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JQZ PTY LTD

Remediation Action Plan

11-17 Columbia Lane, Homebush, NSW

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0	Original	02 July 2019	
1	Revised document	11 July 2019	AB
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Executive Summary

JQZ Pty Ltd engaged EI Australia (EI) to conduct a Remediation Action Plan (RAP) for the property located at 11-17 Columbia Lane, Homebush, NSW (herein referred to as 'the site').

This Remediation Action Plan (RAP) outlines the methods and procedures that will be used to remediate the site identified as 11-17 Columbia Lane, Homebush, NSW ('the site') to a condition suitable for residential land use with minimal opportunities for soil access and associated public open space, without the need for ongoing environmental monitoring.

EI understands that this assessment was conducted for the purpose of enabling the developer to meet its obligations under the *Contaminated Land Management Act 1997* (CLM Act), for the assessment and management of contaminated soil and/or groundwater.

This RAP follows on from a previous environmental assessments completed at the site by STS GeoEnvironmental (STS) entitled:

- STS (2019a). Detailed Site Investigation 11-17 Columbia Lane, Homebush NSW. Columbia Lane Developments Pty Ltd. Report No. 19/1315 Project No. 21024/1934D-E, dated June 2019; and
- STS (2019b). Geotechnical Investigation 11-17 Columbia Lane, Homebush NSW. Columbia Lane Developments Pty Ltd. Report No. 19/1962 Project No. 21024/1803D-G, dated April 2019.

At the time of report preparation the site structures had been demolished and the majority of the site was covered by asphalt and/or concrete building slabs.

Site history

According to the site history reported by STS (2019a) the site has been primarily used for commercial, industrial and manufacturing purposes since at least 1936. The structures at the site are noted to have been demolished between 2014 and 2018. The surrounding land changed is noted to be mixed commercial residential.
STS (2019a) also reported that SafeWork NSW's Stored Chemical Information Database (SCID) records indicated there were two underground storage tanks (UST1 and UST2) at the site that possibly stored alcohol and methylated spirits. The records also showed that an above ground storage system, potentially storing Class 1 and Class 2 Dangerous Goods (mineral oils and mineral spirits) existed within building footprint at some point. However, at the time of STS (2019a) investigation most of all structures had been demolished and the AST could not be located, nor did the records indicate where it had been installed.

Subsurface Conditions and Impacted Areas

Previous environmental investigation (STS, 2019a) described the site soil was as a layer of fill (extending to an approximate maximum depth of 2.7 metres below ground level (m BGL)) overlying alluvial soil and/or residual clays with Ashfield shale bedrock. The investigation identified the following contamination at the site:

- Friable asbestos in fill material located within the proposed public parkland area footprint at the east of the site;
- Elevated concentrations of cadmium, copper and PAHs in fill soil layer within the basement footprint and parkland footprint;

- Elevated concentrations of PAH in the natural soil layer at one borehole location, which is located in the south western boundary of the site, outside the basement footprint; and
- Elevated concentrations of heavy metals (nickel and zinc) in one out of the five monitoring wells identified at GW5; and
- Elevated Total Recoverable Hydrocarbons (TRH) and Benzo (a) Pyrene (B(a)P) in downgradient groundwater well GW4; elevated TRH and traces of volatile organic compounds (VOCs) in upgradient groundwater well GW3.

STS (2019a) investigation concluded that the above issues required remediation to make the site suitable for the proposed residential development.

Remediation Strategy

In summary, EI considers that the site can be made suitable for mixed residential-commercial use with limited accessible soils, through the implementation of the works and validation process described in this RAP.

It is envisaged that the remediation works will be implemented in stages, as follows:

- **Stage 1 –** Preliminaries
- **Stage 2 –** UST removal and validation
- **Stage 3 –** Additional Soil & Groundwater Assessment (Data gap closure)
- **Stage 4 –** Removal of Asbestos Impacted Fill
- **Stage 5 –** Handling, Management and Waste Classification of Remaining Fill and Concrete Slabs for Offsite Disposal
- **Stage 6 –** Soil Validation and Classification of Materials Suitable for Reuse (such as Virgin Excavated Natural Material)
- **Stage 7 –** Validation Report Preparation.

Following completion of site remedial and validation assessment works a Site Validation Report will be prepared in accordance with the OEH (2011) *Guidelines for Consultants Reporting on Contaminated Sites*.

1. Introduction

1.1 Background

JQZ Pty Ltd (the 'client') engaged EI Australia (EI) to prepare this remediation action plan (RAP) to assist the client with a development application for the redevelopment of 11-17 Columbia Lane, Homebush, NSW (the 'site').

As shown in **Figure A.1**, the site which covers a total area of approximately 6,570m^2, is located approximately 13 km west of the Sydney Central Business District (CBD) and is situated within the Local Government Area of Strathfield Municipal Council (Council) , as depicted in the site plan presented as **Figure A.2**.

This RAP follows on from a previous environmental assessments completed at the site by STS GeoEnvironmental (STS) entitled:

- STS (2019a). Detailed Site Investigation 11-17 Columbia Lane, Homebush NSW. Columbia Lane Developments Pty Ltd. Report No. 19/1315 Project No. 21024/1934D-E, dated June 2019; and
- STS (2019b). Geotechnical Investigation 11-17 Columbia Lane, Homebush NSW. Columbia Lane Developments Pty Ltd. Report No. 19/1962 Project No. 21024/1803D-G, dated April 2019.

Site characterisation as part of previous environmental investigation (STS, 2019a) identified the following contamination at the site:

- Friable asbestos in fill material located within the proposed public parkland area footprint at the east of the site;
- Asbestos in fill material located within the proposed basement footprint;
- Potential acid sulfate soils (see separate report Ref. *Acid Sulfate Soils Management Plan*, E24275.E14_Rev1, dated 16 August 2019, completed by EI Australia (EI, 2019));
- Elevated concentrations of cadmium, copper and PAHs in fill soil layer within the basement footprint and parkland footprint;
- Elevated concentrations of PAH in the natural soil layer at one borehole location, which is located in the south western boundary of the site, outside the basement footprint; and
- Elevated concentrations of heavy metals (nickel and zinc) in one out of the five monitoring wells identified at GW5; and
- Elevated Total Recoverable Hydrocarbons (TRH) and Benzo (a) Pyrene (B(a)P) in downgradient groundwater well GW4; elevated TRH and traces of volatile organic compounds (VOCs) in upgradient groundwater well GW3.

As concluded within the (STS, 2019a) investigation, these issues require remediation to make the site suitable for the proposed residential development.

The purpose of this RAP is to establish a sequential process for remediation and validation works, as required as part of a DA package to Council; to enable the site to be redeveloped into the proposed public parkland and residential land use with minimal opportunities for soil access.

Additionally it was required under the *Contaminated Land Management Act 1997* (CLM Act), for the assessment and management of contaminated soil and/or groundwater.

1.2 Proposed Development

Based on the proposed development plans (Ref. Ref. Mosca Pserras Architects). Project No14028, dated 03 October 2017), the site has been designated for the removal of all existing concrete flooring and the construction of two high rise residential towers over a common four level basement car park. The four level basement is proposed to have a finished floor level (FFL) of RL-6m Australia Height Datum (AHD).

The proposed development will also involve the construction of street extension to the east of the site, which will be constructed within the basement footprint; and 1,012.40m^2 of public open space covering the majority of the area outside the basement footprint to the east of the site. A 352.90m^2 deep soil landscaping area is also proposed for the area along the western boundary of the site, which will also serve as a transmission line easement.

Copies of selected development drawings area provided in **Appendix B**.

1.3 Remedial Objective

The main objective of this RAP is to provide a strategy for site remediation, which:

- provide details on the site impact and potential contaminant source;
- provides suitable working zones following demolition to undertake further assessment work of the subsurface;
- minimises the environment and health/safety impacts on site workers and the general public during site demolition and subsequent remediation;
- maximises the protection of workers involved with site remediation;
- minimises potential exposure to contaminants in soil, air and groundwater;
- renders the site suitable for the proposed residential land-use;
- minimises impacts on site users and the local environment following site remediation and
- allows the appointed accredited site auditor to prepare a site audit statement and site audit report that indicates the sites are suitable for residential development. It is envisaged that the site audit statement and report may be staged to allow the overall development to proceed including possible revisions or addendum to this RAP once the further investigations are undertaken.

1.4 Remedial Scope of Works

With the aim of achieving the above objectives while generally complying with the OEH (2011) Guidelines for Consultants Reporting on Contaminated Sites, the scope of work included:

- Review and assessment of the available data relevant to the remediation of the site and provided by the previous investigation reports for the site;
- Definition of remediation goals and acceptance criteria;
- Review and assessment of the latest technical literature on remediation technologies relevant to the site and relevant case studies;

- Technical assessment of alternative remediation technologies;
- Evaluation of available remediation options and selection of the most appropriate remedial strategy (or combination of strategies) for the site;
- Provision of information so that remedial works may be carried out in accordance with relevant laws and regulations;
- Provision of guidance on approvals and licences required for the remedial works, under current legislation (e.g. SEPP 55);
- Provision of information to assist the contractor in their preparation of a Work Health and Safety Plan and other site management/planning documents;
- Development of a sampling, analysis and quality strategy for hotspot delineation and post-remedial validation.

This RAP also outlines measures for the excavation, stockpiling, management and disposal of spoil, water and sediment controls, as well as a contingency plan to handle any additional contamination that may be identified during the additional investigations and/or site remedial works. The measures provided in this RAP are brief and are designed to accompany site-specific management plans, such as an Asbestos Management Plan (AMP) and a Construction Environment Management Plan (CEMP). These measures do not replace any other requirements for the site as a whole. A complete set of site specific management plans should be developed and adhered to. An outline of management measures to be addressed is provided in **Section 9.3**.

1.5 Regulatory Framework

This RAP was prepared with consideration of various acts, standards and guidelines, and those of significance are presented as per the below:

Legislation

- Contaminated Land Management Act 1997 (CLM Act 1997);
- State Environment Protection Policy 55 – Remediation of Land (SEPP 55) under the Environmental Planning and Assessment Act 1997 (EP&A Act 1997);
- Strathfield Development Control Plan 2012; and
- Work Health and Safety Act 2011 (WHS Act 2011) and associated Regulations and Codes of Practice.

Guidelines

- ANZAST (2018) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*;
- ANZECC & ARMCANZ (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*;
- ASSMAC (1998) *Acid Sulfate Soils Assessment Guidelines*;
- CIRIA (2007), *Assessing Risks posed by Hazardous ground gasses to buildings*. Construction Industry Research and Information Association CIRIA C665
- DEC (2007) *Guidelines for the Assessment and Management of Groundwater Contamination*;

- DOP (2011) The Assessment Guideline – Multi-Level Risk Assessment (Ground Gas);
- EPA (1995) *Sampling Design Guidelines*;
- EPA (2012) *Guidelines for the Assessment and Management of Sites Impacted by Hazardous Ground Gases*;
- EPA (2014) *Waste Classification Guidelines (Part 1:Classifying Waste and Part 4: Acid Sulfate Soils)*;
- EPA (2017) *Contaminated Land Management: Guidelines for the NSW Site Auditors Scheme (3rd Scheme);*
- HEPA, 2018 The PFAS National Environmental Management Plan;
- NEPM (2013) Schedule B(1) *Guideline on Investigation Levels for Soil and Groundwater*;
- NEPM (2013) Schedule B(2) *Guideline on Site Characterisation*;
- NHMRC (2018) Australian Drinking Water Guidelines Paper 6 National Water Quality Management Strategy
- OEH (2011) *Guidelines for Consultants Reporting on Contaminated Sites*; and
- WorkCover (2014) *Managing Asbestos In or On Soil*.

1.6 Deviation from This RAP

While it may be possible to vary the sequence and/or details of the actual site remediation and validation works to meet site constraints, a qualified Environmental Scientist performing the roles of Environmental Management Coordinator and Remediation Supervisor will be appointed to the project to ensure that:

- Critical stages of the site remediation/validation process (including, but not limited to, proper site induction of site personnel in relation to contamination hazards and environmental management issues, marking of remediation areas, inspection of environmental monitoring systems, implementation of specified control measures and required data gap closure and validation sampling), are appropriately supervised, implemented and documented, with the relevant data collected for environmental reporting purposes; and
- Any deviations from the works specified in this RAP are properly documented and approved, as required under the OEH (2011) *Guidelines for Consultants Reporting on Contaminated Sites*.

Performing remedial works without the presence of a qualified environmental engineer/scientist when necessary may lead to project delays and extra costs due to additional environmental investigation requirements imposed by a Qualified Independent Consultant or the appointed Site Auditor, to confirm the environmental status of the site.

In worst case scenarios, waste materials removed from the site without proper characterisation and/or waste classification assessment, may lead to regulatory action and potential penalties, as described under the *Waste Regulation 2014*, the *Protection of the Environment Operations Act 1997* and the *Contaminated Land Management Act 1997*.

2. Site Description

2.1 Property Identification, Location and Physical Setting

Table 2-1 Site Identification, Location and Zoning

Attribute	Description
Street Address	11-17 Columbia Lane, Homebush, NSW
Location Description	Approx. 13 km west of Sydney CBD, bound by: North: Nipper Street and mixed used commercial and residential buildings. East: Kennards Warehouse storage facility followed by railway corridor. South: Powells Creek followed by Strathfield STS substation and railway corridor. West: Powells Creek followed by land used for commercial storage purposes and residential buildings.
Site coordinates using GDA94-MGA56 coordinate system:	Northeast corner of site: Easting: 323268.015, Northing: 6251035.35 (Source: https://maps.six.nsw.gov.au/)
Site Area	Approximately 6,570 m^2
Site Owner	JQZ Pty Ltd
Lot and Deposited Plan (DP)	Lot 4 and 5 DP 261926
State Survey Marks	Eleven State Survey Marks (SSM) were situated in close proximity (<150m) to the site. The SSM located within 50m of the site have been listed below: SS114415: 85m to the north of the site at the corner of Columbia Lane and Parramatta Road; and PM14420: 100m to the north of the site at the corner of Parramatta Road and George Street. (Source: https://maps.six.nsw.gov.au/)
Local Government Authority	Strathfield Municipal Council
Parish	Concord
County	Cumberland
Current Zoning	R4 – High Density Residential (Strathfield Local Environment Plan, 2012)
Recent Land Uses	History review indicates the site has been primarily used for commercial and manufacturing purposes since at least 1936. The structures at the site are noted to have been demolished between 2014 and 2018 (STS, 2019a).

2.2 Surrounding Land Use

The site is situated within an area of mixed land uses. As outlined in **Section 2.1**, the most sensitive land use down and cross gradient from the site includes residential buildings to the north and west, and Powells Creek to the west of the site.

2.3 Regional Setting

Regional topography, geology, soil landscape and hydrogeological information are summarised in **Table 2-3**.

Table 2-2 Regional Setting Information

Attribute	Description
Site topography and drainage	An irregular shaped land parcel covering approximately 6,507 m^2, the site topography was generally flat, but gently undulating with a downward slope towards the south. Site drainage is inferred to be consistent with the general slope of the site, stormwater is assumed to flow south via drainage systems discharging to various stormwater easements and the municipal stormwater system.
Regional Geology	With reference to 1:100 000 scale Geological Series Sheet 9130 (Sydney) 1983; the site is likely to be predominantly underlain by black to dark grey shale and laminite (Rwa).
Soil Landscapes	The Soil Conservation Service of NSW Soil Landscapes of the Sydney 1:100,000 Sheet (Chapman and Murphy, 1989) indicates that the site overlies the *Blacktown (bt) - Erosional Landscape* at the north eastern half of the site and *disturbed terrain (xx) Erosional Landscape* in the south western half of the site. Development in the area (residential and commercial) has likely modified the soil landscape. However, typically the soil landscape comprises of gently undulating rises on Wianamatta Group shales and Hawkesbury shale and level plain to hummocky terrain, extensively disturbed by human activity.
Acid Sulfate Soil Risk	With reference to the 1:25 000 scale Prospect Parramatta Acid Sulfate Soil Risk Map – Edition 2 (Ref. Murphy, 1997), in conjunction with the Guidelines for the Use of Acid Sulfate Soil Risk Maps (Naylor et al., 1998), the subject land lies within the map class description of No Known Occurrence. In such cases, land management activities are not likely to be affected by acid sulfate soil materials. The Strathfield Municipal Council Local Environmental Plan 2012 Acid Sulfate Soils Map (ASS_004) shows the site is within an area mapped as Class 5 Acid Sulfate Soils (ASS). Council consent is therefore required prior to commencing any works by which the water table is likely to be lowered beyond 1 mAHD on adjacent class 1, 2, 3 or 4 land. The basement is proposed to have a finished floor level (FFL) of RL -6.0m Australian Height Datum (AHD).Taking into account the aforementioned design information and findings presented in previous investigations (STS, 2019a) where ASS were outlined as a potential concern;, the need for further Acid Sulphate Soil management was therefore considered warranted, and an ASS Management Plan was prepared separately in conjunction with this investigation.
Site Filling	Based on observations during previous investigations carried out by STS (2019A); the average fill depth across the site is approx. 1.5 metre below ground level (mBGL) and at a maximum fill depth of approximately 2.7mBGL. The fill is comprised of gravelly silty clay and gravelly silty sand. The maximum fill depth was found to be 2.7 mBGL (at BH14).
Typical Soil Profile	**Concrete slab–** thickness of approx. 0.2m overlaying; **Fill –** Gravelly clayey sand, fine grained, light grey, with gravel, dry, no odours (varying thickness 0.2 – 2.7 m) overlying; **Fill –** Silty sandy clay, brown, medium to high plasticity, with traces of gravel, moist, no odours (varying thickness 0.3 – 0.8 m) overlying; **Natural –** Silty clay, medium plasticity, light grey with yellow brown and occasional red brown, moist, no odours (varying thickness) overlying; **Bedrock–** Shale, dark grey with some light grey, clay seams, wet, no odour.

Attribute	Description
Depth to Groundwater	Based on this Detailed Site Investigation (STS, 2019a) the groundwater is expected to be encountered at depth ranging between 0.8mBGL to 4.5mBGL.
Nearest Surface Water Feature	Powells Creek <50 to the West and South of the site.
Groundwater Flow Direction	Groundwater has been inferred to flow north west toward Powells Creek.
Groundwater Salinity	Based on GME data presented in STS (2019A) (Electrical Conductivity: 1,040-18,612µS/cm) groundwater is considered to be fresh to brackish to saline in terms of water salinity.

2.4 Groundwater Bore Records and Groundwater Use

An online search of registered groundwater bores was conducted by EI on 01 July 2019 through the NSW Office of Water (Ref. https://realtimedata.waternsw.com.au/water.stm). There were no registered bores within a 500m radius of the site. The nearest registered bore is at distance greater than 1km NW of the site. As the registered groundwater bore is located out of the 1 km radius, it is not considered a receptor of potential contamination deriving from the site.

3. Site Characterisation

3.1 Available documents

This investigation follows on from previous investigations completed at the site, including:

- STS (2019a). Detailed Site Investigation 11-17 Columbia Lane, Homebush NSW. Columbia Lane Developments Pty Ltd. Report No. 19/1315 Project No. 21024/1934D-E, dated June 2019; and
- STS (2019b). Geotechnical Investigation 11-17 Columbia Lane, Homebush NSW. Columbia Lane Developments Pty Ltd. Report No. 19/1962 Project No. 21024/1803D-G, dated April 2019.

The findings of these reports are summarised in **Table 3-1** below; and the analytical results from STS (2019a) are attached in **Appendix C.**

Table 3-1 Summary of STS (2019a and 2019b) Reports

Assessment Details	Project Task Findings
STS, 2019a	
Objectives	▪ to evaluate the potential for site contamination on the basis of historical land uses, anecdotal and documentary evidence of possible pollutant sources; ▪ to investigate the degree of any potential contamination by means of intrusive sampling and laboratory analysis, for relevant contaminants of concern; and ▪ make recommendations for the appropriate management of any contaminated soils and/or groundwater.
Scope of Works	▪ a review of relevant hydrogeological and soil landscape maps for the project area; ▪ detailed site walkover inspection; ▪ construction of 27 borehole and 5 groundwater monitoring wells to depths between 6mBGL and 13.2mBGL; ▪ multiple level soil sampling within fill and natural soils and one round of groundwater sampling from the five groundwater monitoring bores; ▪ laboratory analysis of selected soil samples and for all groundwater samples for relevant analytical parameters as determined from the site history survey and field observation; ▪ laboratory analysis of selected soil samples for the purposes of acid sulfate soils (ASS) assessment; and ▪ data interpretation and reporting.
Key Findings	▪ Historical information reviewed indicated the land has been utilised primarily for commercial and manufacturing purposes since at least 1936, until its demolition between 2014 and 2018. Thus, the potential contaminating activities identified included; historic site filling and pesticide use, weathering of former building structures, historic onsite chemical storage and commercial use, and historic offsite manufacturing and commercial purposes. ▪ SafeWork NSW records indicated that two underground storage tanks (UST1 and UST2) with a volume of 1,000 gallons (approx. 4,500 litres) each were at the site. These tanks could have potentially stored Class 2 Dangerous Goods, including alcohol and methylated spirits.

