 1000	Defect Descriptions / Comments Description, alpha/beta, infilling or coating, shape, roughness, thickness, other
NMLC	Not Observed	100	92					LAMINITE: dark grey and grey 50% sandstone and 50% shale, fine grained, rock fabric visble, developed bedding.				BP 10° CL VN ST RF BP 2° CL VN ST RF
				5.53m Is(50) d=2.25 a=1.83 MPa								BP 2° CN UN RF BP 5° CN CU RF
					53.0	6						
		100	97	6.41m Is(50) d=1.67 a=0.82 MPa								BP 0° CL VN ST RF 1 mm BP 0° CN PR RF BP 2° CN PR RF
								Becoming 70% sandstone and 30% shale, fine to medium grained, rock fabric visible, well developed bedding.				BP 5° CN UN RF
				7.29m Is(50) d=8.59 a=2.75 MPa	52.0	7						BP 2° CN CU RF
								Hole Terminated at 7.40 m Standpipe installed				
					51.0	8						
					50.0	9						

Method
AD/T - Auger drilling TC bit
AD/V - Auger drilling V bit
WB - Washbore
HQ3- Wireline core (63.5 mm)
PQ3- Wireline core (85.0 mm)
SPT- Standard penetration test
PT - Push tube

Water
Inflow
Partial Loss
Complete Loss

Graphic Log/Core Loss
Core recovered (hatching indicates material)
No core recovery

Weathering
EW - Extremely Weathered
HW - Highly Weathered
MW - Moderately Weathered
SW - Slightly Weathered
F - Fresh

Strength
EL - Extremely Low
VL - Very Low
L - Low
M - Medium
H - High
VH - Very High
EH - Extremely High

Defect Type
FT - Fault
SS - Shear Surface
SZ - Shear Zone
BP - Bedding parting
SM - Seam
IS - Infilled Seam
JT - Joint
CO - Contact
CZ - Crushed Zone
VN - Vein
FZ - Fracture Zone
BSH - Bedding Shear
DB - Drilling Break

Infilling/Coating
CN - Clean
SN - Stain
VN - Veneer
CO - Coating
RF - Rock fragments
G - Gravel
S - Sand
Z - Silt
CA - Calcite
CL - Clay
FE - Iron
QZ - Quartz
X - Carbonaceous

Roughness
SL - Slickensided
POL - Polished
S - Smooth
RF - Rough
VR - Very Rough

Shape
PR - Planar
CU - Curved
UN - Undulating
ST - Stepped
IR - Irregular

See Explanatory Notes for details of abbreviations and basis of descriptions.