Assessment Details	Project Task Findings
	The records also indicated that an above ground storage system with a volume of 1,500 gallons (approx. 6,800litres), potentially storing Class 1 and Class 2 Dangerous Goods (mineral oils and mineral spirits) existed within building footprint. However, at the time of investigation most of all structures had been demolished and the AST could not be located, nor did the records indicate where it had been installed. ▪ Land uses on surrounding properties were initially manufacturing and commercial uses to the north and east, with the rail corridor and utilities to the south, until between 2014 and 2018, when the commercial properties to the north were replaced with high-density residential in the form of apartment complexes. To the west, the primary land use was low-density residential until around 2003, at which time the area was redeveloped for medium density, followed by high-density around 2014. ▪ At the time of the investigation, it was noted that the area were UST2 was located appeared to have been backfilled; inferring the tank had been decommissioned and removed from the site. However, no formal documentation outlining the decommissioning and removal of UST1 or UST2 had been received, and so as a conservative approach it was assumed both tanks remain at the site. ▪ Soil sample results were generally within the adopted the adopted human health and ecological soil criteria, with the exception of: ‣ asbestos (friable and non-friable) in fill material at borehole BH8; ‣ PAHs (carcinogenic PAHs and/or B(a)p) in fill layer at boreholes BH2, BH4, BH5, BH7, BH8, BH13, BH16, BH17, BH22 BH23, and BH26; ‣ Cadmium and/or copper in fill material at boreholes BH2, BH8, BH16, and BH19; and ‣ PAHs (carcinogenic PAHs and/or B(α)p) in the natural soil layer at borehole BH1. ▪ Soil sample results for ASS assessment indicated there were present at the site. ▪ Groundwater samples results were generally within the adopted water quality guidelines and drinking water criteria, with the exception of: ‣ TRH and traces of VOCs in groundwater well GW3; ‣ TRH and B(α)p in groundwater well GW4; and ‣ Heavy metals (nickel and zinc) in monitoring well GW5; The soil and groundwater exceeding concentrations of the analytes in some of the soil and groundwater samples were considered to present an unacceptable risk to human health and or ecological receptors for the proposed development and will require a strategy of remediation and/or management to be implemented to mitigate these risks.
Conclusion & Recommendations	STS considered that the contamination identified can be further evaluated and remediated where required to render the site suitable for the proposed land use, provided recommendations detailed below are implemented: ▪ Preparation and implementation of a Remedial Action Plan (RAP) to address the identified soil and groundwater impacts; ▪ Preparation and implementation of a site specific Acid Sulfate Soils Management Plan; and ▪ Submission of a notification to the NSW EPA outlining the soil and groundwater notifiable impacts identified at the site as soon as practicable.
STS, 2019b	
Objectives	▪ To assess the subsurface conditions over the site and provide

Assessment Details	Project Task Findings
	recommendations regarding the appropriate foundation system for the site including design parameters.
Key Findings & Recommendations	▪ Soils on the site consist of low permeability silty clays; ▪ Groundwater was encountered at depths ranging 2.2 – 4.7mBGL; and ▪ Exposure classification for the onsite soils is non-aggressive for steel and mildly aggressive for concrete

3.2 Additional Documents

During this investigation, independent research into Council documents was completed, and identified a WSP Preliminary Site Investigation and Geotechnical Investigation completed in March 2011 (WSP, 2011). The report available online, covered the lands identified as 2-20 Parramatta Road and 11-13 Columbia Lane, Homebush NSW. The report provided further details on the specific site uses of the site and it indicated groundwater within the area that was investigation was between 2.57mAHD and 4.24mAHD. The information provided in the report was useful as an additional line of evidence to support the information outlined by the investigation completed by STS (2019a); however, it was limiting in the fact that the appendices were not available and thus the exact location of groundwater wells and other details could not be confirmed.

3.3 PFAS Assessment

EPA (2017) requires that Per- and poly-fluoroalkyl substances (PFAS) is considered in assessing contamination. EI use the following decision tree (**Table 3-2**) based on EnRisk (2016) for prioritising the potential for PFAS to be present on site and whether PFAS sampling of soil and water is required.

Table 3-2 PFAS Decision Tree

Preliminary Screening	Probability[3]	Justification
Did fire training occur on-site?	L	Historical records presented in past investigations (STS, 2019a) indicate the site was used for commercial and industrial purposes such as frozen food and clothing wholesaler and commercial mower business,
Is an airport or fire station up gradient of or adjacent to the site? [1]	L	No fire station is identified within close vicinity of the site.
Have “fuel” fires ever occurred on-site? e.g. ignition of fuel (solvent, petrol, diesel, kerosene) tanks?	L	Site history (**Section 3.1**) indicates the activities carried out at the site could have potentially involved general chemical storage, but given the size of the land and the multiple businesses that would of operated at one time, indicates that the likelihood of large volumes of petroleum products storage, and mass production of paints, polishes or adhesives is low.

Preliminary Screening	Probability[3]	Justification
Have PFAS been used in manufacturing or stored on-site ?[2]	L	Site history (**Section 3.3**) indicates trades such as furniture restoration, others operated on the site over decades. However, given the small area and the multiple businesses that operated on the site at any one time, the area for businesses to operate within was limited and thus the likelihood of mass use of PFAS containing products is low.

Note 1 **Notes**:
Note 2 L = Low, M = Medium, H = High.
Note 3 1. Runoff from fire training areas may impact surface water, sediment and groundwater.
Note 4 2. PFAS is used wide range of industrial processes and consumer products, including in the manufacture of non-stick cookware, specialised garments and textiles, Scotchguard™ and similar products (used to protect fabric, furniture, leather and carpets from oils and stains), metal plating and in some types of fire-fighting foam (https://www.nicnas.gov.au/chemical-information/factsheets/chemical-name/perfluorinated-chemicals-pfas)
Note 5 3. If medium or high probability is applicable to any of the preliminary screening questions, the site analytical suite will be optimised to include preliminary sampling and testing for PFAS in soil (ASLP Testing) and water.

3.4 Existing Site Contamination

Based on the findings of previous investigation completed by STS (2019a), the following sources of contamination were identified, and were considered relevant to the RAP.

3.4.1 in-situ USTs

WorkCover records indicate that two 1,000-gallon USTs were installed to store Class 2 Dangerous Goods. During their 2019 investigation, STS (2019a) indicated the possible location of the tanks (Ref. **Figure A.2**) and provided a wide range of possible Class 2 Dangeorus Good, as defined by WorkCover NSW; the tanks could have stored. However, further inspection of the documents by EI revealed that the liquids stored in the UST most likely included alcohol and possibly methylated spirits. The tanks are noted as still remaining onsite as no documentation regarding decommissioning has not been included in past investigations nor has it been provided by the landowner. .

3.4.2 Previous Commercial Activities

Historical review of land titles and aerials dating back to 1930 indicated the site was used for commercial, industrial and manufacturing purposes since at least 1936 until demolition of structures began i.e. circa 2014 – 2018 (STS, 2019a). Whilst the DSI did not specify what activities were carried out at the site, independent research completed by EI has indicated that the operations carried out at the land included the possible onsite use and storage of window cleaners, detergents, floor treatments, methylated spirits, degreasers and paint strippers; mechanical seal manufacturing and commercial mower business (WSP, 2011). These various activities in conjunction with the historically imported fill for site levelling activities and the demolition of previous structures (STS, 2019a), were considered a potential source of asbestos, heavy metal (HM) contaminants (being cadmium, copper) and polycyclic aromatic hydrocarbons (PAH) in the site soils.

3.4.3 Soil Vapour

The groundwater analytical data indicated that the individual VOC concentrations for all wells were below the laboratory PQL, total VOCs concentration for one of the upgradient wells (GW3) was detected at a value higher than the PQL. This assessment did not define the source of the VOC which may include the UST tanks. Given the presence of low VOC concentrations in the groundwater, soil gas sampling programme was recommended by STS (2019A) to determine the actual risk of ground gas to the future users of the site. However, EI recommends for further groundwater sampling should be first undertaken to assess whether or not soil vapour is an issue for the site.

3.4.4 Groundwater

The groundwater analytical data indicated that the samples from the five monitoring wells that were installed during the DSI were generally within the adopted water quality guidelines and drinking water criteria, with the exception of:

- TRH and traces of VOCs in upgradient groundwater well GW3;
- TRH and B(α)P in downgradient groundwater well GW4; and
- Heavy metals (nickel and zinc) in upgradient groundwater well GW5;

This assessment did not define the source of the exceeding analytes which may include:

- The in-situ UST tanks; and
- Residual impacts from surrounding land uses to the east of the site, which are inferred to be that of commercial and industrial natures;

An additional groundwater assessment is recommended to determine the actual risk of ground water to the future users of the site.

3.5 Potential Contaminants of Concern

Based on the findings reported in STS (2019A) DSI, the chemicals of concern (COC) for site remediation, validation and data gap closure are as follows:

- **Soil** - heavy metals (HM), total recoverable hydrocarbons (TRH), the monocyclic aromatic hydrocarbon compounds *benzene, toluene, ethyl-benzene* and *xylenes* (BTEX), volatile organic compounds (VOC), polycyclic aromatic hydrocarbons (PAH), organochlorine and organophosphorus pesticides (OCP/ OPP), polychlorinated biphenyls (PCB), and asbestos.
- **Groundwater** - HM, TRH, BTEX, PAH and volatile organic compounds (VOC), including chlorinated VOC and Phenols.

4. Conceptual Site Model

In accordance with NEPM (2013) *Schedule B2 – Guideline on Site Characterisation* and to aid in the assessment of data collection for the site, EI developed a preliminary conceptual site model (CSM) assessing plausible pollutant linkages between potential contamination sources, migration pathways and receptors. The CSM provides a framework for the review of the reliability and useability of the data collected and to identify data gaps in the existing site characterisation.

The CSM takes into account the change in land use from commercial/industrial to residential/recreational, as outlined in **Section 1.2** and presented in the development plans attached under **Appendix B**. The CSM also takes into account the following:

- The development comprises of a four level basement construction on 75% of the site. This will entail the removal of all fill and natural soil within the basement footprint.
- The deep soil areas (i.e. retained soil) will be turned into landscaping and recreational areas.

4.1 Subsurface Conditions

Current site soil was described as a layer of fill overlying alluvial soil and residual clays with Ashfield shale bedrock. Fill across the site was generally found to be 0.2 – 2.7m thick, with greater lenses of filling observed in the west and within the UST area. Shale bedrock was encountered at depths ranging from 4.0 to 6.6 mBGL.

The general site geology encountered during the previous investigations (STS, 2019a) is described as gravelly clayey sand and silty sandy clay fill overlying residual silty clays, sandy silty clays, gravelly silty clays overlying shale bedrock. The generalised subsurface profile of the site is summarised in **Table 3-2** below.

Table 4-1 Generalised Subsurface Profile

Layer	Description	Average Approximate Depth to Top & Bottom of Layer (mBGL)	
		Top	Bottom
Asphalt/Concrete	-	0.0	0.2
Fill	Gravelly clayey sand, fine grained, light grey, with gravel, dry.	0.2	1.5
	Silty sandy clay, brown, medium to high plasticity, with traces of gravel, moist.		
Natural	Silty clay, medium plasticity, light grey with yellow brown and occasional red brown, moist.	1.5	5.5
	Silty sandy clay, medium plasticity, light grey with yellow mottled, fine grained sand, moist.		
	Gravelly silty clay, medium to high plasticity, orange and red with mottled grey, moist.		
Bedrock	Shale, weathered, dark grey, dry to moist, no odour.	5.5	13+

Note 1 Notes:
Note 2 *Approximate depth to bottom of layer shown as mBGL.
Note 3 + Depth to termination of deepest borehole.
Note 4 Refer to borehole logs in **Appendix C** for specific information at individual test bore locations.

4.2 Contamination Pathways

The primary sources of contamination identified for the site were defined using the findings of previous investigations (**Section 3**) and an updated likelihood of exposure was derived for each of the source – receptor pathways applicable to the remedial works, as presented in **Table 4-2**.

Table 4-2 Receptor and Exposure Pathways

Media	COC	Exposure Pathway	Potential Receptor	Likelihood of Exposure
Fill within ecological / landscaping areas	Pesticides, Heavy Metals, TRH, BTEX, PAHs, Phenols, OCPs/OPPs, PCBs, VOCs and Asbestos.	Bioaccumulation Sediment migration Dermal contact Ingestion Inhalation Vapour intrusion	Ecological communities Future site users	Elevated concentrations of heavy metals were identified and a site-specific ecological assessment of all retained fill will be required to confirm suitability of the material for use. Asbestos was also identified in one of the boreholes located within the landscaping area to the north east of the site.
Material surrounding in-situ USTs	Volatile hydrocarbons (white spirits and methylated spirits) and possible components in Fill as above.	Dermal contact Ingestion Inhalation Vapour intrusion	Construction and Maintenance Workers Groundwater Future users of basement (if residual contamination is identified at end use)	Exposure potential considered moderate based on the contaminant concentrations reported. Validation sampling of volatile concentrations should confirm no residual migration to soil vapour exists and should significant impacts to soil be identified, further groundwater characterisation may be required.
Groundwater	Heavy Metals, TRH, BTEX, PAHs, Phenols, and VOCs	Vapour intrusion Offsite migration to Powells Creek Inhalation Dermal Contact Ingestion	Users of basement Offsite residents and receiving waterbodies	Exposure potential considered to be low to medium based on contaminant concentrations identified however should significant impacts to soil be revealed; further assessment may be required.
Vapour	Methylated & White Spirits plus possible other VOCs	Inhalation	Future site occupants Construction and Maintenance Workers Offsite residents	Exposure potential considered to be low based on the minor concentrations of total VOCs identified for the site. The exposure pathway to off-site residents, by migrating contamination under buildings, considered unlikely.

4.3 Data Gaps

Data gaps or uncertainties with the current information are summarised as follows:

- The exact locations of the in-situ USTs and whether they still remain at the site;
- The quality of material surrounding the in-situ USTs;
- The condition of soils beneath the concrete slabs across the site;
- Lateral extent of friable asbestos impact reported in the surficial fill at BH8_0.2m, BH9_0.2m and BH12_0.5m;
- Lateral extent of carcinogenic PAH impact reported in the natural layer at BH1;
- The potential for Acid Sulfate Soils to be encountered along the western and southern boundaries as indicated in EI (2019) ASSMP;
- The quality of the groundwater post removal of the USTs; and
- The classification of fill and soil for waste management according to NSW EPA (2014) Waste Management Guidelines.

The preliminary risk characterisation could be modified with further investigation but as noted above some uncertainties may remain.

4.4 Extend of Remediation Required

4.4.1 Remediation Areas

Based on all existing site characterisation data the areas of the site requiring remediation are illustrated in **Figure A.4** and outlined as follows:

Entire Site – including landscaped areas:

- **Former UST** – The identified USTs in the north east quadrant of the site, will require, appropriate offsite removal and destruction in accordance with NSW WorkCover regulations and *Protection of the Environment Operations (Underground Petroleum Storage Systems) Regulation* (NSW, 2008 & 2014), with supply of disposal documentation. The surrounding soils in the remaining tank pit will require validation in accordance with the adopted Remediation Acceptance Criteria (criteria);
- **Asbestos –** The presence and extent of any asbestos contamination in surface fill materials. After the removal of all hardstand flooring, a qualified environmental scientist/engineer will be required to do a walkover to inspect the presence of any historically buried asbestos on the site.

  Due to the identification of friable asbestos at three out of the 24 sampling locations completed by STS (2019a), it is possible that friable asbestos contamination is not widely distributed across the site and may be localised. An unexpected finds protocol will outline the procedure for actioning should supplementary visible FCS asbestos contamination be identified during the walkover following the removal of the hardstand floor;
- **Residual Impacted Fill** – the waste classification, excavation and offsite disposal of remaining fill, which has been shown (based on the existing data set) to be impacted with PAHs. Natural soils will require validation in accordance with the adopted remediation assessment criteria;

- **Groundwater** – Groundwater assessment should be conducted post removal of site wide fill and USTs. Groundwater will require validation in accordance with the adopted remediation assessment criteria.

Setback Areas – paved areas:

- **Impacted Natural Material** – The presence and extent of any PAH contamination in natural material. Due to the identification of PAH at only one sampling location (BH1), it is possible that PAH contamination is not widely distributed across the site and may be localised. Further delineation of PAH contamination within the vicinity of borehole BH1 is required. Validation of residual natural material within the vicinity of BH1 will require validation in accordance with the adopted remediation assessment criteria.

4.5 Approximate Soil Volumes

The excavation and offsite disposal remedial option should ensure no sources of soil contamination remain that would trigger the requirement for ongoing environmental management and monitoring. As shown in **Table 4-3** it is estimated that a total approximate in-situ volume of 70,264 m^3 of material is to be excavated for the remedial works, including 7,807 m^3 of fill and 61,091 m^3 of natural material (i.e. material meeting the NSW EPA Virgin Excavated Natural Material (VENM) classification).

Further in-situ characterisation of fill material is required to adequately classify the soils to be removed as waste, and may assist by informing the segregation of asbestos-impacted materials.

Natural material which is free of Acid Sulfate Soils (ASS) may be reused onsite in the deep soil areas where backfilling for levelling purposes would be required.

Table 4-3 Approximate Soil Volumes

Material to be removed from the site	Approximate In-situ Volume [3] (m^3)	Excavation Area – Approximate Dimensions	
		Area (m^2)	Average Depth [2] (m)
Hardstand pavement	-	Unknown	0.1
Fill material in landscaping areas[1]	1,365.3	1,365.3	1.0
Fill material excluding landscaping areas[1]	7,807.05	5,204.70	1.5
Natural soil[4,5]	61,091	5,204.70	12
Total Estimated Volume of material	70,264	-	-

Notes:
[1] Thickness of fill in calculation does not include the thickness of the hardstand pavement.
[2] The material thickness relies upon the borehole logs presented in STS (2019a) report. These are attached in **Appendix C**.
[3] EI notes these volumes calculated are approximate only and are based on currently available information. EI note that exact volumes may differ from those presented above.
[4] Thickness of natural material calculated by subtracting the average depth of fill from the difference between the ground level and basement RLs indicated on the proposed plans (Ref. Mosca Pserras Architects. Project No14028, dated 03 October 2017).
[5] EI notes the calculated volume for natural material, assumes material will be reused onsite in the landscaping areas where backfilling for levelling purposes will be required.

5. Remediation Goals

The main objective of this RAP is to make the site suitable for high density residential use. Remediation goals were developed in line with relevant legislation (NSW EPA, SEPP 55 guidelines and Council's contaminated land policy), and include:

- Detailing the methods and procedures to be implemented for site remediation, to guide the earthworks and assist the client in meeting the required objectives of the works;
- Meeting the conditions of the planning consent and to render the site suitable for the proposed land use(s);
- Demonstrating that the proposed remediation strategy for the site is environmentally justifiable practical and technically feasible;
- Define site acceptance criteria, to be applied as a benchmark to assess the suitability of material to remain at the end use of the site;
- Mitigating possible off-site migration of contaminants (including migration in existing utilities such as the sewer, stormwater and other subsurface pipes or service trenches);
- Consideration of the principles of ecologically sustainable development in line with Section 9 of the *Contaminated Land Management Act 1997*;
- Minimising waste generation under the Waste Avoidance and Resource Recovery Act 2001;
- Remediate all site contamination so there are no unacceptable risks to off-site receptors; and
- Demonstrating that the plans for site management of remediation work consider work health and safety, environmental management, community relations and site contingencies.

5.1 Remediation Criteria

5.1.1 Soil Remediation (Validation) Criteria

As the proposed site development will comprise high density residential use with limited access to soils and retained deep soil areas for communal use, the following soil remediation criteria, which are based on NEPM (2013) *Schedule B1 Guideline on Investigation Levels for Soil and Groundwater*, will be adopted as clean up levels for the applicable areas of the site.

Basement Footprint

- NEPM 2013 *Residential B Health-based Investigation Levels* (HIL B) for residential settings with minimal opportunities for soil access (including dwellings with fully and permanently paved yard space such as high-rise buildings and apartments);
  - HIL-B screening values can be applied to soils within the basement footprint as illustrated in **Figure A.5.**
- NEPM 2013 *Soil Health Screening Levels* for vapour intrusion (HSLs D) for coarse-textured (sandy) soils in commercial / industrial settings;
  - HSL-D screening values can be applied to soils within the within the basement footprint as illustrated in **Figure A.5.**; and

- NEPM 2013 *Management Limits for TRH fractions* for residential, parkland, and public open space - coarse-textured soils.

Landscaped Areas and Paved Set Back Areas

- NEPM 2013 *Recreational C Health-based Investigation Levels* (HIL C) for Public open space such as parks, playgrounds, playing fields (e.g. ovals), secondary schools and footpaths;
  - HIL-C screening values can be applied to soils within the landscaped areas and in the paved set back areas as illustrated in **Figure A.5.**
- NEPM 2013 *Soil Health Screening Levels* for vapour intrusion (HSLs C) for coarse-textured (sandy) soils in commercial / industrial settings;
  - HSL-C screening values can be applied to soils within the landscaped areas and in the paved set back areas as illustrated in **Figure A.5.**;
- NEPM 2013 *Management Limits for TRH fractions* for residential, parkland, and public open space - coarse-textured soils; and

For landscaped areas only:

- NEPM (2013), Schedule B1, Ecological Investigation Levels (EIL) – urban residential and public open space; and
- NEPM (2013), Schedule B1, Ecological Screening Levels (ESL) – urban residential and public open space.

The contaminant threshold values relating to the adopted soil remediation criteria are tabulated in **Appendix D, Table D-1**. Conformance with the soil remediation criteria will be deemed to have been attained when soil validation samples from similar lithology and depth show contaminant concentrations that are below the specified criteria, or, as a minimum, the 95% upper confidence limit (UCL) mean concentration values of each contaminant in the soil remediated area (i.e. across the excavated surface), are below the respective remediation criteria.