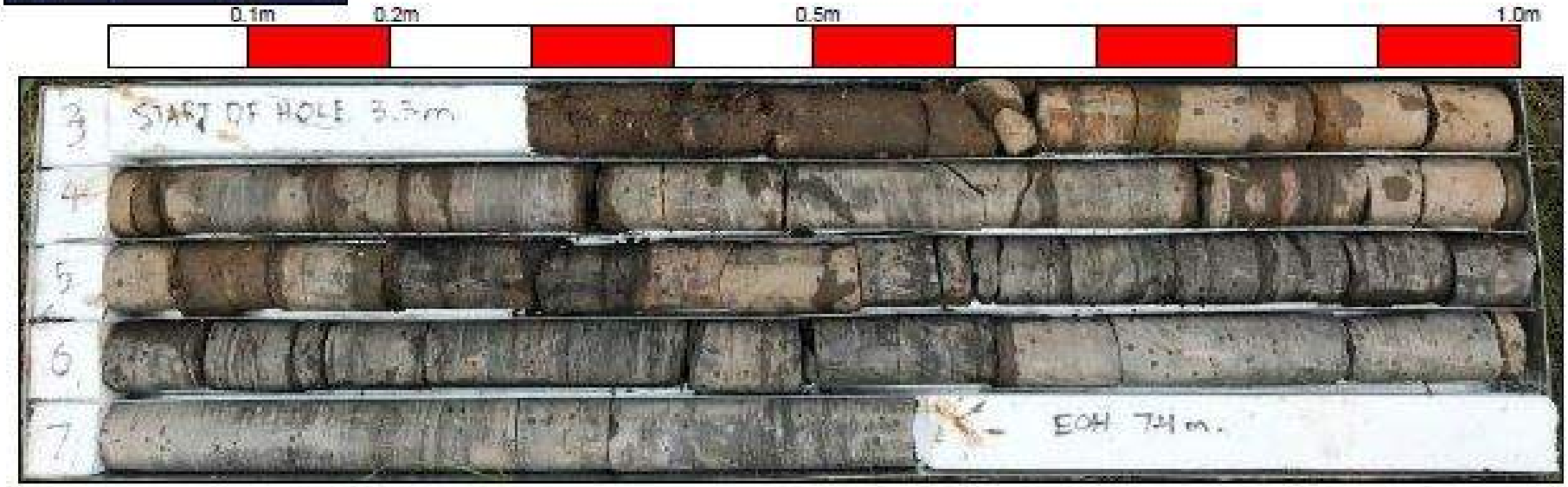
PSM 3.00.2 LIB V2.GLB Log IS_AU_CORE_BH_PSM PSM3750 GINT LOGS.GPJ <<DrawingFile>> 08/02/2019 15:45 8.30.003 Datgel Lab and In Situ Tool - DGD | Lib: PSM 3.00.2 2015-10-23 Prj: PSM 2.01 2015-04-07

JOB No.: PSM 3750 BH ID: BH 03

PROJECT: Landcom 6.0 HA Land

LOCATION: Lot 375 Edmondson Park

FROM: 3.3m TO: 7.4m DATE: 21/1/19



APP Corportation

School Infrastructure NSW

Lot 375 Edmondson Park, NSW

CORE PHOTO BH03 - 3.3m to 7.4m

Pells Sullivan Meynink **PSM3750-006L Attachment A Figure 1**

Borehole ID

BH04

Page 1 of 1

Engineering Log - Non Cored Borehole

Project No.: PSM3750

Client:	SINSW	Commenced:	22/01/2019
Project Name:	Geotechnical Investigation on Landcom 6.0 Ha Land	Completed:	22/01/2019
Hole Location:	Lot 375 Edmondson Park	Logged By:	MB
Hole Position:	301622.0 m E 6239539.0 m N	Checked By:	YB

Drill Model and Mounting:	Hanjin Track Mounted	Inclination:	-90°	RL Surface:	60.50 m		
Hole Diameter:	110 mm	Bearing:		Datum:	AHD	Operator:	B&G Drilling

Drilling Information							Soil Description					Observations
Method	Penetration	Support	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description SOIL NAME: Colour, structure, plasticity, additional	Moisture Condition	Consistency / Relative Density / Hand Penetrometer UCS (kPa) 100 200 300 400 500	Structure and Additional Observations
AD/V		N		Atterberg 0.20-0.50 m					CL	CLAY: pale brown and orange, low plasticity, roots and rootlets observed.		St	0.00: Topsoil
									CL	CLAY: pale brown, medium to high plasticity.			0.30: V-bit refusal.
				ES 0.50 m									
AD/T		N	Not Observed	SPT 1.00 - 1.45 m 4, 11, 14 N = 25		59.5	1				D	VSt	1.00: SPT recovered: 0.45 m
						58.5	2			SILTSTONE: Grey and orange, extremely low strength, extremely weathered.			2.00: Inferred Bedrock, strength and weathering inferred from cuttings.
				SPT 2.50 - 2.90 m 13, 19, Refusal									2.50: SPT recovered: 0.40 m
						57.5	3						
						56.5	4			Hole Terminated at 3.40 m Refusal			3.40: TC-bit refusal.