5.1.2 Waste Classification Criteria

Prior to being removed from the site, excavated soils must be classified in accordance with the NSW EPA (2014) Waste Classification Guidelines (the 'Waste Guidelines'). Under these guidelines, fill/soils may be classified into the following groups: *General Solid Waste*, *Restricted Solid Waste* or *Hazardous Waste*, subject to chemical assessment using NATA-registered laboratory methods for total and leachable contaminant levels.

The total contaminant threshold concentrations and leachate thresholds tested using the TCLP methodology for each relevant contaminant parameter will then be interpreted against the respective NSW EPA (2014) thresholds, which are presented in **Appendix D, Tables D-2, Table D-3** and **D-4**, in order to classify the waste soils. Any soils containing asbestos would also be classified as *Special Waste - Asbestos Waste*. In accordance with the *NSW Waste Regulation 2014*, waste soils must only be disposed to a waste facility that is appropriately licenced to receive the incoming waste. It is therefore recommended that confirmation is obtained from the waste facility prior the materials being removed from the site.

Should the analytical results exceed the SCC2 and/or TCLP2 thresholds, then the materials will be classified as *Hazardous Waste*. In such cases, material stabilisation treatment with EPA approval may be required prior to offsite disposal. Unexpected material may need to be segregated depending on the source of the waste, prior to conducting waste classification assessment. This approach is discussed in more detail under *Contingency Management* in **Section 9.6**.

5.1.3 Groundwater Criteria

- ANZAST (2018) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality – Marine Waters*, as the site is located approx. 1.0km from Homebush Bay (the receiving water body), which is considered to be tidally influenced and therefore classed as a marine water ecosystem;
- NHMRC (2018) *Australian Drinking Water Guidelines Paper 6 National Water Quality Management Strategy for Recreational settings (the lowest of the Health Guideline x10 or the Aesthetic Guideline is chosen as the assessment criteria)*, were applied in light of the potential for industrial and recreational use of groundwater down-hydraulic gradient of the site;
- *NEPM 2013 Groundwater Health Screening Levels* for vapour intrusion (HSLs A&B) for coarse-textured (sandy) soils on low to high density residential settings;
    - These values should be applied to the potential offsite migration of groundwater concentrations.

The contaminant threshold values relating to the adopted groundwater remediation criteria are tabulated in **Appendix D, Table D-5**. Conformance with the groundwater remediation criteria will be deemed to have been attained when additional groundwater samples show contaminant concentrations that are below the respective remediation criteria.

6. Data Quality Objectives

In accordance with the US EPA (2006) *Data Quality Assessment* and the EPA (2017) *Contaminated Land Management: Guidelines for the NSW Site Auditor Scheme* (3rd Edition), data quality objectives (DQO) will be defined by the EI team to determine the appropriate level of data quality needed for the specific requirements of the project. The DQO process to be applied for the proposed remediation is documented in **Table 6-1**.

Table 6-1 Summary of Project Data Quality Objectives

DQO Steps	Details
1. State the Problem Summarise the contamination problem that will require new environmental data, and identify the resources available to resolve the problem; develop a conceptual site model.	Historically the site has been used for commercial and manufacturing purposes since at least 1936, until its demolition between 2014 and 2018. The site uses have entailed onsite chemical storage in USTs and ASTs. A conceptual site model is presented in **Section 3**. The site is required to be rendered suitable for the proposed residential development with associated public open space. Previous site investigations indicate the presence of possibly two UST tanks; asbestos, heavy metal (HM) contaminants (being cadmium, copper) and polycyclic aromatic hydrocarbons (PAH) in the site soils; and TRH, heavy metal (HM) contaminants (being nickel and zinc) and traces of VOCs in the groundwater.
2. Identify the Goal of the Study (Identify the decisions) Identify the decisions that need to be made on the contamination problem and the new environmental data required to make them	Based on the objectives outlined in **Section 1.3,** the following decisions are identified: Has the nature, extent and source of any soil, vapour and/or groundwater impacts onsite been defined? What impact do the site specific, geologic and hydrogeological conditions have on the fate and transport of any impacts that may be identified? Does the level of impact coupled with the fate and transport of identified contaminants represent an unacceptable risk to identified human and/or environmental receptors on or offsite? Will site soils and groundwater require further remediation and/or special management before the site can be used for residential purposes?
3. Identify Information Inputs (Identify inputs to decision) Identify the information needed to support any decision and specify which inputs require new environmental measurements	Inputs to the decision making process include: The proposed end land use outlined in **Section 1.2**; Previous investigations performed at the site, summarised in **Section 3**; Additional soil, groundwater and/or soil vapour investigation sampling, and laboratory analytical results; Soil validation sampling of remedial excavation surfaces including, the UST areas and identified contamination points; Sampling from stockpiled soil material for waste classification assessment; Laboratory analytical results of soil validation samples; and Assessment of analytical results in relation to the remediation criteria. At the end of the validation, a decision must be made regarding whether the environmental conditions are suitable for the

DQO Steps	Details
	proposed redevelopment, or if additional investigation or remedial works are required to make the site suitable.
4. Define the Boundaries of the Study Specify the spatial and temporal aspects of the environmental media that the data must represent to support decision	**Lateral** – The cadastral site boundaries. **Vertical** – From existing ground surface, underlying fill and natural soil horizons, to the base of contaminated soil and/or bulk excavation level (BEL), and underlying water-bearing zones. **Temporal** – Results are valid on the day of data and sample collection and remain valid as long as no changes occur on site or contamination (if present) does not migrate on site or on to the site from off-site sources.
5. Develop the Analytic Approach (Develop a decision rule) To define the parameter of interest, specify the action level, and integrate previous DQO outputs into a single statement that describes a logical basis for choosing from alternative actions	Laboratory analytical results will be accepted if: All contracted laboratories are accredited by NATA for the analyses undertaken; All detection limits fall below the remediation criteria; RPDs for duplicate samples are within accepted limits; and Laboratory QA/QC protocols and results comply with NEPM requirements. Further decisions are also required following any additional assessment. This may require updating of the RAP to include groundwater remediation or management.
6. Specify Performance or Acceptance Criteria (Specify limits on decision errors) Specify the decision-maker's acceptable limits on decision errors, which are used to establish performance goals for limiting uncertainties in the data	Specific limits for this project are to be in accordance with the National and NSW EPA guidance, and appropriate indicators of data quality and standard procedures for field sampling and handling. This includes the following points to quantify tolerable limits: The null hypothesis for the remediation of soils is that the: 95% Upper Confidence Limits (UCL) of the mean for contaminants of concern exceed the adopted remediation criteria across the site; Sampling on a $25m^2$ grid will allow detection of a circular hotspot with a nominal diameter of 6m with 95% certainty. The acceptance of the site as validated will be based on the probability that: The 95% UCL of the mean of the data will satisfy the given site criteria. Therefore a limit on the decision error will be 5% that a conclusive statement may be incorrect; and The standard deviation of the results is less than 50% of the relevant remediation acceptance criterion; and No single results exceeds the remediation acceptance criteria by 250% or more; and Soil concentrations for chemicals of concern that are below investigation/validation criteria made or approved by the NSW EPA will be treated as acceptable and indicative of suitability for the proposed land use(s).
7. Develop the Detailed Plan for Obtaining Data (Optimise the design for obtaining data) Identify the most resource-effective sampling and analysis design for general data that are expected to	Written instructions will be issued to guide field personnel in the required fieldwork activities. Soil remedial excavation is to be performed as per **Section 7**. Soil validation sampling is to be completed as per the methodology prescribed in **Section 9**. Groundwater and soil vapour investigations will adopt the methodologies outlined in this RAP.

DQO Steps	Details
satisfy the DQOs	Validation sampling procedures that would be implemented to optimise data collection for achieving the DQOs. Review of the results will be undertaken to determine if further excavation and additional sampling is warranted. Additional investigations would be considered to be warranted where soil, groundwater and/or vapour concentrations are found to exceed remediation criteria endorsed by the NSW EPA, relevant to the proposed land use(s).

7. Remediation Technologies

7.1 Regulatory Overview

Section 16 in Volume 1 of the NEPC (2013) *National Environmental Protection (Assessment of Site Contamination) Amendment Measure 2013* indicates that the preferred hierarchy for site remediation options and/or management is:

- On-site treatment of the contamination so that it is destroyed or the associated risk is reduced to an acceptable level; and
- Off-site treatment of excavated soil, so that the contamination is destroyed or the associated risk is reduced to an acceptable level, after which soil is returned to the site; or, if the above are not practicable:
- Consolidation and isolation of the soil on-site by containment with a properly designed barrier; and
- Removal of contaminated material to an approved site or facility, followed, where necessary, by replacement with appropriate material; or
- Where the assessment indicates remediation would have no net environmental benefit or would have a net adverse environmental effect, implementation of an appropriate management strategy.

When deciding which option to choose, the sustainability (environmental, economic and social) of each option should be considered, in terms of achieving an appropriate balance between the benefits and effects of undertaking the option.

Other considerations to mitigate groundwater contamination measures, as outlined by the EPA (2007) *Guidelines for the Assessment and Management of Groundwater Contamination*, include:

- Notifying of the affected property (under the CLM Act 1997) and the downgradient receptors;
- Containment of the contamination plume;
- Active or passive clean-up of contaminated groundwater (this may include the concept of clean-up to the extent practicable (CUTEP)), which may include ongoing monitoring of groundwater and/or contingency plans and management plans to mitigate risks; and
- Legislative control through restricting groundwater use in and down-gradient of the contaminant plume.

For this site, a number of remediation options were reviewed to examine the suitability of each method, the surrounding properties, geological and hydrogeological limitations and the following considerations:

- Development requirements (residential, with limited access to soils and landscaped areas);
- Prioritisation of works in areas of most concern;
- Ability of remedial method to treat contamination with respect to material and infrastructure limitations;
- Remedial timetable;
- Defensible method to ensure the site is remediated to appropriate levels / validation criteria; and
- Regulatory compliance.

7.2 Remedial Technologies Review

A number of remediation options were reviewed to examine the suitability of each method, with due regard for the surrounding land uses, as well as the geological and hydrogeological limitations.

Brief discussion of the various remediation technology options is provided in **Appendix E**. Each of the available remediation technologies, except ones that are not commonly used in Australia (for instance *in situ* thermal or steam injection), are summarised in terms of their suitability in **Table 7-1** below.

Table 7-1 Remedial Technology Review

Remediation methodology	Description	Advantages	Disadvantages	Suitability
No Action	'No Action' can be considered if: There is no measurable contamination; Contaminant concentrations are below assessment guidelines; Contaminants are not mobile; or Exposure to contaminated soils is unlikely.	No remediation costs Creates minimal disturbance to the site Retains material on-site	Not applicable to the kind of contamination encountered at the site. Contamination would remain *in situ* allowing potential vapour intrusion and off-site migration of contamination and impacts on groundwater. Would pose limitations on land use options. Requires an Environmental Management Plan and ongoing monitoring.	Not Suitable - the key objective of the remedial strategy is to make the site suitable for residential use without the need for ongoing monitoring. In addition, the USTs require decommissioning and remediation, and soils located in the areas of the proposed basement require excavation and offsite disposal.
On-site bioremediation (biostimulation)	Excavated soils are thoroughly broken down and aerated, mixed with microorganisms and nutrients, stockpiled and aerated in above ground enclosures.	Cost effective if soils are utilised on-site. Lower disposal costs. Limited requirement to import fill material to site. Retains material on-site.	Significant area of site required to land farm material. Undefined remediation timeframe. Potential for odour problems. Uncertainty of successful results, particularly for the VOCs. Not suitable for asbestos or metal contamination.	Not suitable – asbestos, PAH and heavy metal contamination within the fill are not addressed by this remediation.
In situ treatment	*In situ* treatment of impacted soils by SVE, steam stripping, ISCO or injection of oxygen releasing	Creates minimal disturbance to the site (no excavation). Cost effective for large scale site	Not applicable to the kind of contamination encountered at the site. Expensive establishment and on-going	Not suitable - this method is designed for widespread hydrocarbon impacted soils. Since the present dataset does

Remediation methodology	Description	Advantages	Disadvantages	Suitability
	compounds.	remediation projects of light to mid-weight petroleum hydrocarbons. Potential to simultaneously remediate dissolved phase hydrocarbons in site groundwater.	costs. Potential for odour problems. Requires detailed design, pilot trials and management. SVE requires high vacuum pressure over a long period and will not work in saturated conditions.	not provide evidence of widespread contamination, this is not considered to be an economically viable option.
Consolidation and/or capping	Risk minimisation approach where impacted soils are managed on-site by capping the ground surface with a clean, impermeable layer of fill material.	Effectively removes risk to human health by eliminating exposure pathways.	Importance of capping materials. Contamination would remain *in situ* allowing potential off-site migration of contamination and impacts on groundwater. Would pose limitations on land use options. Requires an Environmental Management Plan and ongoing monitoring.	Not Suitable - an EMP with ongoing monitoring would be required, due to the retention of contaminated materials on the site, and the key objective of the remedial strategy is to make the site suitable for residential use without the need for ongoing monitoring.
Excavation and off-site disposal	Excavate impacted materials. Transport directly to a licensed landfill facility. Re-instate site with imported clean fill material.	Fast – impacted material removed immediately, significantly reducing potential for impact to groundwater. No storage or treatment problems. Reduced vapour/odour issues as impacted materials removed from site. Minimal design and management costs. In line with the proposed development, which includes a 4 level basement that covers 75% of the site.	Transfer of waste to another location (licensed waste facility). High costs associated with the disposal of waste soils / bedrock and importation of clean backfill (in the case that a basement car park is not approved). Requires waste classification prior to disposal, keeping of thorough waste records, waste tracking and reporting. Sustainability issues related with disposal to landfill.	Suitable – for meeting the key project objective to make the site suitable for residential use without the need for ongoing monitoring. This will remove potentially leachable contamination source and prevent vertical migration to the groundwater system. Should soil vapour be an issue for the site, this remediation strategy will allow for the installation of a vapour mitigation membrane and venting layer thus providing added level of

Remediation methodology	Description	Advantages	Disadvantages	Suitability
				protection.
Natural attenuation	Allowing the contaminants to biodegrade naturally following removal of the contamination source.	No remedial excavation of site. Retains materials on site. Sustainable, cost effective remediation method.	Slow process. Potential for contamination to further impact on the groundwater aquifer and nearby environmental receptors. Would require Environmental Management Plan and ongoing monitoring.	Not Suitable - primarily suited to addressing groundwater contamination, which is not identified as being significant. In addition, the approach would not address soil and soil vapour impacts.

7.3 Preferred Remediation Option

Based on the available remedial technologies, the proposed site development (high density residential, with associated four level basement car parking and landscaped areas), the potential risks to human health and the environment, as well as the relative cost effectiveness of feasible remedial techniques, the preferred remedial option for the site is:

- Removal of USTs; followed by
- Complete and thorough offsite disposal to licensed waste facilities of all impacted fill and natural soils up to a depth of maximum 9mBGL. This coincides with the proposed depth of the proposed four level basement. Excavation of bedrock would be undertaken where necessary. All wastes shall be transported to appropriate, EPA-licensed facilities, after formal classification. All excavated (remediation) areas shall be validated by base and wall, soil sampling.
- Site reinstatement with validated, imported (or recovered) excavated natural materials;
- Soil vapour monitoring prior to bulk excavation works; and
- Groundwater monitoring prior and during bulk excavation works.

7.4 Site Preparation, Licences & Approvals

7.4.1 Consent Requirements

In accordance with *SEPP 55 - Remediation of Land*, the category of the remediation works defines whether consent is required prior to the commencement of the works. Under *SEPP 55*, works where there is the potential for significant environmental impact are classed as *Category 1* and require development consent. *Category 2* works pose a low potential for environmental impact and do not therefore require prior consent. The determination for the subject site is outlined in **Table 7-2**.

Table 7-2 Remediation Works Category Determination

Significant Environment Impact	Yes/No	Category
Designated Development or State Significant Development	No	2
Critical or threatened species habitat	No	2
Have significant impact on threatened species, populations, ecological communities or their habitats	No	2
In area identified environmental significance such as scenic areas, wetlands (see list*)	No	2
Comply with a policy made under the contaminated land planning guidelines by the council.	Yes	2
Is work ancillary to designated development	Yes	2

Notes: * Environmental significance list -coastal protection, conservation or heritage conservation, habitat area, habitat protection area, habitat or wildlife corridor, environment protection, escarpment, escarpment protection or escarpment preservation, floodway, littoral rainforest, nature reserve, scenic area or scenic protection, or wetland.

Based on the above assessment, the remediation works for the site are considered as Category 2 and will not require development consent. Category 2 works do however require notification to the consent authority; therefore, Council should be notified 30 days before commencement of the works. The 30-day limit does not prevent Council intervention after that time for a breach of the *EPA Act 1997* or non-compliance with *SEPP 55*. The notification also serves as the basis for updating Council records on properties in the local government area and must:

- Be in writing;
- Provide contact details for the notice;
- Briefly describe the remediation work;
- Show why the work is considered Category 2 remediation work;
- Specify the property description and street address on which the remediation work is to be carried out;
- Provide a location map; and
- Provide estimates for commencement and completion dates of the work.

Provision of this RAP, as well as an indication of commencement and completion dates of the works in writing, is usually sufficient to meet the requirements of this notification.

7.4.2 Development Consent & Control Plans

All works should be in accordance with the Strathfield Municipal Council DCPs and any development consent issued by Council for the development.

7.4.3 Other Licence Requirements

The appointed site contractor should prepare an appropriate Construction Environmental Management Plan (CEMP), health and safety plans and other plans required by the Council DA and DCPs. Where asbestos removal is required, the contractor must be appropriately licensed to perform such works.

8. Remediation Works

8.1 Remediation Strategy

The preferred remediation strategy involves bulk excavation and disposal of impacted materials, and the monitoring of groundwater and soil vapour.

Following approvals and site establishment, the main site remediation works would include, but not be limited to:

- **Stage 1 –** Preliminaries
- **Stage 2 –** UST removal and validation
- **Stage 3 –** Additional Soil & Groundwater Assessment (Data gap closure)
- **Stage 4 –** Removal of Asbestos Impacted Fill
- **Stage 5 –** Handling, Management and Waste Classification of Remaining Fill and Concrete Slabs for Offsite Disposal
- **Stage 6 –** Soil Validation and Classification of Materials Suitable for Reuse (such as virgin excavated natural material)
- **Stage 7 –** Validation Report Preparation.

Contingent Action

Should unexpected finds be discovered during the course of the remediation program, or should any phase of the validation identify residual, high level contamination requiring additional remediation, then the procedures described under the Unexpected Finds Protocol (**Section 9.8**) and/or the Validation Plan (**Section 10.1**) will be implemented, until the remediation goals have been achieved and the area is deemed suitable for the intended land use.

8.2 Remediation Methodology

8.2.1 Stage 1 – Preliminaries

Site Preparation

Notice should be given to Council at least 30 days prior to the commencement of remediation works. A list of all required work permits will be obtained from Council and arrangements are to be made to obtain the necessary approvals from the relevant regulatory authorities.

The site itself will be prepared in accordance with the requirements of the Site Management Plan outlined in **Section 9**. The site developer would also need to prepare and implement a Construction Environmental Management Plan (CEMP), Asbestos Management Plan (AMP) and Site Work Health and Safety (WHS) Plan prior to any site works. A framework for CEMP and WHS requirements are outlined in **Section 9.** Establishment of environmental controls, site access, security, fencing, warning signage and preparation of a Health Safety and Environment Plan is required prior to works commencement. A project plan should also be developed to outline engineering design for excavation support (if required), water treatment requirements and design, staging of excavation works, stockpiling, waste stabilisation, waste material loading, traffic management and waste tracking.

As part of the site preparation phase and preliminary tasks a remediation workshop should be conducted with the appointed contractor(s) to further develop any remedial measures, excavation plans and environmental management requirements.

Also prior to commencing work the site contractor is to complete a staging or project plan that outlines the basic stages of the remediation works. The staging plan should include, but not be limited to:

- Staging of the decommissioning and removal of tanks and associated equipment;
- Staging of areas to be excavated;
- Areas designated for waste segregation, screening and storage (stockpiling), amenities, soil and groundwater treatment (if required);
- Truck movements to allow loading to mitigate impacts to surrounding land users and council infrastructure; and
- Proposed environmental mitigation measures.

Site inspection

Following removal of USTs and floor slab/pavement; a site walkover is to be conducted by a qualified and experienced environmental scientist/engineer to assess any visual signs of contamination, supplementary asbestos contamination in surface fill soils, and building waste (potentially containing asbestos) that may have been buried beneath the building slab prior to any further excavation.

8.2.2 Stage 2 – UST removal and validation

Tank decommissioning and removal of the associated infrastructure has not been completed. Based on the site investigation completed by STS (2019A), it is understood that two UST possibly storing any liquid that contains methylated spirits with a flash point of less than 65^0 Celsius; are present at the site. The STS (2019A) assessment indicated the location of the USTs to be within the norther eastern quadrant of the. The area of where the USTs are likely to be located is illustrated in **Figure A.4.**

Prior to any deep excavation, the ASSMP prepared by EI (2019) should be implemented.

UST Decommissioning

Two UST areas have been identified at the site, as discussed in **Section3.2**. UST infrastructure, including UST, anchors, air vent pipes and direct or remote fill points, will require decommissioning and removal as part of the site remediation process.