Method
AD/T - Auger drilling TC bit
AD/V - Auger drilling V bit
WB - Washbore
SPT - Standard penetration test
PT - Push tube
AS - Auger Screwing

Penetration
No resistance through to refusal

Water
Inflow
Partial Loss
Complete Loss

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
ES - Environmental Sample
TW - Thin Walled
LB - Large Disturbed Sample

Classification symbols and soil descriptions based on Unified Soil Classification System

Moisture Condition
D - Dry
M - Moist
W - Wet

Consistency/Relative Density
VS - Very soft
S - Soft
F - Firm
St - Stiff
VSt - Very stiff
H - Hard
VL - Very loose
L - Loose
MD - Medium dense
D - Dense
VD - Very dense
Ce - Cemented
C - Compact

See Explanatory Notes for details of abbreviations and basis of descriptions.

PSM 3.00.2 LIB V2.GLB Log IS_AU_NONCORE_BH_NZ_AU PSM3750 GINT LOGS.GPJ <<DrawingFile>> 08/02/2019 15:46 8.30.003 Datgel Lab and In Situ Tool - DGD | Lib: PSM 3.00.2 2015-10-23 Prj: PSM 2.01 2015-04-07

Borehole ID

BH05

Page 1 of 1

Engineering Log - Non Cored Borehole

Project No.: PSM3750

Client:	SINSW	Commenced:	22/01/2019
Project Name:	Geotechnical Investigation on Landcom 6.0 Ha Land	Completed:	22/01/2019
Hole Location:	Lot 375 Edmondson Park	Logged By:	MB
Hole Position:	301677.0 m E 6239566.0 m N	Checked By:	YB

Drill Model and Mounting:	Hanjin Track Mounted	Inclination:	-90°	RL Surface:	60.50 m		
Hole Diameter:	110 mm	Bearing:		Datum:	AHD	Operator:	B&G Drilling

Drilling Information								Soil Description					Observations
Method	Penetration	Support	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description SOIL NAME: Colour, structure, plasticity, additional	Moisture Condition	Consistency / Relative Density	Hand Penetrometer UCS (kPa) 100 200 300 400 500	Structure and Additional Observations
AD/V		N	Not Observed	CBR 0.00-1.50 m					CL	SILTY CLAY: pale brown, low plasticity, roots and rootlets observed.	D to M	St		0.00: Topsoil
									CL	CLAY: grey and red, low plasticity.				0.10: Inferred Natural Soil.
												VSt		
				SPT 1.00 - 1.45 m 6, 8, 17 N = 25		59.5	1							1.00: SPT recovered: 0.45 m
				ES 1.50 m					CI-CH	CLAY: pale brown and grey, medium to high plasticity.	D			
						58.5	2					H		
AD/T		N		SPT 2.50 - 2.75 m 5, Refusal										2.20: V-bit refusal.
										SILTSTONE: Grey and orange, extremely low strength, extremely weathered				2.50: SPT recovered: 0.25 m
						57.5	3							2.70: Inferred Bedrock, strength and weathering inferred from drill cuttings.
				ES 3.00 m						Hole Terminated at 3.00 m Refusal				3.00: TC-bit refusal.
						56.5	4							

Method
AD/T - Auger drilling TC bit
AD/V - Auger drilling V bit
WB - Washbore
SPT - Standard penetration test
PT - Push tube
AS - Auger Screwing

Penetration
No resistance through to refusal

Water
Inflow
Partial Loss
Complete Loss

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
ES - Environmental Sample
TW - Thin Walled
LB - Large Disturbed Sample

Classification symbols and soil descriptions based on Unified Soil Classification System

Moisture Condition
D - Dry
M - Moist
W - Wet

Consistency/Relative Density
VS - Very soft
S - Soft
F - Firm
St - Stiff
VSt - Very stiff
H - Hard
VL - Very loose
L - Loose
MD - Medium dense
D - Dense
VD - Very dense
Ce - Cemented
C - Compact

See Explanatory Notes for details of abbreviations and basis of descriptions.