Residual flammable liquids, and solvent/water mixtures may be present within the tank and product lines. Any liquid waste remaining within site infrastructure should firstly be drained, and classified for disposal purposes as defined in NSW EPA (2014b). The liquid waste should be removed from site by a licensed liquid waste transporter and disposed to a suitably licensed liquid waste facility. The contractor shall provide appropriate documentation for waste disposal.

A SafeWork licensed and experienced tank removal contractor should be engaged to manage the tank and infrastructure removal process, in accordance with Australian Standard for the removal and disposal of underground petroleum storage tanks (AS4976 – 2008), SafeWork guidelines and the *Protection of the Environment Operations (Underground Petroleum Storage Systems) Regulation 2014* (the 'UPSS Regulation'). SafeWork NSW should be notified within 7 days of the removal of UST. Where buried UST are discovered, these will be targeted for decommissioning and offsite destruction in accordance with NSW SafeWork guidelines and the UST Regulation.

The contractor is also to record the condition of the tanks and associated infrastructure, and provide documentary evidence on destruction of the USTs for final validation report.

Remedial Excavations

Following decommissioning and removal, contaminated soils may be found in vicinity of the UST and associated lines. Such materials will require separate management from the remainder of the site, via remedial excavations, followed by waste classification and off-site disposal.

The general procedure for remedial excavation of the UPSS is described below:

1 Any infrastructure, residual product and liquid in the excavation area should be removed in accordance with the procedure described above. Localised deep excavations (sumps) may be created within the area to allow perched groundwater to drain to the sumps. The accumulated liquid will be removed by an appropriately licenced liquid waste removal contractor for appropriate disposal and /or recycling, after on-site treatment (if necessary).

2 "Chase-out" excavation of walls and base of the area, with regular field screening of soil headspace samples using a calibrated Photo-ionisation Detector (PID). Materials exhibiting unusual odour, staining and / or PID reading > 30 ppm will be stockpiled separately for waste classification. Excavation should not jeopardise the stability of adjoining properties and structures. The open excavation pits should be clearly demarcated with star pickets and tapes.

3 "Chase-out" excavation should continue until all walls and base of the excavation are observed to be free of odour and staining and PID reading of headspace sample are less than 30 ppm. Validation samples will be collected for laboratory analysis, from the base and side walls of the final remedial excavations, in accordance with NSW EPA (2014a) *Technical Note: Investigation of Service Station Sites.* Further details are discussed in **Section 10**.

4 Spoils from remedial excavations are to be stockpiled separately from other site fill / soils, for *ex-situ* waste classification assessment. General management requirements of stockpiles on site are described in **Section 9.2**.

5 Stockpiles resulting from remedial excavations will be visually inspected, sampled and analysed for waste classification in accordance with Section 7.5 in Schedule B2 in NEPM (2013) and NSW EPA (2014b) *Waste Classification Guidelines*:

6 Collection of one sample per 25 m^3 of stockpiled materials, up to 250 m^3. A minimum of three samples is required for any stockpile. For stockpiles > 250 m^3 but < 2,500 m^3 in size, a statistical analysis approach may be used with the collection of 10 samples.

7 Analytical suite for waste classification will include:

8 priority metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc); TRH; BTEX; PAH; OCP; OPP; PCB, asbestos, TCLPs (as required) and any additional chemicals of potential concern that may be identified during site remediation.

8 Waste classification certificates will be prepared for classified stockpiles, which will be transported and disposed to appropriately licensed waste landfill facilities according to classification. General material handling and management requirements are discussed in **Section 9.2**. Waste disposal documentation will be maintained by the site contractor and provided to the environmental consultant for reporting purposes.

9 Validation of voids following remedial excavation of UST and associated contaminated soil should be undertaken according to the validation plan provided in **Section 10**.

8.2.3 Stage 3 – Additional Soil & Groundwater Assessment

Following the removal of the hardstand pavement across the site, to enable appropriate contaminated fill disposal and site characterisation, the following data gap closure investigations, which will address the issues raised in **Section 4.3**; are to be conducted prior to the commencement of remedial works:

Soil Assessment – Public open space and set back areas

- Complete four (4) test pits across the proposed public open space area, and four (4) test pits along the setback area as shown in **Figure A.4**. An upper soil profile sample (or soil extracted immediately beneath the concrete hardstand / pavement) will be collected at each of the eight (8) test pit locations and tested for chemicals of concern including asbestos (NEPM 2013 WADOH Guidelines - quantitative analysis methodology), to assess the condition of the fill layer, and impacts from activities above ground. Further sampling would also be carried out at deeper soil

layers. These samples would be selected for testing based on field observations (including visual and olfactory evidence, as well as soil vapour screening in headspace samples) whilst giving consideration to characterise the subsurface stratigraphy.

Groundwater Assessment – Entire Site

- Construct four (4) groundwater monitoring bores drilled to a maximum depth of 1m below BEL (i.e. 14mbgl) outside the proposed basement area as indicated in **Figure A.4**. Groundwater monitoring bores will be constructed to standard environmental protocols to investigate the potential for groundwater contamination, and migration of contaminants on/off-site;
- Complete one round of ground water sampling of existing and newly installed monitoring wells. This should be conducted as follows:
  - Prior to well sampling, wells should be developed until sediment loading within the groundwater is reduced, and purged groundwater is considered stabilised to three consecutive readings for pH, electrical conductivity (EC), dissolved oxygen (DO), temperature and redox (ORP).
  - Conduct a second round of groundwater sampling using micro purge techniques. Assess for priority metals (M-8), TRHs, PAHs and VOCs (extended suite).

    Note: Should residual contaminants in groundwater be found at concentrations exceeding the adopted GILs (**Section 4.4**), a risk assessment may be required to determine if groundwater impacts pose unacceptable risks to human health and/or the environment. Following this risk assessment, should groundwater remediation be warranted, an addendum to this RAP shall be completed prior to any further work.

Following the aforementioned additional investigations, the remediation works can be continued.

8.2.4 Stage 4 – Removal of Asbestos Impacted Fill

Asbestos Management Controls

Contaminated fill/soil hotspot removal must be carried out under the supervision of a qualified environmental scientist and in compliance with a site-specific AMP. Fill disturbance for the remediation works must not be commenced therefore, until the relevant control measures are in place, including friable asbestos management controls and associated asbestos fibre monitoring, as specified in the AMP. Air monitoring for asbestos fibres should be conducted as per **Section 9.5** during asbestos remediation works due to the potential for aerial dispersion of asbestos fibres.

Prior to any deep excavation, the ASSMP prepared by EI (2019) should be implemented.

The fill in borehole BH8_0.2m, was identified to contain ACM (non-friable and friable), and boreholes BH9_0.2m and BH12_0.5m as shown in **Figure A.2**, were identified to contain ACM (non-friable) Thus, given the nature of the development which requires deep excavation for basement construction; the following works should be implemented:

1 Delineation of fill material with ACM, using the results obtained from additional investigations outlined above (Stage 3).

2 Excavation and stockpiling of ACM impacted fill soils located within the basement boundary and the public open space boundary, as shown in **Figure A.4**.

   Note: Excavation should not jeopardise the stability of the neighbouring properties and structures.

3 Collection of validation samples in accordance with the sampling plan outlined in **Section 10** within the basement boundary and proposed public open space area to ensure that no asbestos impacted soils remain. Should asbestos impacted soils remain, further excavations are required to remove the impacted soils followed by subsequent validation sampling. This process will be continued until asbestos impacted soils have appropriately been segregated;

4 Spoil from remedial excavations are to be stockpiled separately from other site fill / soils, for *ex-situ* waste classification assessment. General management requirements of stockpiles on site are described in **Section 9.2**.

5 Stockpiles resulting from remedial excavations will be visually inspected, sampled and analysed for waste classification in accordance with Section 7.5 in Schedule B2 in NEPM (2013) and NSW EPA (2014b) *Waste Classification Guidelines*:

6 Collection of one sample per 25 m^3 of stockpiled materials, up to 250 m^3. A minimum of three samples is required for any stockpile. For stockpiles > 250 m^3 but < 2,500 m^3 in size, a statistical analysis approach may be used with the collection of 10 samples.

7 Analytical suite for waste classification will include:

8 priority metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc); TRH; BTEX; PAH; OCP; OPP; PCB and asbestos (presence/absence), TCLPs (as required) and any additional chemicals of potential concern that may be identified during site remediation.

8 Waste classification certificates will be prepared for classified stockpiles, which will be transported and disposed to appropriately licensed waste landfill facilities according to classification. General material handling and management requirements are discussed in **Section 9.2**. Waste disposal documentation will be maintained by the site contractor and provided to the environmental consultant for reporting purposes. The classification should include original results from BH8.

9 Validation of voids following remedial excavation of BH8 and any other ACM impacted area should be undertaken according to the validation plan provided in **Section 9**.

EI recommend over-excavating the fill by approximately 0.1 m into the natural soils to allow for the removal of any residual impacts from the overlying fill at the top of natural material.

Remedial excavations should only be conducted under the supervision of a suitably qualified environmental professional.

Should unexpected finds be discovered during the course of the site remediation programme, then the procedures described under the Contingency Management (**Section 10.4**) and Unexpected Finds Protocol (**Section 10.6**) will be implemented, until the site remediation goals have been achieved and the site is deemed suitable for the intended land use.

8.2.5 Stage 5 – Handling, Management and Waste Classification of Remaining Fill and Concrete Slabs for Offsite Disposal

The following is provided to assist with handling and management of remaining fill for offsite disposal.

Prior to any deep excavation, the ASSMP prepared by EI (2019) should be implemented.

Excavation Considerations

Excavation depths should be in accordance with DA conditions. If further excavation is required, it should not jeopardise the stability of the neighbouring properties and structures.

Off-Site Disposal of Contaminated Soils

Waste classified soils for disposal shall be loaded onto EPA-licensed waste vehicles for transport to the designated landfill facility. It is proposed that in-situ waste classified soils will be excavated and directly loaded onto transport vehicles for disposal to landfill. Waste transport contractors must carry a copy of the relevant Waste Classification Certificate with every transported load. Other important requirements as part of the excavation procedure are as follows:

- Filling soils within the basement footprint and proposed public open space that are not in-situ classified are to be excavated and stockpiled for ex-situ waste classification assessment;

- Excavation of the fill soils is to be conducted to the full depth of filling (visually) over the entire basement footprint and public open space area, with regular headspace screening of excavated materials (taken from the excavator bucket) for VOCs using a PID; and
- Soils with headspace VOC concentrations >30 ppm, heavy staining and/or odour are to be stockpiled separately from other excavated materials, for supplementary classification sampling and testing.

Loading and Transport of Contaminated Material

Direct loading of contaminated fill / soils to appropriate transport vehicles is preferred, with the transport of contaminated material off the site to be via a clearly distinguished haul route. Removal of waste materials from the site shall only be carried out by a recognised contractor holding the appropriate EPA NSW licenses, consents and approvals.

A site log shall be maintained by the contractor for each discrete excavation (numbered locations) to enable the tracking of disposed loads against on-site origin and location of the materials and corresponding (validation) sample numbers.

Measures shall be implemented to ensure no contaminated material is spilled onto public roadways or tracked off-site on vehicle wheels. Such measures will include the deployment of a vehicle washing/cleaning facility, which should be placed at a location before the egress point on the site. The facility shall be able to handle all vehicles and plant operating on-site.

All trucks transporting soils from the site are to be covered with tarpaulins (or equivalent).

Residue from a cleaning facility (if provided) will be collected periodically and either dewatered on site in a contained bunded area or disposed as a slurry to an approved facility. Such residue will be deemed contaminated unless shown by sampling and analysis to be below criteria.

The proposed waste transport route will be notified to Council and truck dispatch shall be logged and recorded by the contractor for each load leaving the site.

Disposal of Contaminated Material and Waste Tracking

All contaminated materials excavated and removed from the site shall be disposed at an appropriately licensed landfill facility. Copies of all necessary approvals shall be provided to the remediation consultant prior to any contaminated material being removed from the site.

Details of all contaminated materials removed from the site shall be documented by the contractor with copies of weighbridge slips, trip tickets and consignment disposal confirmation (where appropriate). Such information should be provided to the remediation/environmental consultant for reporting purposes.

Management of Stockpiled Contamination Material

Where waste classification of soil stockpiles is required, excavated soils will be stockpiled separately on either hardstand pavement or HDPE plastic liner, and limited to a maximum height of 2 m. Stockpiles should be surrounded by star pickets and marking tape, or other suitable material, to clearly delineate their boundaries. Stockpiles shall be lightly conditioned by sprinkler to prevent dust blow. Where stockpiles are to remain onsite for a period >24 hours, silt fences or hay bales should be erected around each stockpile to prevent losses from surface erosion (runoff).

Supplementary Waste Classification (where required)

Prior to being assigned to an appropriate waste disposal facility, all waste soils will be classified in accordance with the NSW EPA (2014a). If prior immobilisation treatment of the waste soils is required, disposal consent will be obtained from the NSW EPA prior to spoil transport.

After waste classification, the materials will be transported and disposed to EPA-licensed, waste landfill facilities.

In accordance with the NEPM (2013) guidelines, stockpiled soils will be sampled and laboratory analysed for waste classification purposes in accordance with the following methodology:

- Collection of one sample per 25 m^3 of stockpiled materials as per NEPM (2013) guidelines, up to 250 m^3. A minimum of three samples is required for any stockpile. For stockpiles > 250 m^3 but < 2,500 m^3 in size, a statistical analysis approach may be used with the collection of 10 samples.
- Collection of one intra-laboratory duplicate for every 10 primary samples collected and one inter-laboratory duplicate for every 20 primary samples collected;
- Collection of one rinsate blank per sampling round;
- Analytical suite for waste classification will include:

  8 priority metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc); TRH; BTEX; PAH; OCP; OPP; PCB and asbestos, TCLPs (as required) and any additional chemicals of potential concern that may be identified during site remediation.

- Preparation of a Waste Classification Certificate detailing the interpreted soil waste classification for each stockpile, to enable appropriate off-site disposal.

As described above, appropriate dust control measures must be implemented during excavation of fill material at the site. These measures are described further in **Section 9** of this RAP.

The proposed sampling plan may be varied due to site constraints; however guidance from the appointed Environmental Consultant must be sought to ensure that deviations from this RAP are properly documented, as required under the OEH (2011) guidelines. Where anomalies in fill/soil consistency are noted (such as heavy staining, odour and/or presence of waste or oils), additional sampling and analysis may be necessary and guidance in this regard should be sought from the appointed Environmental Consultant.

8.2.6 Stage 6 – Site Validation and Classification of Materials Suitable for Reuse (such as Virgin Excavated Natural Material)

Prior to any deep excavation, the ASSMP prepared by EI (2019) should be implemented.

Validation of in situ Natural Soils

All fill and contaminated soil needing to be remediated must be removed from the site and a shallow validation assessment of freshly exposed natural soil must be completed prior to the commencement of bulk excavation works. Natural soil is potentially classifiable as virgin excavated natural material (VENM), however surface inspection and validation by near surface sampling and analysis is required. A validation plan is outlined in **Section 10.**

Where impact is identified in natural soils, the impact would be remediated and validated in accordance with the remedial excavation procedure described in Stage 4 above (**Section 8.2.4**). The resulting spoils would be assessed and classified in accordance with NSW EPA (2014b).

Validation of Imported Backfill Soils

Should reinstatement of remedial excavations require importation of backfill soils from offsite source(s), the imported backfill materials must be certified as meeting the NSW EPA Virgin Excavated Natural Material (VENM) classification, prior to importation to the site. To deem soils suitable for reuse on the subject site, the following confirmation procedure should be undertaken:

- All imported soils brought to the site should be certified as VENM by the supplier; and

- NO soil or rock is to be imported onto the site for backfilling purposes, unless the supporting documentation is approved, and the materials are inspected by the appointed Environmental Consultant.
- Where certification cannot be provided, the imported materials must be validated in accordance with the procedure outlined in **Section 10.1**.

8.2.7 Stage 7 – Validation Report Preparation

At the completion of the remedial works, site validation sampling of environmental media (soil) and reporting must be completed in accordance with **Section 10** by a suitably qualified and experienced environmental consultant.

8.3 Remediation Hold Points

Given the nature of the development, specific hold points in the remediation work will be necessary. These will be dependent on data gap closure and other specific sampling and analysis tasks, as well as approvals required by the conditions of DA consent. They are designed to minimise remediation risks and identify the outcome/criteria that need to be met for the hold-point to be removed.

8.3.1 Remediation Schedule

An estimated schedule for the remedial works is detailed below in **Table 8-1**. The proposed preliminary schedule is based on the remedial works being completed as outlined in this RAP and is dependent on Council approval of any DA and conditions of consent.

Table 8-1 Indicative Site Remediation Schedule

Timeframe	Action
Start	Client Approval of Remediation Plan
Week 1/2	Stage 1 – Preliminaries
Week 3/4	Stage 2 – UST removal and validation
Weeks 4/5/6	Stage 3 – Additional Soil & Groundwater Assessment
Week 6/7	HOLD POINT – Re assess site contamination. Identify whether groundwater remediation or soil vapour assessment is warranted. *
Week 7/8	Stage 4 – Removal of Asbestos Impacted Fill
Approx. 2weeks after completion of Stage 4	Stage 5 - Handling, Management and Waste Classification of Remaining Fill and Concrete Slabs for Offsite Disposal
Approx. 4weeks after completion of Stage 5	Stage 6 – Soil Validation and Classification of Materials Suitable for Reuse (such as Virgin Excavated Natural Material)
Approx. 4 weeks after completion of Stage 6	Stage 7 – Validation Report Preparation

Note:
* If groundwater remediation or soil vapour assessment is needed, RAP will need to be revised and an additional 4 weeks may apply.

8.4 Remedial Contingencies

The proposed remedial technologies should be effective in dealing with the contamination present across the site. Nevertheless, remedial contingencies may be required should the scenarios detailed in **Table 8-2** arise.

Table 8-2 Remedial Contingencies

Scenario	Remedial Contingencies/Actions Required
Highly contaminated soils / sludges not identified during previous investigations are encountered, particularly at site boundaries	Work to be suspended until the Environmental Project Manager can assess impacted materials and associated risks. The leachability of contaminants to be assessed, before disposal options are considered. Follow the unexpected finds protocol in **Section 9.8** of this RAP.
Underground tanks (i.e. USTs that have not been previously identified) are encountered at the site	Systems to be removed and the excavations appropriately validated and backfilled by experienced contractor. Tank removal works to be reported by appropriate environmental consultant, in accordance with EPA (2014b) *Technical Note: Investigation of Service Station Sites* and Australian Standard AS4976 (2008). Follow the unexpected finds protocol in **Section 9.8** of this RAP.
Asbestos wastes are encountered	Work to be suspended and asbestos removed by a suitably qualified contactor, in accordance with SafeWork NSW regulations. Follow the unexpected finds protocol in **Section 9.8** of this RAP.
Residual soil impacts remain on-site between site boundary and basement excavation post removal of USTs	Assess potential vapour hazard and delineate plume. Should significant soil vapour contamination be identified during Stage 3 (Refer to **Section 8.2**), consider soil vapour monitoring program and the implementation of a vapour membrane barrier system within the final development design.
Contaminated groundwater (including LNAPL or DNAPL) encountered	Review groundwater conditions on site. Determine need for further investigation / remediation and/or longer-term management plan. Any dewatering may require approval under the *Water Management Act 2000*. Remedial options may include natural attenuation, extraction, bioremediation, PSH recovery using active pumping (including hydraulic control), installation of a groundwater permeability barrier, *in situ* oxidation or stabilisation.
Contaminated groundwater plume is identified and is migrating off-site, or there are increases in concentration due to increased infiltration	Review contaminant increase and analytes. Review active remediation alternatives (if necessary). Ensure down-gradient monitoring is undertaken. Carry out fate and transport modelling and assess the need for further action.
Contamination is identified near heritage items or significant trees (if identified)	Stop work. Review contaminant concentrations and risks to heritage items / flora. Assess human health and environmental risks if contamination remains in place. Review natural attenuation options.
Changes in proposed basement excavation depth	Review remediation works for the site.
Changes in proposed land use(s) at the site	Review remediation works for the site.

9. Site Management

9.1 Responsibilities and Contacts

The responsibilities for the various parties involved with the remediation program are outlined in **Table 9-1.**

Table 9-1 Site Management Responsibilities

Responsible Party	Details/Contacts	Responsible for:
Principal Project Manager (PPM)	JQZ Pty Ltd	▪ Overall management of the site remedial activities.
Property Owner and Site Contractor	JQZ Pty Ltd	▪ Notification of site conditions to the EPA under the duty to report contamination under the *Contaminated Land Management Act 1997.* ▪ Registration of details of Site Audit Statement. ▪ Implementation of and compliance with the RAP. ▪ Notification to contractors of the existence of a RAP. ▪ Provision of copies of the RAP.
Environmental Management Coordinator / Remediation Supervisor	JQZ Pty Ltd and EI Australia	▪ Ensuring site remediation works are carried out in an environmentally responsible manner. ▪ Liaison between the appointed Environmental Consultant and Council, providing regular updates and informing of any problems encountered. ▪ Ensuring all environmental protection measures are in place and functioning correctly during site remediation works. ▪ Reporting any environmental issues to owner.
Environmental Consultant	EI Australia	▪ Preparation of the RAP. ▪ On-site management and guidance of the remedial works. ▪ Coordination of validation works, documentation, notifications and permits required to conduct remedial works to a standard suitable of obtaining approval from the NSW EPA. ▪ Completing validation sampling and monitoring as requested by the Remediation Contractor and dictated by the RAP. ▪ Liaison between remediation contractor and the client. ▪ Preparation and submission of supporting documentation for Site Auditor review.
Earthworks or Remediation Contractor	Engaged by JQZ Pty Ltd	▪ Ensuring all operations are carried out as identified in the RAP (remediation), as directed by the PPM and EMC. ▪ Inducting all employees, subcontractors and authorised visitors on procedures with respect to site works, WHS and environmental management

Responsible Party	Details/Contacts	Responsible for:
		procedures. ▪ Reporting any environmental issues to EMC. ▪ Maintaining site induction, site visitor and complaint registers. ▪ Ensuring that fugitive emissions and dust potentially leaving the confines of the site are suitably controlled and minimised. ▪ Ensuring that water containing any suspended matter or contaminants is minimised, does not leave the site and is suitably controlled, so as not to pollute the environment. ▪ Ensuring that vehicles are cleaned and secured so that no mud, soil or water is deposited on any public roadways or adjacent areas. ▪ Ensuring that noise and vibration levels at the site boundaries comply with the legislative requirements. ▪ Preparation of a Construction Environmental Management Plan (CEMP) and Work Method Statement.
Local Council	Strathfield Municipal Council	▪ The RAP will accompany the DA and implementation of the RAP shall become a condition of the Development Consent. ▪ Ensuring requirements of Development Consent and other planning instruments are met. ▪ Registration of details of Site Audit Statement on Section 149(5) Planning Certificate.
Qualified Independent Consultant – NSW Accredited Site Auditor (if appointed)	TBA	▪ Review of RAP, Site Validation Report. ▪ Preparation of Site Audit Statement and Site Audit Report. ▪ Review of updates, revisions or amendments as applicable. ▪ Provide interim audit advice of consultant or client submissions. ▪ Conduct inspections during remedial works.

9.2 Materials Handling and Management

Table 9-2 summarises the measures that should be implemented in respect of materials handling during excavation and remediation works at the site.

Table 9-2 Materials Handling and Management Requirements

Item	Description/ Requirements
Earthworks contractors	Excavation of fill materials should be completed by a suitably qualified contractor to ensure: ▪ All site staff are aware of the environmental and health and safety requirements to be adhered to; ▪ There is no discernible release of dust into the atmosphere as a consequence of the works; ▪ There is no discernible release of contaminated soil into any waterway as a consequence of the works; and ▪ There are no pollution incidents, health impacts or complaints.
Stockpiling of materials	All stockpiles will be maintained as follows: ▪ Stockpiles must be located on sealed surfaces such as sealed concrete, asphalt, or high density polyethylene. ▪ Should stockpiles be placed on bare soils, they should be so on yet to be remediated areas. Contaminated materials should only be stockpiled in locations that do not pose any environmental risk (e.g. hardstand areas). ▪ Excavated soils should be stored in an orderly and safe condition (≤2m height). ▪ Stockpiles should be battered with sloped angles to prevent collapse. ▪ Stockpiles should be covered after being lightly conditioned by sprinkler to prevent dust blow and control odours. ▪ Air emissions to be controlled by using a hydrocarbon mitigation agent, such as BioSolve®, Pinkwater®, Anotech® or an equivalent product selected by the contractor, in combination with the fine mist spraying. ▪ Should the stockpile remain *in situ* for over 24 hours, silt fences or hay bales should be erected around each stockpile to prevent losses from surface erosion (runoff). ▪ Stockpiles will be strategically located to mitigate environmental impacts while facilitating material handling requirements.
Loading of material	Loading of stockpiles / materials will be as follows: ▪ Transport of contaminated material off the site is to be via a clearly distinguished haul route. ▪ Measures shall be implemented to ensure no contaminated material is spilled onto public roadways or tracked off-site on vehicle wheels. Such measures should include the use of a wheel washing/cleaning facility, placed before the egress point on the site, and should be able to handle all vehicles and plant operating on-site. ▪ Residue from the cleaning facility should be collected and either dewatered on site in a contained / bunded area, or disposed as a slurry to an approved facility. Such residue will be deemed contaminated unless proven otherwise.
Transport of materials	Prior to being assigned to an appropriate waste disposal facility, all waste fill/soils will be classified in accordance with the EPA (2014a) *Waste Classification Guidelines*. If prior immobilisation treatment of the waste soils is required, disposal consent will be obtained from the NSW EPA prior to spoil transport. ▪ All trucks transporting soils from the site are to be covered with tarpaulins (or equivalent).

Item	Description/ Requirements
	▪ All haulage routes for trucks transporting soil, materials, equipment and machinery shall comply with all road traffic rules, minimise noise, vibration and odour to adjacent premises, utilise state roads and minimise use of local road. ▪ All deliveries of soil, materials equipment or machinery should be completed during the approved hours of remediation and exit the site in a forward direction. ▪ Removal of waste materials from the site shall only be carried out by a recognised contractor holding the appropriate EPA NSW licenses, consents and approvals. ▪ Unless hazardous, waste materials must be transported less than 150km from the source (POEO 1997, Waste 2014) and landfills are required to be licensed for the category of waste they are scheduled to receive.
Material tracking	Materials excavated from the site should be tracked from the time of their excavation until their disposal. Tracking of the excavated materials should be completed by recording the following: ▪ Origin of material; ▪ Material type; ▪ Approximate volume; and ▪ Truck registration number. Disposal locations will be determined by the remediation contractor. Disposal location, waste disposal documentation (weighbridge dockets) and the above listed information should be provided to the remediation consultant for reporting purposes.
Material visual inspection prior to validation sampling.	Following the completion of remedial works as specified within this RAP, the following applies: ▪ A suitably qualified environmental scientist should undertake a visual inspection of the work area. If visual observations indicate contamination, the earthworks contractors should rectify any issues arising from the inspection (i.e. further excavation or 'chasing out' until soils show no evidence of contamination based on visual inspection and/or odours). ▪ Following satisfactory completion of the visual inspection, validation sampling of soils should be completed. Validation sampling is discussed in **Section 9**. Only following satisfactory validation will remedial works be deemed as completed.

9.3 Management Measures

All work should be undertaken with due regard to the minimisation of environmental effects and to meet all statutory environmental and safety requirements. A CEMP and Dewatering Management Plan should be developed for the site works by the site contractor/builder, which takes into account relevant guidance including, but not limited to:

- DA Conditions of Consent;
- Strathfield Municipal Council Local Environmental Plan 2012; and
- *Managing Urban Stormwater, Soils and Construction*, Volume 1: 4th Edition (March 2004).

Overall site management requirements related to the remedial works are presented in **Table 9-3**.

Table 9-3 Site Management Measures

Category	Measure
Demolition (including Asbestos Management)	Appropriate measures shall be taken to ensure that demolition works are completed in accordance with SafeWork NSW Standards and Codes of Practice. Any asbestos identified within building materials should be managed in accordance with SafeWork NSW Codes of Practice and Australian Standards. Note: As demolition has already been completed at the site, site walkover inspections will be performed after the hardstand flooring is removed to visually screen the site and assess for visible evidence of fibre cement sheeting (FCS), which could potentially be asbestos-containing material (ACM). All detected fragments of FCS must therefore be collected and bagged for appropriate offsite disposal.
Groundwater Management and Control	Given the proposed site redevelopment involves a four level basement car parking and dewatering will be required; appropriate measures shall be taken to ensure that a Dewatering Management Plan and application to WaterNSW is put in place. Geotechnical advice should be sought with respect to this.
Site Stormwater Management and Control	Appropriate measures shall be taken to ensure that potentially contaminated water does not leave the site. Such measures should include, but not be limited to: ▪ Diversion and isolation of any stormwater from any contaminated areas; ▪ Provision of sediment traps including geotextiles or hay bales; and ▪ Discharge of any water to drains and water bodies must meet the appropriate effluent discharge consent condition under the *Protection of the Environmental Operations Act 1997*.
Soil Management	Appropriate measures shall be taken to ensure soils are excavated using a methodology appropriate to reduce nuisance dust and odours from leaving the boundary, and are disposed of in accordance with the NSW Government *Protection of the Environment Operations (Waste) Regulation 2014*.
Dust and Odour	Control of dust and odour during the course of the remediation works shall be maintained by the contractor to ensure no nuisance dust or odours are received at the site boundary according to requirements of Strathfield Municipal Council DCP 2012. Action levels and specific control measures would be described in the site CEMP and may include, but not necessarily be limited to the following: ▪ Site wide water spraying, as and when appropriate, to eliminate wind-blown dust; ▪ Use of mist sprays, and/or sprinklers on stockpiles, fill screening areas and loaded fill to lightly condition the material; ▪ Use of tarpaulin or tack-coat emulsion or sprays to prevent dust blow from stockpiles or from vehicle loads; ▪ Covering of stockpiles or loads with polythene or geotextile membranes; ▪ Restriction of stockpile heights to 2m above surrounding site level; ▪ Ceasing works during periods of inclement weather such as high winds or heavy rain; ▪ Use of vapour masks or respirators for works near VOCC-impacted areas (if required); and ▪ Regular checking of the fugitive dust and odour issues to ensure compliance with the CEMP requirements, undertaking immediate remedial measures to rectify any cases of excessive dust or odour (e.g. use of misting sprays or odour masking agent). It is advised that all site workers use adequate dust masks during soil excavation and that machine operators remain within an enclosed, air conditioned cabin.

Category	Measure
Noise and Vibration	Noise and vibration will be restricted to reasonable levels. All plant and machinery used on site will be noise muffled to ensure emissions do not breach statutory levels as defined within the Strathfield Municipal Council LEP 2012.
Hours of Operation	Working hours will be restricted to those specified in the site specific DA conditions.
Community Engagement	Community engagement should be carried out in accordance with Schedule B(8) of the NEPM (NEPC, 2013). Prior to the commencement of any remediation works at the site, every owner and occupier of any land located either wholly or partly within 100m of the boundary of the premises (including local council and the RMS) should be notified at least 30 days in advance. The notice should include: ▪ Advice of demolition and excavation work to be carried out on the premises; ▪ State the time and date such work is to commence; ▪ Indicate that the works are being conducted to minimise any risk of site contamination impacting on off-site receptors; ▪ Provide appropriate site signage at an easily readable location on the site fencing, including site contact name and phone number to be contacted should any matter arise; and ▪ Provide contact information and procedure for registering any complaints.
Incident Management and Community Relations	While various environmental management and occupational safety plans will be developed to protect human health and the environment, incidents may occur which pose a risk to the various stakeholders. To mitigate these risks and ensure that a suitable response is carried out quickly, a response plan to any incident that may occur on site should be prepared and various responsibilities assigned. The site health and safety plan and environmental management plan should document these procedures and responsibilities, and incident contact numbers should be maintained in an on-site register. All other relevant emergency contact numbers such as Police, Fire Brigade, and Hospital should be listed in the Health and Safety Plan and posted on-site for easy access.

9.4 Amendment of RAP

The RAP must be amended and re-issued in one, or more, of the following circumstances:

1 There is a change in land use to something more sensitive than residential with limited access to soil (as defined in NEPC (2013) Schedule B1, Table 1A(1));

2 There is modification to the Certificate(s) of Title;

3 Contaminated material found within the site is different to that described in this RAP; and/or

4 There is a modification to NSW environmental or planning legislation affecting the RAP.

The RAP can only be amended and re-issued by a certified Environmental Consultant.

9.5 Distribution of RAP

The RAP and any subsequent amendments must be distributed to the following parties:

1 Current Site Owner;

2 Strathfield Municipal Council; and

3 Remediation Contractor responsible for remedial works, construction, demolition, management and maintenance of the site.

9.6 Contingency Management

Contingency plans for anticipated problems that may arise on-site during the course of the remediation are presented below in **Table 9-4.**

Table 9-4 Contingency Management

Anticipated Problems	Corrective Actions
Chemical / Fuel Spill	Stop work, notify above site project manager. Use accessible soil or appropriate absorbent material on site to absorb the spill (if practicable). Stockpile the impacted material in a secure location, sample and determine the appropriate disposal/treatment option.
Supplementary Asbestos Identification	Where asbestos containing material is detected in soil all works are to stop. The contractor is to engage a suitably qualified environmental consultant to undertake an assessment of contamination. All works associated with the disturbance and removal of asbestos impacted fill at the site must be undertaken in accordance with SafeWork NSW guidelines. A risk assessment by an independent licensed asbestos assessor or competent person, including contaminated site assessment practitioners, should determine the most appropriate control measures and remediation strategies. Asbestos-contaminated soil is also subject to requirements of other regulatory agencies such as the EPA, Pubic Health and local governments. Where guidance on the assessment and remediation of contaminated sites is sought, the NEPM (2013) should be referred to. A licensed asbestos removalist must notify the regulator in writing at least five days before the licensed asbestos removal work commences and must also obtain a permit (SafeWork, 2016). Removal of asbestos from contaminated soil will require a Class A licensed asbestos removalist for any friable asbestos to be removed, or a Class B licensed asbestos removalist if non-friable asbestos is to be removed. The asbestos removalist must prepare an asbestos removal control plan for the proposed earthworks. A site specific Asbestos Management Plan (AMP) plan must be prepared in conjunction with an asbestos register competent person to document the management measures required to address risk associated with potential exposure to asbestos in accordance with NSW SafeWork requirements and must include: ▪ Work area isolation (barrier protection, buffer zone); ▪ Removal methods (friable/non-friable); ▪ Contamination control methods (decontamination procedures); and ▪ Health and safety procedures (respiratory protection). Asbestos related works at the site involving disturbance of soil must be managed strictly in accordance with this RAP and the AMP. There is no requirement to undertake asbestos fibre air monitoring during the removal of the non-friable asbestos materials on the boundary of the work areas. However as a matter of due diligence asbestos fibre air monitoring is recommended to be undertaken on the boundary of the work areas. Asbestos fibre air monitoring is required to be undertaken by a company independent of the demolition and /or asbestos removal company. The asbestos fibre air monitoring should be undertaken by a company that is NATA (National Association of Testing Authorities) accredited. Air monitoring for asbestos fibres must be conducted during the removal of friable asbestos-contaminated soils

	All asbestos fibre air monitoring must be conducted in accordance with the site specific AMP. The licensed asbestos removalist must stop work and notify SafeWork NSW immediately when respirable asbestos fibres are recorded at more than 0.02 fibres/ml in accordance with the Work Health and Safety Regulation (2017). All asbestos and any contaminated soil removed must be disposed of as asbestos waste according to the EPA and the requirements of the local licensed waste disposal facility. Under Clause 473 of the NSW Work Health and Safety Regulation 2017, a clearance inspection is required following the removal of ACM. A clearance inspection is to be carried out and a clearance certificate issued before the area can be re-occupied. The company undertaking the clearance inspection should be independent of the demolition and / or asbestos removal company.
Excessive Dust	Use water sprays to suppress the dust or stop site activities generating the dust until it abates.
Excessive Noise	Identify the source, isolate the source if possible, modify the actions of the source or erect temporary noise barriers if required.
Excessive Odours / Vapours	Stage works to minimise odours/vapours. If excessive organic odours/vapours are being generated, stop works and monitor ambient air across site for organic vapours with a PID and odours at site boundaries. Implement control measures including respirators for on-site workers, use of odour suppressants, wetting down of excavated material. No nuisance odours shall be detected at any site boundary as part of the remedial works. Should odour emissions be detected at or beyond the site boundary, it is recommended, as part of the CEMP and community consultation procedure, that the Remediation Contractor and the Principal Project Manager: Notify the owners and occupiers of premises adjoining and across the road from the site regarding potential odour issues. Notification should be in writing. This is also required by the Council Contaminated Land Policy. In the notification, as well as on street signage, provide contact details of the site personnel for anyone who may be concerned by odour emission during the remediation. Temporarily pause site works to allow for excess odour to subside to a level acceptable by off-site receptors, should it be necessary, after implementation of the above-listed control measures. Record logs for volatile emissions and odours. Such records should be kept on-site and made available for inspection on request. In regard to off-site impact from petroleum vapour, odour is generally detected at concentrations much lower than what will constitute a health-based risk. Measures listed above for odour control (**Table 9-3**) may also be applied for vapour control.
Excessive Rainfall	Ensure sediment and surface water controls are operating correctly. If possible divert surface water away from active work areas or excavations.
Water in Excavations	Collect samples and assess against relevant EPA (2014a) *Waste Classification Guidelines*, to enable disposal options to be formulated.
Leaking Machinery or Equipment	Stop the identified leak (if possible). Clean up the spill with absorbent material. Stockpile the impacted material in a secure location, sample and determine the appropriate disposal/treatment option.
Failure of Erosion or Sedimentation Control Measures	Stop work, repair failed control measure.

Unearthing Unexpected Materials, Fill or Waste	Stop activities, contact the site project manager. Follow the unexpected finds protocol as detailed in **Section 10.8** of this RAP. Prepare a management plan if required, to address the issue.
Identification of Cultural or Building Heritage Items	Stop work and notify site project manager. Follow the unexpected finds protocol as detailed in **Section 10.8** of this RAP. Prepare action or conservation plan as required.
Equipment Failures	Ensure that spare equipment is on hand at site, or that the failed equipment can be serviced by site personnel or a local contractor.
Complaint Management	Notify Client, Project Managers and Environmental Consultant (if required) following complaint. Report complaint as per management procedures. Implement control measures to address reason of complaint (if possible). Notify complainant of results of remedial actions.

9.7 Work Health and Safety Plan

As required by the NSW *Work Health and Safety Act 2011* and associated regulations, a Work Health and Safety (WHS) Plan should be prepared by the Principal Contractor (see **Responsibilities and Contacts, Section 9.1**). The purpose of this plan is to manage the health and safety of site workers and nearby residents, and address such issues as site security, exclusion zones, excavation safety, vibration, noise, odour and dust levels. The plan should address the risks during the remediation works and cover site specific requirements associated with the contaminants present within the site soils (including vapour) and groundwater.

The site officer responsible for implementing health and safety procedures should induct all site personnel so that they are aware of and comply with, the requirements of this document. It is the contractor's responsibility, with assistance from client/owner(s) of the site to ensure that all other permits, approvals, consents or licences are current. The hazards and mitigation measures relevant to the remedial works are presented in **Table 9-5**.

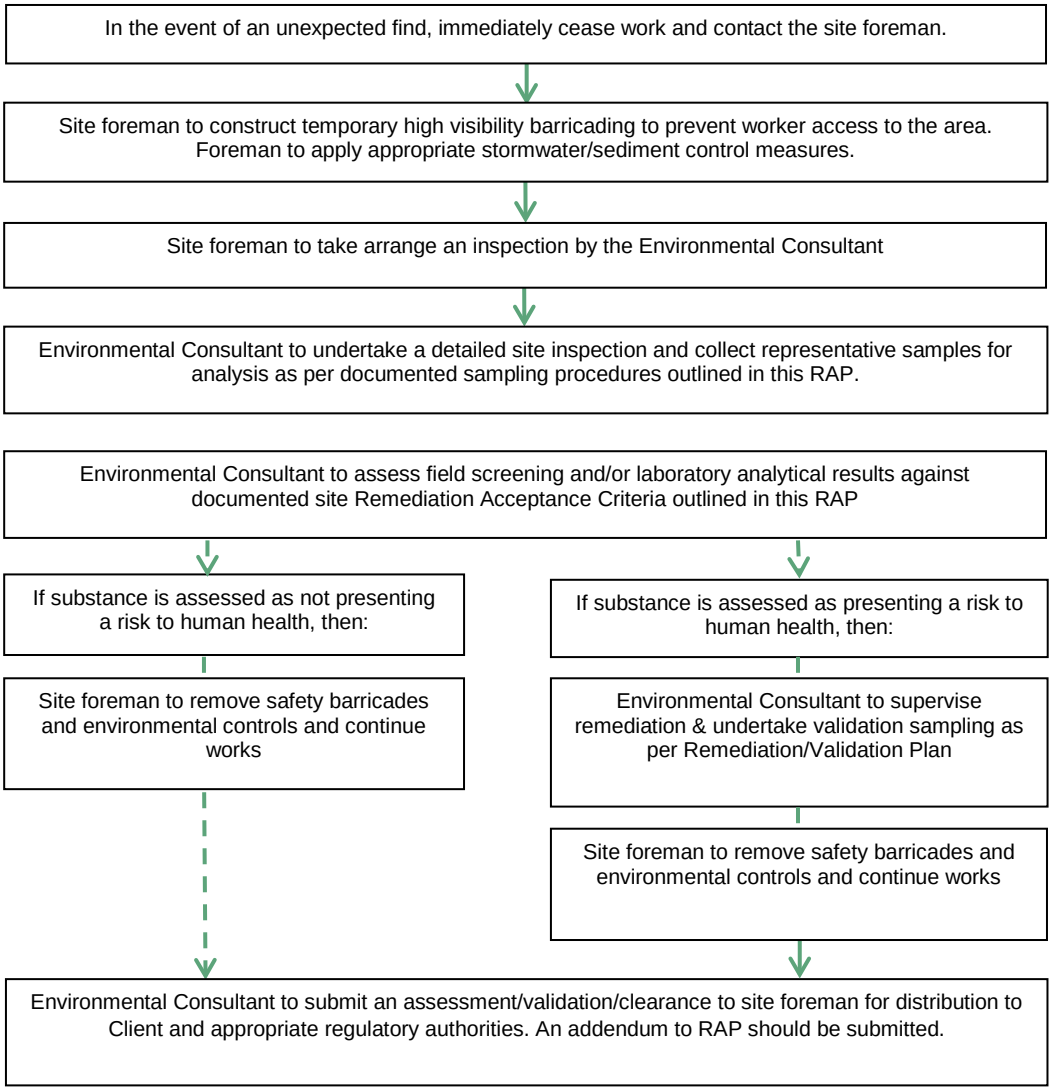
Table 9-5 Remedial Hazards

Anticipated Problems	Corrective Actions
Chemical Hazards	Contaminated sites have chemical substances that may present a risk to human health and the environment. Chemicals of concern and associated risks are as detailed within the Conceptual Site Model, in **Section 3.** The site specific WHS plan should set out controls to mitigate any potential risks.
Physical Hazards	The following hazards are associated with conditions that may be created during site works: ▪ Heat exposure; ▪ Buried services; ▪ Noise, vibration and dust; ▪ Electrical equipment; and ▪ The operation of heavy plant equipment.
Personal Protective Equipment and Monitoring	Personnel should, wherever possible, avoid direct contact with potentially contaminated material. Workers are to ensure that surface waters or groundwater is not ingested or swallowed and that direct skin contact with soil and water is avoided. Standard PPE with the addition of disposable P2 dust masks as specified for the contractor will be sufficient for the prescribed remedial works.