PSM 3.00.2 LIB V2.GLB Log IS_AU_NONCORE_BH_NZ_AU PSM3750 GINT LOGS.GPJ <<DrawingFile>> 08/02/2019 15:46 8.30.003 Datgel Lab and In Situ Tool - DGD | Lib: PSM 3.00.2 2015-10-23 Prj: PSM 2.01 2015-04-07

Attachment B
Point Load Test Results

Pells Sullivan Meynink

POINT LOAD STRENGTH INDEX TEST RESULTS

Job No. ***PSM3750*** **Sheet 1 of 1**

Project ***Landcom 6.0 HA Land, Lot 375 Edmondson Park***

Test Method	*AS 4133.4.1 - 1993 Methods of Testing Rocks for Engineering Purposes, Determination of Point Load Strength Index*	Sampling Technique	*NLMC*	Sampling Date	*21/1/2019*
		Storage History	*North Ryde office indoor core storage area*	Testing Date	*25/01/2019*
Test Machine	*GSA 6500*	Moisture Condition	*Natural*	Tested By	*MB*
Calibration Date	*3/12/2012*	Loading Rate	*< 30 seconds*		

Rock Type	Location	Depth	Diametral Tests					Axial, Block, and Irregular Lump Tests							AS 1726 Strength Class
			D	L	P	$I_{s(50)}$	Failure Mode	W	D	L	P	I_s	$I_{s(50)}$	Failure Mode	
		(m)	(mm)	(mm)	(kN)	(MPa)		(mm)	(mm)	(mm)	(kN)	(MPa)	(MPa)		
Siltstone	***BH01***	***5.36***	*50*	*50*	*3.9*	***1.6***	*Parallel to bedding*	*50*	*34*		*10.6*	*4.9*	***4.8***	*Through substance*	***H / VH***
Siltstone	***BH01***	***6.40***	*50*	*58*	*0.5*	***0.2***	*Along defect*	*50*	*32*		*2.4*	*1.2*	***1.1***	*Through substance*	***L / H***
Siltstone	***BH01***	***7.51***	*50*	*63*	*0.1*	***0***	*Parallel to bedding*	*50*	*29*		*0.7*	*0.4*	***0.3***	*Through substance*	***M***
Siltstone	***BH01***	***8.45***	*50*	*55*	*0.1*	***0.1***	*Parallel to bedding*	*50*	*45*		*0.2*	*0.1*	***0.1***	*Through substance*	***VL***
Laminite	***BH03***	***3.09***	*50*	*65*	*0.1*	***0***	*Parallel to bedding*	*50*	*25*		*1.1*	*0.7*	***0.6***	*Through substance*	***VL / M***
Laminite	***BH03***	***4.51***	*50*	*80*	*1.7*	***0.7***	*Parallel to bedding*	*50*	*41*		*1.3*	*0.5*	***0.5***	*Through substance*	***M***
Laminite	***BH03***	***5.53***	*50*	*55*	*2.3*	***0.9***	*Parallel to bedding*	*50*	*27*		*1.8*	*1.1*	***1***	*Through substance*	***M***
Laminite	***BH03***	***6.41***	*50*	*72*	*1.7*	***0.7***	*Parallel to bedding*	*50*	*30*		*0.8*	*0.4*	***0.4***	*Through substance*	***M***
Laminite	***BH03***	***7.29***	*50*	*65*	*8.6*	***3.4***	*Parallel to bedding*	*50*	*22*		*2.8*	*2*	***1.7***	*Through substance*	

By: ***MB*** **Checked:** ***YB*** **Date:** ***1/2/2019***

Attachment C
CBR Testing Results

115 Wicks Road
Macquarie Park, NSW 2113
PO Box 976
North Ryde, Bc 1670
Telephone: 02 9888 5000
Facsimile: 02 9888 5001

SOIL TEST SERVICES
ABN 43 002 145 173

FOUR DAY SOAKED CALIFORNIA BEARING RATIO TEST REPORT

Client: Pells Sullivan Meynink
PSM Job No.: PSM3750

Ref No: L4245E
Report: 1
Report Date: 6/02/2019
Page 1 of 1

BOREHOLE NUMBER	BH 1	BH 3	BH 5
DEPTH (m)	0.00 - 1.50	0.00 - 1.50	0.10 - 0.50
Surcharge (kg)	4.5	4.5	4.5
Maximum Dry Density (t/m^3)	1.70 STD	1.67 STD	1.58 STD
Optimum Moisture Content (%)	17.8	20.0	21.1
Moulded Dry Density (t/m^3)	1.66	1.63	1.55
Sample Density Ratio (%)	98	98	98
Sample Moisture Ratio (%)	101	102	102
Moisture Contents			
Insitu (%)	16.4	17.7	19.2
Moulded (%)	18.0	20.3	21.6
After soaking and			
After Test, Top 30mm(%)	33.3	27.4	31.6
Remaining Depth (%)	22.8	22.4	25.0
Material Retained on 19mm Sieve (%)	0	0	1*
Swell (%)	5.5	1.0	1.5
C.B.R. value: @2.5mm penetration	0.5	2.0	3.0

NOTES:

- Refer to appropriate Borehole logs for soil descriptions
- Test Methods : AS 1289 6.1.1, 5.1.1 & 2.1.1.
- Date of receipt of sample: 25/01/2019.
- Sampled and supplied by client.
- * Denotes not used in test sample.

NATA Accredited Laboratory Number:1327

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Authorised Signature / Date (D. Treweek) 6/2/19

All services provided by STS are subject to our standard terms and conditions. A copy is available on request.

Attachment D
Atterberg Limit Test Results

GROUND TECHNOLOGIES

Geotechnical . Environmental . Laboratories

Ground Technologies Pty Ltd
ABN 25 089 213 294
19 Bernera Road, Prestons NSW 2170
PO Box 1121 Green Valley NSW 2168

Test Results - Atterberg Limits

Client:	**PSM**	Job No.:	**GT3023**
Project:	**Material Testing**	Report No.:	**GTR3023-L6**
Location:	**Edmondson Park**	Test Date:	**05-Feb-19**
Contact:	**Yun Bai**	Client Ref No:	**PSM3750**

Sample Location		**BH01 (2.5m)**	**BH03 (1.5 - 2.0m)**	**BH04 (0.2 - 0.5m)**
Sample Number		**L12**	**L13**	**L14**
Test Procedure		AS1289 3.1.2,3.2.1,3.3.1,3.4.1, 2.1.1		
ATTERBERG LIMITS				
Liquid Limit	%	**41**	**27**	**34**
Plastic Limit	%	**16**	**14**	**15**
Plasticity Index	%	**25**	**13**	**19**
Linear Shrinkage	%	**ND**	**ND**	**ND**
Curling/ Crumbling/ Cracking		**None**	**None**	**None**
Sample History		Low Temperature Oven Dried, Dry Sieved	Low Temperature Oven Dried, Dry Sieved	Low Temperature Oven Dried, Dry Sieved
Sample Description		**Red Grey Silty Clay**	**Grey Brown Silty Clay with Gravel**	**Brown Silty Clay**

Comments: Sampling Method: Sample supplied by Client
Date Sampled: Sample supplied by Client

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The results of the tests, calibrations and/or measurements in this document are traceable to Australian/National Standards