9.8 Unexpected Finds Protocol

Should unexpected finds be encountered, the procedure outlined in **Table 9-6** should be followed.

Table 9-6 Unexpected Finds Protocol



10. Validation Sampling and Analysis Quality Plan

The remediation of the impacted area will be deemed acceptable based on the achievement of the following three validation objectives:

1. ***Remedial Excavations*** – Validation of the remedial excavations will continue to the extent of the impacts as defined by delineation testing, and resulting contaminant concentrations are within the *Remediation Acceptance Criteria* (**Section 5.1**).
2. ***Backfill Materials*** – Should backfilling be required, validation of imported fill materials used for the backfilling of remediated areas would be required to verify their suitability for the proposed land use.

10.1 Validation Soil Sampling Methodology

Validation sampling would be undertaken following the removal of identified contaminated material to ensure that the vertical and lateral extent of the contamination has been defined, as outlined in **Table 10-1**. Should residual contamination be identified, it would be "chased out" where appropriate until material exceeding the validation criteria has been removed. Soil sampling and handling of the collected samples will be as described in **Table 10-2.**

The collection of validation samples will be based on:

- Visual and olfactory observations; and
- Screening of material using a photo-ionisation detector (PID) for the presence of elevated levels of volatile organic compounds (VOCs).

All samples should be sent under appropriate 'chain of custody' (COCs) to NATA accredited laboratories.

If the levels of contaminants are found to exceed the criteria for solid waste, soil treatment by stabilisation and/or micro-encapsulation could be required before disposal.

Table 10-1 Validation Sampling Design

Remediation Area	Sampling Density	Chemical of Concern
Remediated excavations ▪ Potential UPSS remediation (**Section 8.2.2**)	▪ Linear – 1 sampling location per 5 m length of excavation wall. ▪ Vertical – 1 sampling location per 0.5 m depth of excavation. ▪ Base – 1 sample location per 25 m^2. ▪ Vent and fuel lines – 1 sample location per 5 m length.	▪ Heavy metals, TRH, BTEX, PAHs, Phenols, Asbestos
Remediated excavations ▪ Staged fill excavations (**Section 8.2.3**)	▪ Linear – 1 sampling location per 10 m length of excavation wall. ▪ Vertical –1 sampling location per 0.5m depth of excavation.	▪ Asbestos (Gravimetric according to NEPM 2013/WADOH Guidelines) ▪ PAHs including Carcinogenic PAHs
Excavated surfaces Top of natural material within the basement footprint and retained deep	▪ 1 Sample per 200m^2 NOTE: These samples will be used for: ‣ The classification of natural material within the proposed basement footprint prior to offsite	TRH, BTEX, PAHs, heavy metals, OC/OP pesticides, PCBs, asbestos (gravimetric according to NEPM 2013 WADOH

soils	disposal; and ‣ The validation of natural soils remaining onsite within retained deep soil area and the basement footprint.	Guidelines - quantitative analysis methodology).
Stockpiled Material	As per requirements specified in **Section 8.2.5**	Waste Classification: Heavy metals, TRH, BTEX, PAHs, OC/OP pesticides, PCBs, asbestos (presence / absence).
Imported Fill Material	▪ Imported Backfill Materials (Validation Sampling): ‣ 1 sample per 25m^3 for VENM materials (lower sampling frequency may be accepted for uniform materials, subject to approval by EI Environmental Manager). ▪ If material is required to be sourced from off-site to reinstate the sites, it should be certified suitable for the intended use. If the material is not Virgin Natural Excavated Material (VENM), Excavated Natural Material (ENM) or if no suitable certification can be supplied by the source then the material should be sampled at a rate of one per 100 m^3.	TRH, BTEX, PAHs, heavy metals, OC/OP pesticides, PCBs, asbestos (as per the NEPM 2013 WADoH Guidelines - quantitative analysis methodology).

Excavation of contaminated material shall continue until the analytical results indicate compliance with the criteria (i.e. either the concentrations of all contaminants are within the criteria, or the 95% UCL average contaminant concentration for each detected parameter is within the criteria). If results indicate that additional excavation is necessary, the excavation shall be extended until the excavation surface samples indicate that the location is validated as meeting the criteria for each respective contaminant.

Table 10-2 Validation Sample Collection and Handling Procedures

Action	Description
Sample Collection	Soil validation sampling will be directly from the exposed (excavated) surface, or from the material brought to the surface by the backhoe/excavator bucket. Sampling data shall be recorded to comply with routine chain of custody requirements.
Sampling Frequency	*As outlined in **Table 10-1**.*
Sampling, Handling, Transport and Tracking (for non-volatiles)	▪ The use of stainless steel sampling equipment. ▪ All sampling equipment (including hand tools or excavator parts) to be washed in a 3% solution of phosphate free detergent, followed by a rinse with potable water prior to each sample being collected. ▪ Direct transfer of the sample into new glass jars or plastic bags is preferred, with each plastic bag individually sealed to eliminate cross contamination during transportation to the laboratory. ▪ Label sample containers with individual and unique identification including project number, sample number, sampling depth, date and time of sampling. ▪ Place sample containers into a chilled, enclosed and secure container for transport to the laboratory. ▪ Provide chain of custody documentation to ensure that sample tracking and custody can be cross-checked at any point in the transfer of samples from the field to the environmental laboratory.
Soil Sample Containers	Metals - 250g glass jar / refrigeration 4^{o}C / 6 months (maximum holding period).

Action	Description
and Holding Times	TRH/VOCs - 250g glass jar / refrigeration 4^{o}C / 14 days (maximum holding period). PAH/OCP/OPP/PCB - 250g glass jar / refrigeration 4^{o}C / 14 days (maximum holding period). Asbestos – up to a 10 litre resealable plastic (polyethylene) bag/no refrigeration/indefinite holding time.
Laboratory Analysis	Each sample obtained for soil validation purposes will be analysed for COCP list outlined in **Section 3.3**. Testing of imported materials intended for backfilling of excavated areas shall include, but not be limited to, the minimum suite specified for imported fill under the EPA (2014a) guideline (e.g. heavy metals, TPHs, BTEX, PAHs, OCPs, OPPs, PCBs and asbestos), plus foreign materials (via RTA T276 method) and the physicochemical parameters pH and EC.
Field QA/QC	Quality assurance (QA) and quality control (QC) procedures will be adopted throughout the field sampling program to ensure sampling precision and accuracy, which will be assessed through the analysis of 10% field duplicate/replicate samples. Appropriate sampling procedures will be undertaken to prevent cross contamination, in accordance with EI's Standard Operating Procedures Manual. This will ensure: ▪ Standard operating procedures are followed; ▪ Site safety plans are developed prior to works commencement; ▪ Split duplicate field samples are collected and analysed; ▪ Samples are stored under secure, temperature controlled conditions; ▪ Chain of custody documentation is employed for the handling, transport and delivery of samples to the contracted environmental laboratory; and ▪ Contaminated soil, fill or groundwater originating from the site area is disposed in accordance with relevant regulatory guidelines. In total, field QA/QC will include one in 10 samples to be tested as blind field duplicates, one in 20 samples to be tested as inter-laboratory duplicates (ILD), as well as one VOC trip blank (intra-lab) sample and one equipment wash blank sample per sample batch.
Laboratory Quality Assurance and Quality Control	The contract laboratory will conduct in-house QA/QC procedures involving the routine analysis of: ▪ Reagent blanks; ▪ Spike recoveries; ▪ Laboratory duplicates; ▪ Calibration standards and blanks; ▪ QC statistical data; and ▪ Control standards and recovery plots.
Achievement of Data Quality Objectives	Based on the analysis of quality control samples (i.e. duplicates/replicates and in-house laboratory QA/QC procedures), the following data quality objectives are required to be achieved: ▪ conformance with specified holding times; ▪ accuracy of spiked samples will be in the range of 70-130%; and ▪ field and laboratory duplicates and replicates samples will have a precision average of +/- 30% relative percent difference (RPD). ▪ An assessment of the overall data quality will be presented in the final validation report, in accordance with the OEH (2011) and EPA (2017) guidelines.

10.2 Validation Reporting

All fieldwork, chemical analyses, discussions, conclusions and recommendations will be documented in a validation report for the site. The validation report will be prepared in general accordance with requirements of the EPA (2011) *Guidelines for Consultants Reporting on Contaminated Sites* and EPA (2017) *Guidelines for the NSW Site Auditor Scheme* and will confirm that the site has been remediated to a suitable standard for the proposed development.

The Site Validation Report will be submitted for Council, at the completion of the remediation works program.

11. Conclusions

Based on the information available from previous investigations at the site, this RAP has been prepared to inform the remediation works, including contingency management and unexpected finds protocol; at 11-17 Columbia Lane, Homebush, NSW. The buildings at the site have been demolished with only concrete slabs remaining.

It is envisaged that the remediation works will be implemented in stages, as follows:

- **Stage 1 –** Preliminaries
- **Stage 2 –** UST removal and validation
- **Stage 3 –** Additional Soil & Groundwater Assessment (Data gap closure)
- **Stage 4 –** Removal of Asbestos Impacted Fill
- **Stage 5 –** Handling, Management and Waste Classification of Remaining Fill and Concrete Slabs for Offsite Disposal
- **Stage 6 –** Soil Validation and Classification of Materials Suitable for Reuse (such as Virgin Excavated Natural Material)
- **Stage 7 –** Validation Report Preparation.

In summary, EI considers that the site can be made suitable for mixed residential-commercial use with limited accessible soils, through the implementation of the works and validation process described in this RAP.

12. Statement of Limitations

This report has been prepared for the exclusive use of JQZ Pty Ltd, who is the only intended beneficiary of our work. The scope of the investigations carried out for the purpose of this report is limited to those agreed with JQZ Pty Ltd on 26 June 2019.

No other party should rely on the document without the prior written consent of EI, and EI undertakes no duty, or accepts any responsibility or liability, to any third party who purports to rely upon this document without EI's approval.

EI has used a degree of care and skill ordinarily exercised in similar investigations by reputable members of the environmental industry in Australia as at the date of this document. No other warranty, expressed or implied, is made or intended. Each section of this report must be read in conjunction with the whole of this report, including its appendices and attachments.

The conclusions presented in this report are based on a limited investigation of conditions, with specific sampling locations chosen to be as representative as possible under the given circumstances.

EI's professional opinions are reasonable and based on its professional judgment, experience, training and results from analytical data. EI may also have relied upon information provided by the Client and other third parties to prepare this document, some of which may not have been verified by EI.

EI's professional opinions contained in this document are subject to modification if additional information is obtained through further investigation, observations, or validation testing and analysis during remedial activities. In some cases, further testing and analysis may be required, which may result in a further report with different conclusions.

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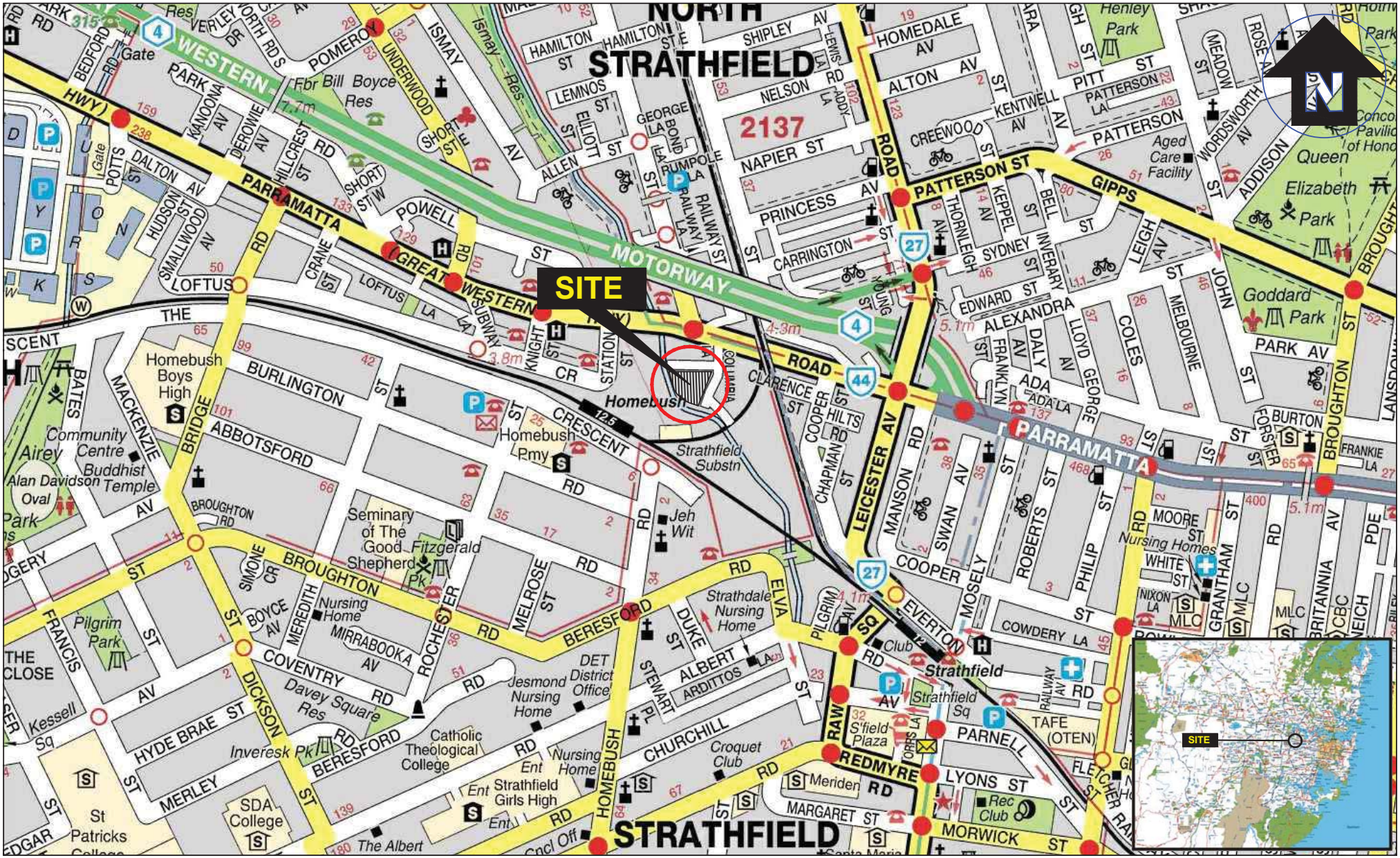
ABBREVIATIONS

AHD	Australian Height Datum
ANZECC	Australian and New Zealand Environment Conservation Council
ANZG	Agriculture and Resource Management Council of Australia and New Zealand
B(a)P	Benzo(a)Pyrene
BGL	Below Ground Level
BH	Borehole
BTEX	Benzene, Toluene, Ethyl benzene, Xylene
CSM	Conceptual Site Model
DECC	Department of Environment and Climate Change, NSW (formerly DEC)
DP	Deposited Plan
DQO	Data Quality Objectives
EPA	Environment Protection Authority
EMP	Environmental Management Plan
ENM	Excavated Natural Material
GIL	Groundwater Investigation Level
GME	Groundwater monitoring event
HIL	Health-based Investigation Level
HSL	Health-based Screening Level
m	Metres
m AHD	Metres relative to Australian Height Datum
m bgl	Metres below ground level
NSW	New South Wales
OEH	Office of Environment and Heritage, NSW (formerly DEC, DECC, DECCW)
PAHs	Polycyclic Aromatic Hydrocarbons
PFAS	Polyfluoroalkyl substances
RAP	Remediation Action Plan
SIL	Soil Investigation Level
TRH	Total Recoverable Hydrocarbons
UCL	Upper Confidence Limit
USEPA	United States Environmental Protection Agency
UST	Underground Storage Tank
VENM	Virgin Excavated Natural Material
VOCs	Volatile Organic Compounds

Appendix A - Figures



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Ph (02) 9516 0722 Fax (02) 9518 5088

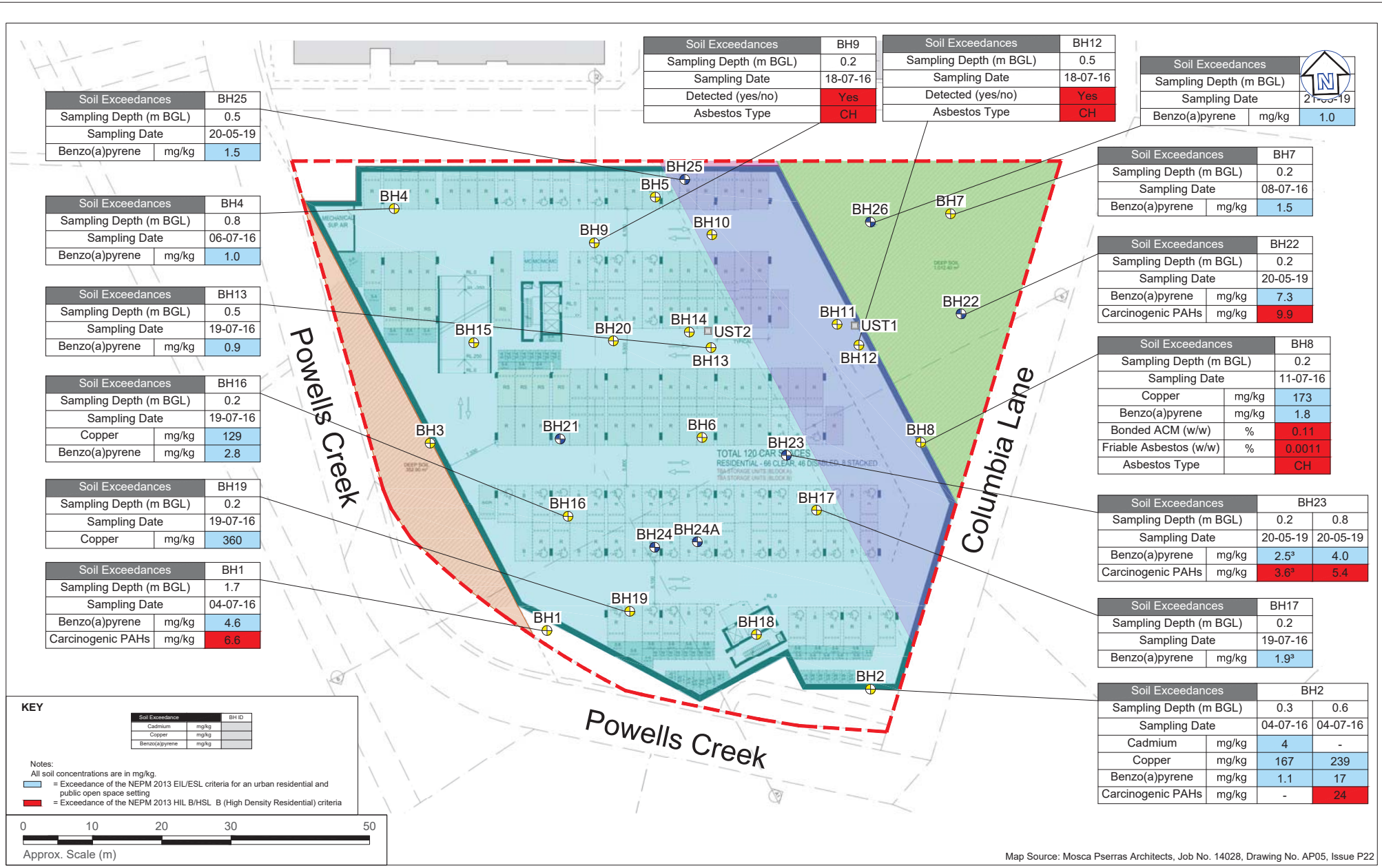
Drawn:	M.G.
Approved:	A.B.
Date:	28-06-19
Scale:	Not To Scale

JQZ Pty Ltd
Remediation Action Plan
11-17 Columbia Lane, Homebush NSW

Site Locality Plan

Figure:
A.1

Project: E24275.E06_Rev1



Soil Exceedances		BH25
Sampling Depth (m BGL)		0.5
Sampling Date		20-05-19
Benzo(a)pyrene	mg/kg	1.5

Soil Exceedances		BH4
Sampling Depth (m BGL)		0.8
Sampling Date		06-07-16
Benzo(a)pyrene	mg/kg	1.0

Soil Exceedances		BH13
Sampling Depth (m BGL)		0.5
Sampling Date		19-07-16
Benzo(a)pyrene	mg/kg	0.9