Mahamood Firoz

Approved Signatory

Date of issue 6/02/2019

Attachment E
Piezometer Construction Records

Pells Sullivan Meynink
Engineering Consultants
Rock - Soil - Water

JOB no.: PSM3750

PROJECT: Edmondson Park

PIEZOMETER CONSTRUCTION RECORD

HOLE NUMBER: BH01
PIEZOMETER: 01
COLLAR EASTING: 301756 m E
COLLAR NORTHING: 6239364 m N
COLLAR RL(m): 60.00
DATUM: AHD

DRILLING CONTRACTOR: BG Drilling
RIG: Rig 6
DEPTH OF HOLE (m): 8.60
BOREHOLE INCLINATION: -90
PIEZO INSTALLATION DATE: 21/01/2019
SUPERVISED BY: MB

Tick boxes

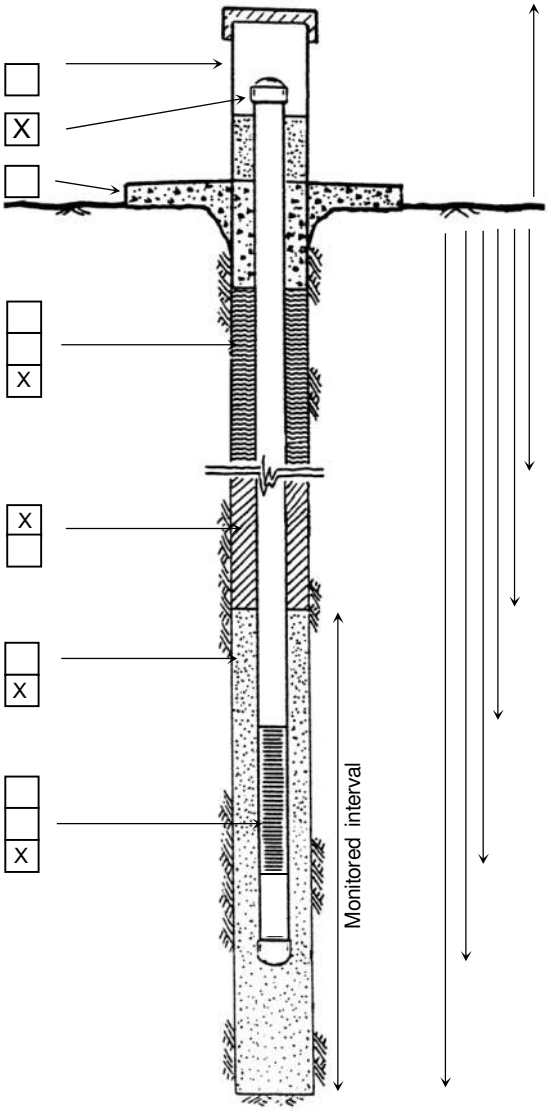
Steel protective well cover [ ]
PVC cap [X]
Concrete colar [ ]

Back fill type:
Cement bentonite [ ]
Soil [ ]
None [X]

Seal:
Bentonite pellets [X]
Other [ ]

Gravel type:
2-5mm gravel [ ]
Other [ ]
2mm Sand [X]

Perforation type:
Drill holes [ ]
Hack saw cuts [ ]
40um machine slots [X]



Complete dimensions if appropriate

Height of stickup (m)	0.5
Diameter of PVC (mm)	50
Depth to top of seal	0.0 m
Depth to top of gravel pack	0.0 m
Depth to top of screen	1.0 m
Depth to base of screen	8.6 m
Depth to base of piezo	8.6 m
Depth to base of gravel	8.6 m

COMMENTS:

Pells Sullivan Meynink
Engineering Consultants
Rock - Soil - Water

JOB no.: PSM3750

PROJECT: Edmondson Park

PIEZOMETER CONSTRUCTION RECORD

HOLE NUMBER: BH03
PIEZOMETER: 02
COLLAR EASTING: 301718 m E
COLLAR NORTHING: 6239491 m N
COLLAR RL(m): 59.00
DATUM: AHD

DRILLING CONTRACTOR: BG Drilling
RIG: Rig 6
DEPTH OF HOLE (m): 8.60
BOREHOLE INCLINATION: -90
PIEZO INSTALLATION DATE: 21/01/2019
SUPERVISED BY: MB

Tick boxes

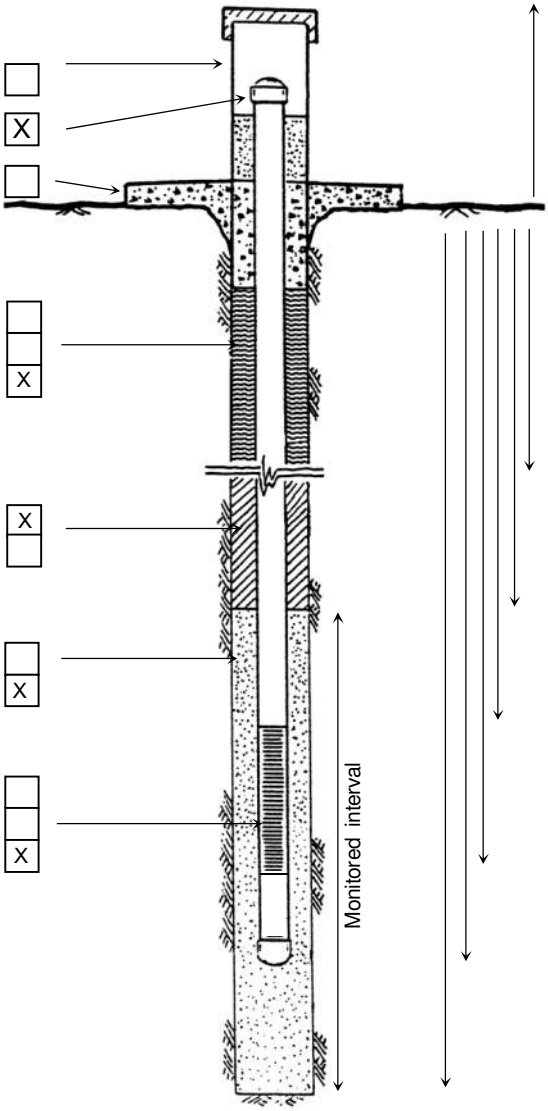
Steel protective well cover: [ ]
PVC cap: [X]
Concrete colar: [ ]

Back fill type:
Cement bentonite: [ ]
Soil: [ ]
None: [X]

Seal:
Bentonite pellets: [X]
Other: [ ]

Gravel type:
2-5mm gravel: [ ]
Other: [ ]
2mm Sand: [X]

Perforation type:
Drill holes: [ ]
Hack saw cuts: [ ]
40um machine slots: [X]



Complete dimensions if appropriate

Height of stickup (m)	0.5
Diameter of PVC (mm)	50
Depth to top of seal	0.0 m
Depth to top of gravel pack	0.0 m
Depth to top of screen	1.0 m
Depth to base of screen	6.2 m
Depth to base of piezo	6.2 m
Depth to base of gravel	6.2 m

COMMENTS:

Attachment F
Environmental Testing Results

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES1902196**	Page	: 1 of 4
Client	: **PELLS SULLIVAN MEYNINK T/A PSM Admin PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: YUN BAI	Contact	: Customer Services ES
Address	: G3, 56 DELHI ROAD NORTH RYDE NSW, AUSTRALIA 2113	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: +61 02 9812 5000	Telephone	: +61-2-8784 8555
Project	: Edmonson Park	Date Samples Received	: 22-Jan-2019 12:30
Order number	:	Date Analysis Commenced	: 24-Jan-2019
C-O-C number	: ----	Issue Date	: 30-Jan-2019 12:12
Sampler	: ----		
Site	: ----		
Quote number	: EN/333		
No. of samples received	: 8		
No. of samples analysed	: 8		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW
Dian Dao		Sydney Inorganics, Smithfield, NSW
Wisam Marassa	Inorganics Coordinator	Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- ED007 and ED008: When Exchangeable Al is reported from these methods, it should be noted that Rayment & Lyons (2011) suggests Exchange Acidity by 1M KCl - Method 15G1 (ED005) is a more suitable method for the determination of exchange acidity (H+ + Al3+).