Soil Exceedances		BH16
Sampling Depth (m BGL)		0.2
Sampling Date		19-07-16
Copper	mg/kg	129
Benzo(a)pyrene	mg/kg	2.8

Soil Exceedances		BH19
Sampling Depth (m BGL)		0.2
Sampling Date		19-07-16
Copper	mg/kg	360

Soil Exceedances		BH1
Sampling Depth (m BGL)		1.7
Sampling Date		04-07-16
Benzo(a)pyrene	mg/kg	4.6
Carcinogenic PAHs	mg/kg	6.6

Soil Exceedances	BH9
Sampling Depth (m BGL)	0.2
Sampling Date	18-07-16
Detected (yes/no)	Yes
Asbestos Type	CH

Soil Exceedances	BH12
Sampling Depth (m BGL)	0.5
Sampling Date	18-07-16
Detected (yes/no)	Yes
Asbestos Type	CH

Soil Exceedances		
Sampling Depth (m BGL)		
Sampling Date		21-05-19
Benzo(a)pyrene	mg/kg	1.0

Soil Exceedances		BH7
Sampling Depth (m BGL)		0.2
Sampling Date		08-07-16
Benzo(a)pyrene	mg/kg	1.5

Soil Exceedances		BH22
Sampling Depth (m BGL)		0.2
Sampling Date		20-05-19
Benzo(a)pyrene	mg/kg	7.3
Carcinogenic PAHs	mg/kg	9.9

Soil Exceedances		BH8
Sampling Depth (m BGL)		0.2
Sampling Date		11-07-16
Copper	mg/kg	173
Benzo(a)pyrene	mg/kg	1.8
Bonded ACM (w/w)	%	0.11
Friable Asbestos (w/w)	%	0.0011
Asbestos Type		CH

Soil Exceedances		BH23	
Sampling Depth (m BGL)		0.2	0.8
Sampling Date		20-05-19	20-05-19
Benzo(a)pyrene	mg/kg	2.5[3]	4.0
Carcinogenic PAHs	mg/kg	3.6[3]	5.4

Soil Exceedances		BH17
Sampling Depth (m BGL)		0.2
Sampling Date		19-07-16
Benzo(a)pyrene	mg/kg	1.9[3]

Soil Exceedances		BH2	
Sampling Depth (m BGL)		0.3	0.6
Sampling Date		04-07-16	04-07-16
Cadmium	mg/kg	4	-
Copper	mg/kg	167	239
Benzo(a)pyrene	mg/kg	1.1	17
Carcinogenic PAHs	mg/kg	-	24

KEY

Soil Exceedance		BH ID
Cadmium	mg/kg	
Copper	mg/kg	
Benzo(a)pyrene	mg/kg	

Notes:
All soil concentrations are in mg/kg.
= Exceedance of the NEPM 2013 EIL/ESL criteria for an urban residential and public open space setting
= Exceedance of the NEPM 2013 HIL B/HSL B (High Density Residential) criteria

0 10 20 30 50
Approx. Scale (m)

Map Source: Mosca Pserras Architects, Job No. 14028, Drawing No. AP05, Issue P22

LEGEND

- Approximate site boundary
- Approximate borehole location (STS - July 2016)
- Approximate borehole location (STS - May 2019)
- Approximate underground storage tank location
- Approximate boundary of deep soil zone / transmission line easement
- Approximate basement boundary
- Approximate Nipper Street exit
- Approximate public open space

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Drawn:	M.G.
Approved:	A.B.
Date:	28-06-19

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Remediation Action Plan
11-17 Columbia Lane, Homebush NSW
Sampling Location Plan with Soil Exceedances

Figure: A.2

Project: E24275.E06_Rev2

Groundwater Exceedances		GW4-1
Sampling Date		20-05-19
Total C6-C10	µg/L	50
Total C10-C40	µg/L	366
Benzo(a)anthracene	µg/L	0.4

Groundwater Exceedances		GW5-1
Sampling Date		20-05-19
Nickel	µg/L	50
Zinc	µg/L	36

Groundwater Exceedances		GW3-1
Sampling Date		20-05-19
Zinc	µg/L	45
Total C6-C10	µg/L	100
Total C10-C40	µg/L	100

KEY

Groundwater Exceedance		MW ID
Nickel	µg/L	
Zinc	µg/L	
Total C6-C10	µg/L	

Notes:
All groundwater concentrations are in µg/L.
= Exceedance of the NHRMC/NRMMC Australian Drinking Water Guidelines 2011 (2018 updated) - Health Guidance Value
= Exceedance of the Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2018 - Marine Water Values

Map Source: Mosca Pserras Architects, Job No. 14028, Drawing No. AP05, Issue P22

LEGEND

- Approximate site boundary
- Approximate monitoring well location (STS - July 2016)
- Approximate monitoring well location (STS - October 2017)
- Approximate monitoring well location (STS - January 2018)
- Approximate underground storage tank location
- Approximate boundary of deep soil zone / transmission line easement
- Approximate basement boundary
- Approximate Nipper Street exit
- Approximate public open space

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Ph (02) 9516 0722 Fax (02) 9518 5088

Drawn:	M.G.
Approved:	A.B.
Date:	28-06-19

JQZ Pty Ltd
Remediation Action Plan
11-17 Columbia Lane, Homebush NSW

Sampling Location Plan with GW Exceedances

Figure: A.3

Project: E24275.E06_Rev2

Map Source: Mosca Pserras Architects, Job No. 14028, Drawing No. AP05, Issue P22

LEGEND

- Approximate site boundary
- Approximate underground storage tank location
- Approximate location of proposed test pits
- Approximate location of proposed monitoring wells
- Approximate location of existing monitoring well (STS,2019)
- Approximate location of existing borehole (STS,2019)
- Approximate boundary of deep soil zone / transmission line easement
- Approximate basement boundary
- Approximate Nipper Street exit
- Approximate public open space

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Drawn:	M.G.
Approved:	A.B.
Date:	28-06-19

JQZ Pty Ltd
Remediation Action Plan
11-17 Columbia Lane, Homebush NSW

Proposed Sampling Locations

Figure: A.4

Project: E24275.E06_Rev2

Note: all material that is for offsite disposal should be assessed and classified in accordance with NSW EPA (2014) Waste Classification Guidelines (Part 1:Classifying Waste and Part 4: Acid Sulfate Soils).

0 10 20 30 50

Approx. Scale (m)

Map Source: Mosca Pserras Architects, Job No. 14028, Drawing No. AP05, Issue P22

LEGEND

- Approximate site boundary
- HIL-B, HSL-D
- HIL-C, HSL-C
- HIL-C, HSL-C, EIL, ESL

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Drawn:	M.G.
Approved:	A.B.
Date:	02-07-19

JQZ Pty Ltd
Remediation Action Plan
11-17 Columbia Lane, Homebush NSW

Proposed Applicable Site Criteria

Figure: A.5

Project: E24275.E06_Rev2

Appendix B – Proposed Development Plans

Drawing No:	Description
AP01	Cover Page
AP02	Data
AP03	Site Plan
AP04	Basement 3 & 4
AP05	Basement 2
AP06	Basement 1
AP07	Ground Floor
AP08	Level 1
AP09	Level 2-6
AP10	Level 7
AP11	Level 8
AP12	Level 9-12
AP13	Level 13
AP14	Level 14-16
AP15	Level 17
AP16	Level 18-21
AP17	Levels 22
AP18	Level 23
AP19	Level 24
AP20	Level 25
AP21	Elevation NE
AP22	Elevation N
AP23	Elevation SE
AP24	Elevation SW
AP25	Section A
AP26	Section B
AP27	Adaptable & Livable Units
AP28	Shadow Diagrams 1
AP29	Shadow Diagrams 2

Drawing No:	Description
SP01	Site Analysis
SP02.1	GFA Calculation
SP02.2	GFA Calculation
SP02.3	GFA Calculation
SP02.4	GFA Calculation
SP03.1	ADG Natural Ventilation
SP04.1	ADG Solar Access 3D
SP04.2	ADG Solar Access 3D
SP04.3	ADG Solar Access 2D
SP04.4	ADG Solar Access 2D

11-17 COLUMBIA LANE, HOMEBUSH

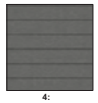
PROPOSED MIXED-USE DEVELOPMENT

schedule of finishes

1: Sydney sandstone Main entry feature wall blades

2: PGH Bricks 'Macarthur Mix Linear' Podium feature facade

3: White metal powdercoat finish Feature tower facade

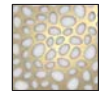


4: Grey metal wall cladding finish

5: Dark grey powdercoat finish Garage door, open grill commercial door

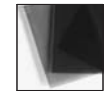
6: White paint finish Balcony upstands and slab edges

7: Dark grey paint finish External walls



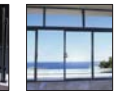
8: Duralloy paperbark satin powdercoat finish Metrix group riverstone screen Gallery balustrades

9: Light grey powdercoat finish Aluminium door & window frames



10: Glazing 'Grey Laminated' Windows, doors & balustrades

11: Metal vertical blade courtyard fencing Black powdercoat finish



12: Door & window style to basix requirements

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north point:

N

key plan:

notes:

amendments:

Revision	Description	By	Date
P6	Preliminary	GH	15/08/17
P7	Pre-DA	GH	17/08/17
P11	Preliminary Consultant Issue	MA	17/01/18
P12	Preliminary Consultant Issue	SB	17.10.18
P13	Pre-DA Issue	SB	05.11.18
P14	Pre-DA Issue	SB	04.06.19
P17	Preliminary Consultant Issue	MR	09.05.19
P18	Preliminary Consultant Issue	SB	20.05.19
P19	Preliminary Consultant Issue	SB	22.05.19
P22	Preliminary Consultant Issue	SB	04.06.19

WORK IN PROGRESS

mpa mosca pserras architects

project: MIXED USE DEVELOPMENT
location: 11-17 Columbia Lane, HOMEBUSH
client: Columbina Lane Development Pty. Ltd

drawing title: Cover Page

scale: 1:50,72 @ A1 | project architect: SP / GK | drawn: GH/ MA
job no. 14028 | drawing no. AP01 | issue P22

11-17 COLUMBIA LANE, HOMEBUSH

DATE : 06.06.19

LEVEL 24 (continued)

	UNIT	1 BED	2 BED	3 BED	NOTES	GFA	INTERNAL	TERRACE	MISC	TOTAL	ADAPTABLE	LIVABLE	STORAGE within unit	STORAGE basement	SOLAR ACCESS >2HRS (9-15)	SOLAR ACCESS <2HRS (9-15)	NO SOLAR ACCESS	CROSS VENTILATION
391	A24.05	1B					53	8		61			✓	✓	✓			
392	B24.01		2B		2 storey		95	10		105			✓	✓			✓	
393	B24.02			3B	2 storey		108	40		148			✓	✓	✓			
394	B24.03		2B		2 storey		98	14		112			✓		✓			
395	B24.04		2B		2 storey		89	12		101			✓		✓			
396	B24.05		2B		2 storey		89	12		101			✓		✓			
397	B24.06			3B	2 storey		98	36		134			✓	✓	✓			
398	B24.07			3B	2 storey		114	38		152			✓	✓	✓			
	TOTAL	2	7	3		1167	1027	211	0	1238	0	0		6	11			

OVERALL TOTALS

	1 BED	2 BED	3 BED	TOTAL	GFA	INTERNAL	TERRACE	MISC	TOTAL	ADAPTABLE	LIVABLE		STORAGE basement	SOLAR >2HRS (9-15)	SOLAR <2HRS (9-15)	NO SOLAR ACCESS	CROSS VENTILATION
	133	234	31	398	32840	28562	4875		33437	59	78		215	280	59	59	107
% mix	33%	59%	8%							15%	20%			70.4%	14.8%	14.8%	62.2%
														to be confirmed			

SITE AREA	6,568	m2
FSR allowed 5.0:1	32,840	m2
Total Proposed	**32,840**	m2

CARPARKING

Residential				
1Bed	@	1.0	space	133.0
2Bed	@	1.0	space	234.0
3Bed	@	1.5	space	46.5
Sub Total				413.5
Visitors	@	1.0 per 5 units		79.6
Total Required				493

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north point: N

key plan:

notes:

amendments:

Revision	Description	By	Date
P6	Preliminary	GH	15/08/17
P7	Pre-DA	GH	17/08/17
P11	Preliminary Consultant Issue	MA	17/01/18
P12	Preliminary Consultant Issue	SB	17.10.18
P13	Pre-DA Issue	SB	05.11.18
P14	Pre-DA Issue	SB	04.06.19
P17	Preliminary Consultant Issue	MR	09.05.19
P18	Preliminary Consultant Issue	SB	20.05.19
P19	Preliminary Consultant Issue	SB	22.05.19
P22	Preliminary Consultant Issue	SB	04.06.19

WORK IN PROGRESS

mosca pserras architects

project: MIXED USE DEVELOPMENT
location: 11-17 Columbia Lane, HOMEBUSH
client: Columbina Lane Development Pty. Ltd

drawing title: Data

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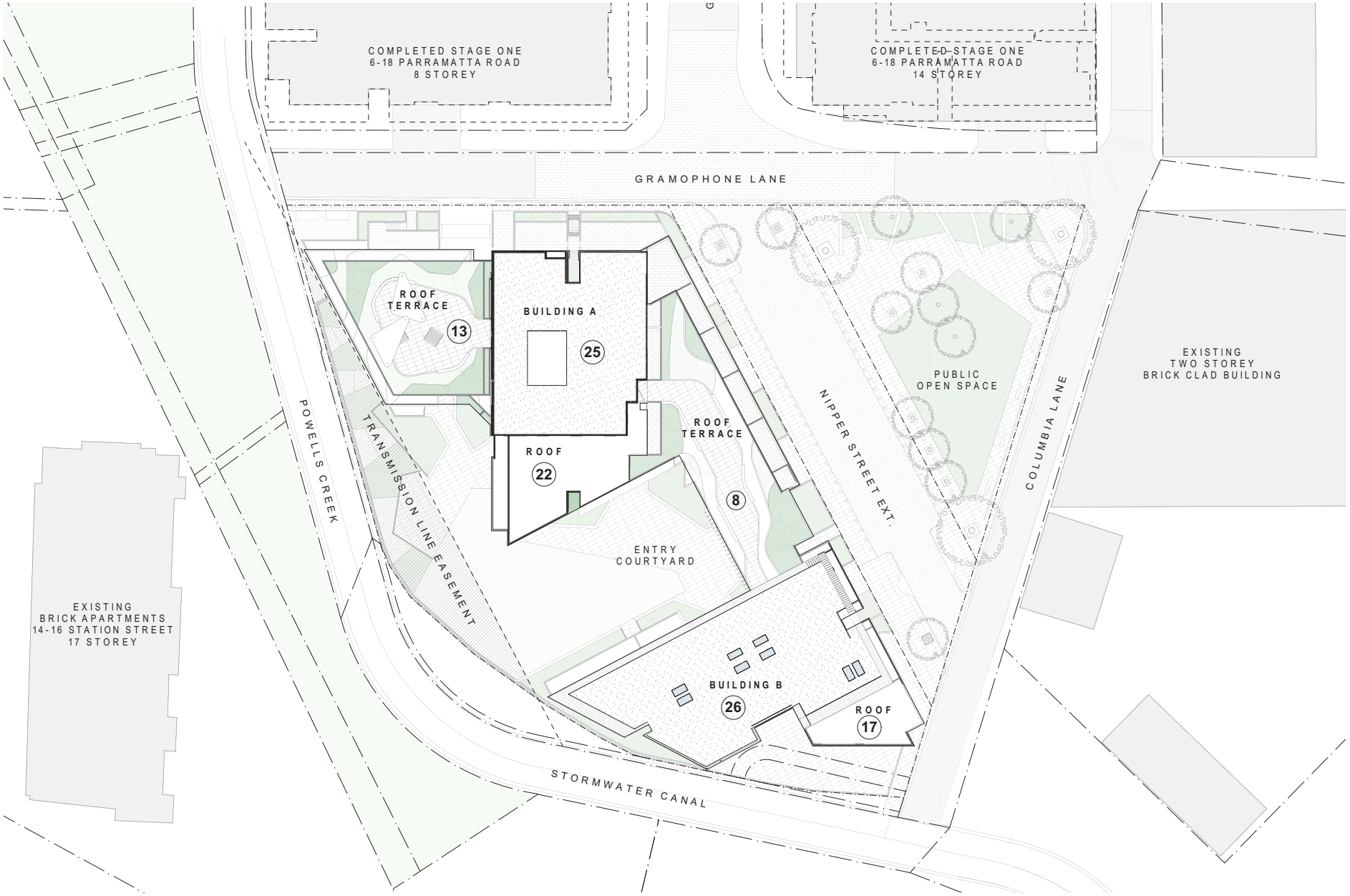
job no.	14028	drawing no.	AP02	issue	P22



Site Plan
1:250

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north point: N

key plan:

notes:

amendments:

Revision	Description	By	Date
P7	Pre-DA	GHI	17/08/17
P9	Podium and tower wing adjustments	MA	19/10/17
P11	Preliminary Consultant Issue	MA	17/01/18
P12	Preliminary Consultant Issue	SIB	17.10.18
P13	Pre-DA Issue	SIB	05.11.18
P14	Pre-DA Issue	SIB	04.06.19
P17	Preliminary Consultant Issue	MR	09.05.19
P18	Preliminary Consultant Issue	SIB	20.05.19
P19	Preliminary Consultant Issue	SIB	22.05.19
P22	Preliminary Consultant Issue	SIB	04.06.19

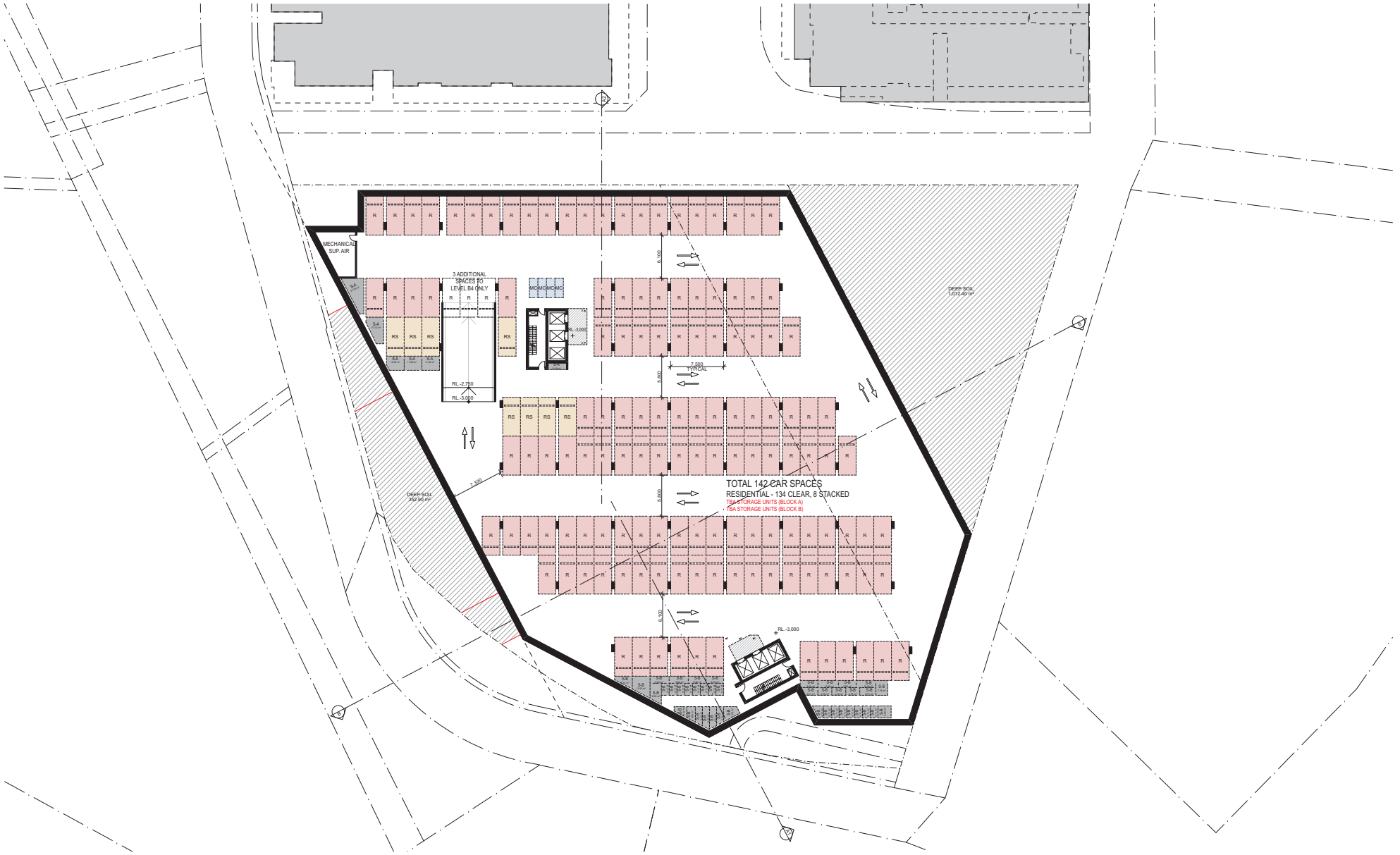
WORK IN PROGRESS

mpa mosca pserras architects

project: MIXED USE DEVELOPMENT
location: 11-17 Columbia Lane, HOMEBUSH
client: Columbina Lane Development Pty. Ltd

drawing title: Site Plan

scale	1:250 @ A1	project architect	SP / GK	drawn	GH/ MA
job no.	14028	drawing no.	AP03	issue	P22