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	BH05-1.5m	BH05-3.0m	BH03-2.0m	BH04-0.5m	BH01-2.0m
			Client sampling date / time	22-Jan-2019 09:00	22-Jan-2019 09:15	21-Jan-2019 13:30	22-Jan-2019 09:50	21-Jan-2019 09:30
Compound	CAS Number	LOR	Unit	ES1902196-001	ES1902196-002	ES1902196-003	ES1902196-004	ES1902196-005
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	5.5	5.8	5.8	5.5	5.2
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	216	300	142	94	553
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	9.3	8.0	5.8	12.1	11.8
EA080: Resistivity								
Resistivity at 25°C	----	1	ohm cm	4630	3330	7040	10600	1810
ED007: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	<0.1	0.1	<0.1	0.8	----
Exchangeable Magnesium	----	0.1	meq/100g	7.2	7.4	3.9	4.6	----
Exchangeable Potassium	----	0.1	meq/100g	0.3	0.5	0.2	0.2	----
Exchangeable Sodium	----	0.1	meq/100g	3.0	3.2	1.8	1.0	----
Cation Exchange Capacity	----	0.1	meq/100g	10.5	11.2	6.0	6.6	----
Exchangeable Sodium Percent	----	0.1	%	28.6	28.8	30.7	15.0	----
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	----	----	----	----	<0.1
Exchangeable Magnesium	----	0.1	meq/100g	----	----	----	----	7.9
Exchangeable Potassium	----	0.1	meq/100g	----	----	----	----	0.2
Exchangeable Sodium	----	0.1	meq/100g	----	----	----	----	4.0
Cation Exchange Capacity	----	0.1	meq/100g	----	----	----	----	12.2
Exchangeable Sodium Percent	----	0.1	%	----	----	----	----	33.4
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	150	230	30	80	180
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	230	280	160	80	660

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	BH03-1.5m	BH02-4.0m	BH01-1.0m	----	----
			Client sampling date / time	22-Jan-2019 13:30	22-Jan-2019 08:13	21-Jan-2019 09:15	----	----
Compound	CAS Number	LOR	Unit	ES1902196-006	ES1902196-007	ES1902196-008	--------	--------
				Result	Result	Result	----	----
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	5.8	7.1	4.9	----	----
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	145	82	526	----	----
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	6.3	14.4	13.7	----	----
EA080: Resistivity								
Resistivity at 25°C	----	1	ohm cm	6900	12200	1900	----	----
ED007: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	<0.1	0.8	----	----	----
Exchangeable Magnesium	----	0.1	meq/100g	4.6	5.6	----	----	----
Exchangeable Potassium	----	0.1	meq/100g	0.3	0.4	----	----	----
Exchangeable Sodium	----	0.1	meq/100g	1.8	3.6	----	----	----
Cation Exchange Capacity	----	0.1	meq/100g	6.8	10.3	----	----	----
Exchangeable Sodium Percent	----	0.1	%	26.7	34.4	----	----	----
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	----	----	<0.1	----	----
Exchangeable Magnesium	----	0.1	meq/100g	----	----	4.7	----	----
Exchangeable Potassium	----	0.1	meq/100g	----	----	0.1	----	----
Exchangeable Sodium	----	0.1	meq/100g	----	----	1.9	----	----
Cation Exchange Capacity	----	0.1	meq/100g	----	----	6.8	----	----
Exchangeable Sodium Percent	----	0.1	%	----	----	28.4	----	----
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	90	20	290	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	120	70	410	----	----