Basement 3 & 4
1:250

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north point: N

key plan:

notes:

amendments:

Revision	Description	By	Date
P6	Building A Southern podium wing adjustments	MA	03/10/17
P11	Preliminary Consultant Issue	MA	17/01/18
P12	Preliminary Consultant Issue	SB	17.10.18
P13	Pre-DA Issue	SB	05.11.18
P14	Pre-DA Issue	SB	04.06.19
P15	Basement adjustments	MR	06.05.19
P17	Preliminary Consultant Issue	MR	09.05.19
P18	Preliminary Consultant Issue	SB	20.05.19
P19	Preliminary Consultant Issue	SB	22.05.19
P22	Preliminary Consultant Issue	SB	04.06.19

WORK IN PROGRESS

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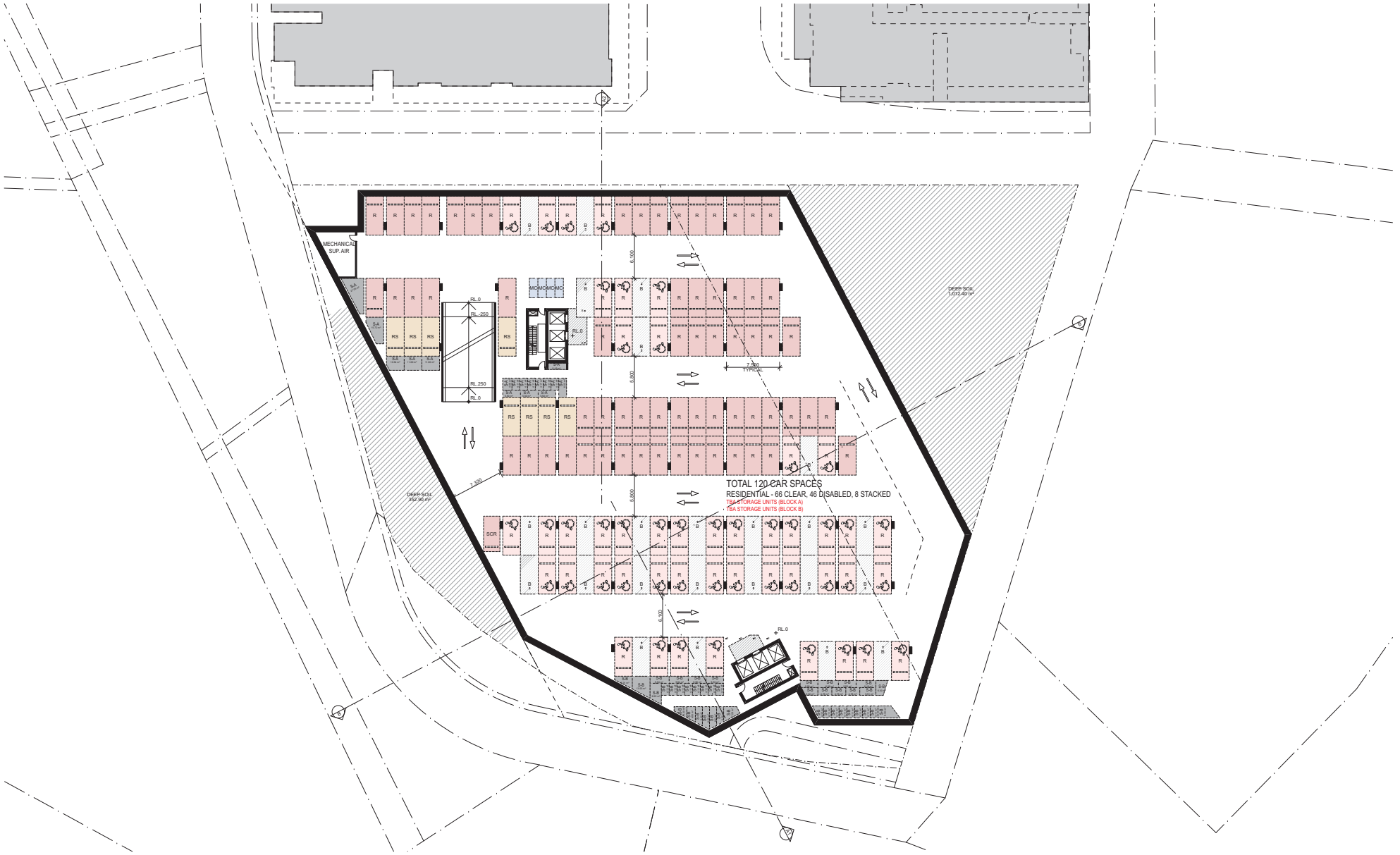
project: MIXED USE DEVELOPMENT
location: 11-17 Columbia Lane, HOMEBUSH
client: Columbina Lane Development Pty. Ltd

drawing title: Basement 3 & 4

scale	1:250 @ A1	project architect	SP / GK	drawn	GH/ MA
job no.	14028	drawing no.	AP04	issue	P22



Basement 2
1:250

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north point: N

key plan:

notes:

amendments:

Revision	Description	By	Date
P6	Building A Southern podium wing adjustments	MA	03/10/17
P11	Preliminary Consultant Issue	MA	17/01/18
P12	Preliminary Consultant Issue	SB	17.10.18
P13	Pre-DA Issue	SB	05.11.18
P14	Pre-DA Issue	SB	04.06.19
P15	Basement adjustments	MR	06.05.19
P17	Preliminary Consultant Issue	MR	09.05.19
P18	Preliminary Consultant Issue	SB	20.05.19
P19	Preliminary Consultant Issue	SB	22.05.19
P22	Preliminary Consultant Issue	SB	04.06.19

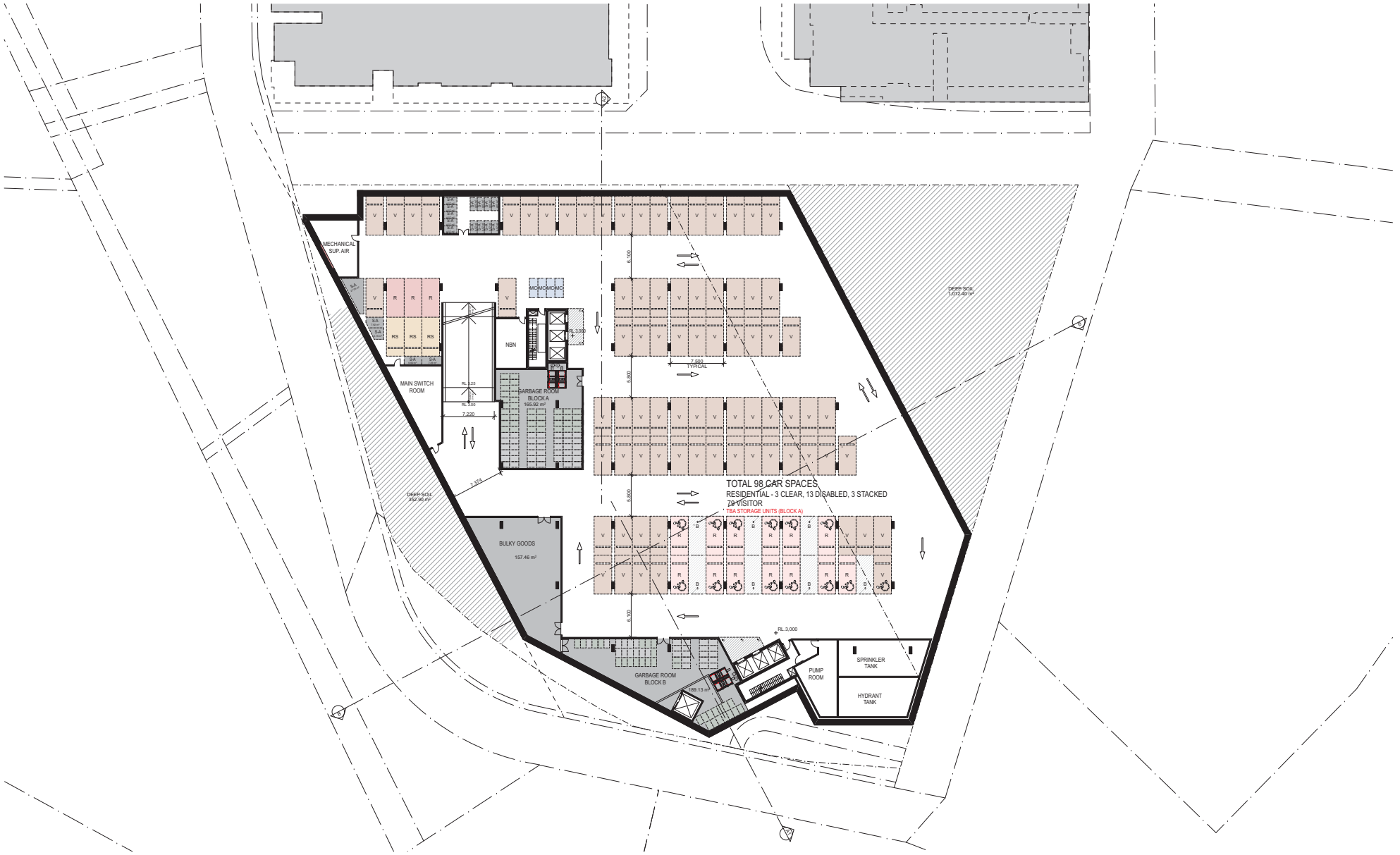
WORK IN PROGRESS

mpa mosca pserras architects

project: MIXED USE DEVELOPMENT
location: 11-17 Columbia Lane, HOMEBUSH
client: Columbina Lane Development Pty. Ltd

drawing title: Basement 2

scale	1:250 @ A1	project architect	SP / GK	drawn	GH/ MA
job no.	14028	drawing no.	AP05	issue	P22



Basement 1
1:250

WORK IN PROGRESS

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north point: N

key plan:

notes:

amendments:

Revision	Description	By	Date
P6	Building A Southern podium wing adjustments	MA	03/10/17
P11	Preliminary Consultant Issue	MA	17/01/18
P12	Preliminary Consultant Issue	SB	17.10.18
P13	Pre-DA Issue	SB	05.11.18
P14	Pre-DA Issue	SB	04.06.19
P15	Basement adjustments	MR	06.05.19
P17	Preliminary Consultant Issue	MR	09.05.19
P18	Preliminary Consultant Issue	SB	20.05.19
P19	Preliminary Consultant Issue	SB	22.05.19
P22	Preliminary Consultant Issue	SB	04.06.19

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project: MIXED USE DEVELOPMENT
location: 11-17 Columbia Lane, HOMEBUSH
client: Columbina Lane Development Pty. Ltd

drawing title: Basement 1

scale	1:250 @ A1	project architect	SP / GK	drawn	GH/ MA
job no.	14028	drawing no.	AP06	issue	P22

Ground.
1:250

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north point:

N

key plan:

notes:

- 1 BED UNITS
- 2 BED UNITS
- 3 BED UNITS
- LIVE WORK UNITS

amendments:

Revision	Description	By	Date
P6	Building A Southern podium wing adjustments	MA	03/10/17
P11	Preliminary Consultant Issue	MA	17/01/18
P12	Preliminary Consultant Issue	SB	17.10.18
P13	Pre-DA Issue	SB	05.11.18
P14	Pre-DA Issue	SB	04.06.19
P15	Client unit adjustments	MA	20.04.19
P17	Preliminary Consultant Issue	MR	09.05.19
P18	Preliminary Consultant Issue	SB	20.05.19
P19	Preliminary Consultant Issue	SB	22.05.19
P22	Preliminary Consultant Issue	SB	04.06.19

WORK IN PROGRESS

mpa mosca pserras architects

project	MIXED USE DEVELOPMENT
location	11-17 Columbia Lane, HOMEBUSH
client	Columbina Lane Development Pty. Ltd
drawing title	Ground Floor
scale	1:250 @ A1
job no.	14028
project architect	SP / GK
drawing no.	AP07
drawn	GH/ MA
issue	P22

Level 1
1:250

WORK IN PROGRESS

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north point:

N

key plan:

notes:

- 1 BED UNITS
- 2 BED UNITS
- 3 BED UNITS
- LIVE WORK UNITS

amendments:

Revision	Description	By	Date
P6	Building A Southern podium wing adjustments	MA	03/10/17
P11	Preliminary Consultant Issue	MA	17/01/18
P12	Preliminary Consultant Issue	SB	17.10.18
P13	Pre-DA Issue	SB	05.11.18
P14	Pre-DA Issue	SB	04.06.19
P15	Client unit adjustments	MA	20.04.19
P17	Preliminary Consultant Issue	MB	09.05.19
P18	Preliminary Consultant Issue	SB	20.05.19
P19	Preliminary Consultant Issue	SB	22.05.19
P22	Preliminary Consultant Issue	SB	04.06.19

mpa
mosca pserras architects

project: MIXED USE DEVELOPMENT
location: 11-17 Columbia Lane, HOMEBUSH
client: Columbina Lane Development Pty. Ltd

drawing title: Level 1

scale	1:250 @ A1	project architect	SP / GK	drawn	GH/ MA
job no.	14028	drawing no.	AP08	issue	P22

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- larger scale drawings and written dimensions take preference.
- do not scale from drawing
- all dimensions to be checked on site before commencement of work.
- all discrepancies to be brought to the attention of the author.

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north point:

N

key plan:

notes:

- 1 BED UNITS
- 2 BED UNITS
- 3 BED UNITS
- LIVE WORK UNITS

amendments:

Revision	Description	By	Date
P8	Building A Southern podium wing adjustments	MA	03/10/17
P11	Preliminary Consultant Issue	MA	17/01/18
P12	Preliminary Consultant Issue	SB	17.10.18
P13	Pre-DA Issue	SB	05.11.18
P14	Pre-DA Issue	SB	04.06.19
P15	Client unit adjustments	MA	30.04.19
P17	Preliminary Consultant Issue	MR	09.05.19
P18	Preliminary Consultant Issue	SB	20.05.19
P19	Preliminary Consultant Issue	SB	22.05.19
P22	Preliminary Consultant Issue	SB	04.06.19

WORK IN PROGRESS

mosca pserras architects

project: MIXED USE DEVELOPMENT
location: 11-17 Columbia Lane, HOMEBUSH
client: Columbina Lane Development Pty. Ltd

drawing title: Level 2-6

scale 1:250 @ A1	project architect SP / GK	drawn GH/ MA
job no. 14028	drawing no. AP09	issue P22

WORK IN PROGRESS

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north point:

N

key plan:

notes:

- 1 BED UNITS
- 2 BED UNITS
- 3 BED UNITS
- LIVE WORK UNITS

amendments:

Revision	Description	By	Date
P8	Building A Southern podium wing adjustments	MA	03/10/17
P11	Preliminary Consultant Issue	MA	17/01/18
P12	Preliminary Consultant Issue	SB	17.10.18
P13	Pre-DA Issue	SB	05.11.18
P14	Pre-DA Issue	SB	04.06.19
P15	Client unit adjustments	MA	20.04.19
P17	Preliminary Consultant Issue	MR	09.05.19
P18	Preliminary Consultant Issue	SB	20.05.19
P19	Preliminary Consultant Issue	SB	22.05.19
P22	Preliminary Consultant Issue	SB	04.06.19

mpa mosca pserras architects

project: MIXED USE DEVELOPMENT
location: 11-17 Columbia Lane, HOMEBUSH
client: Columbina Lane Development Pty. Ltd

drawing title: Level 7

scale	1:250 @ A1	project architect	SP / GK	drawn	GH/ MA
job no.	14028	drawing no.	AP10	issue	P22

Level 8 - Podium
1:250

WORK IN PROGRESS

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north point:

N

key plan:

notes:

- 1 BED UNITS
- 2 BED UNITS
- 3 BED UNITS
- LIVE WORK UNITS

amendments:

Revision	Description	By	Date
P12	Preliminary Consultant Issue	SB	17.10.18
P13	Pre-DA Issue	SB	05.11.18
P14	Pre-DA Issue	SB	04.06.19
P15	Client unit adjustments	MA	20.04.19
P17	Preliminary Consultant Issue	MR	09.05.19
P18	Preliminary Consultant Issue	SB	20.05.19
P19	Preliminary Consultant Issue	SB	22.05.19
P22	Preliminary Consultant Issue	SB	04.06.19

mpa mosca pserras architects

project: MIXED USE DEVELOPMENT
location: 11-17 Columbia Lane, HOMEBUSH
client: Columbina Lane Development Pty. Ltd

drawing title: Level 8

scale	1:250 @ A1	project architect	SP / GK	drawn	GH/ MA
job no.	14028	drawing no.	AP11	issue	P22

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north point:

N

key plan:

notes:

- 1 BED UNITS
- 2 BED UNITS
- 3 BED UNITS
- LIVE WORK UNITS

amendments:

Revision	Description	By	Date
P6	Building A Southern podium wing adjustments	MA	03/10/17
P11	Preliminary Consultant Issue	MA	17/01/18
P12	Preliminary Consultant Issue	SB	17.10.18
P13	Pre-DA Issue	SB	05.11.18
P14	Pre-DA Issue	SB	04.06.19
P15	Client unit adjustments	MA	20.04.19
P17	Preliminary Consultant Issue	MR	09.05.19
P18	Preliminary Consultant Issue	SB	20.05.19
P19	Preliminary Consultant Issue	SB	22.05.19
P22	Preliminary Consultant Issue	SB	04.06.19

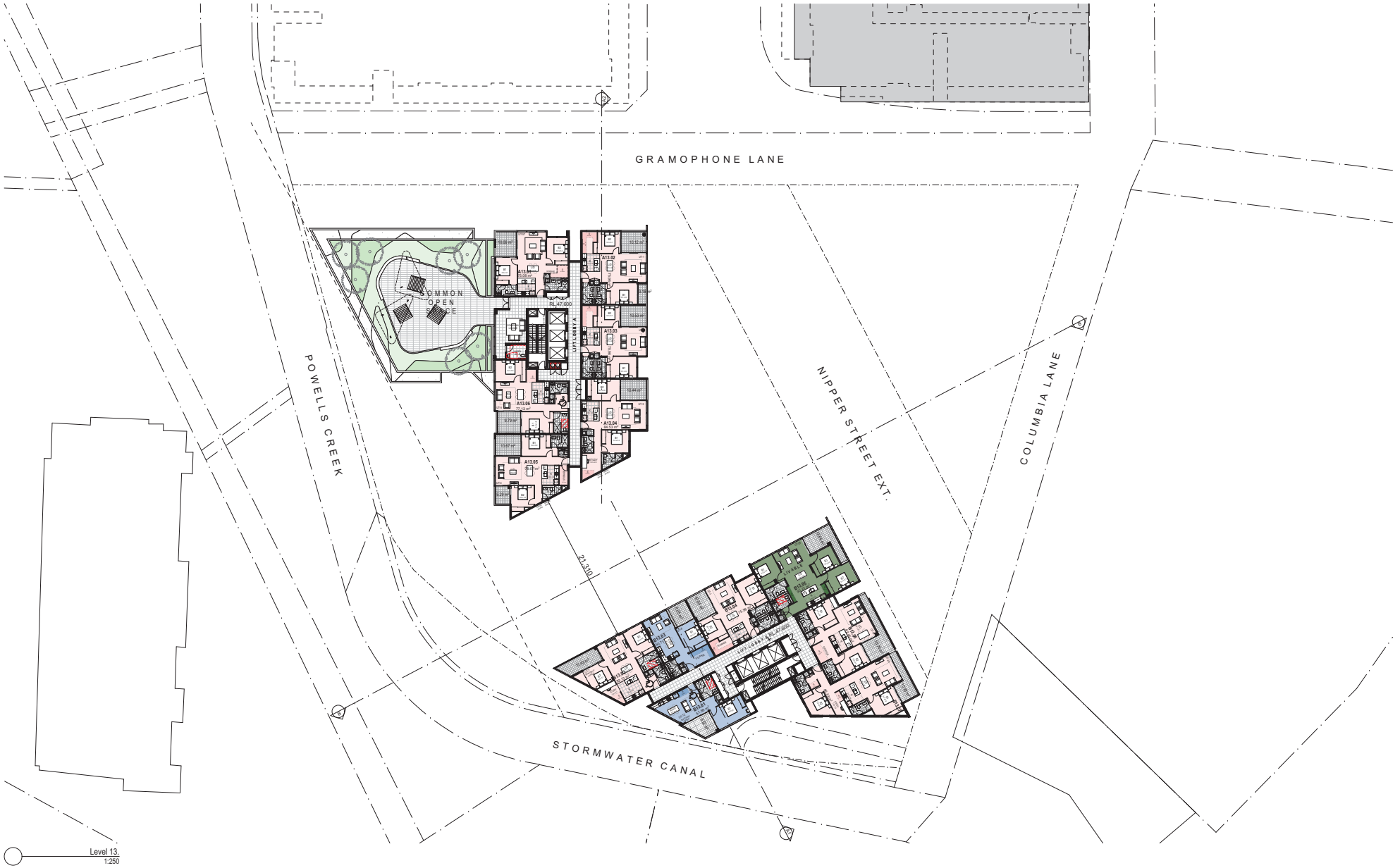
WORK IN PROGRESS

mpa mosca pserras architects

project: MIXED USE DEVELOPMENT
location: 11-17 Columbia Lane, HOMEBUSH
client: Columbina Lane Development Pty. Ltd

drawing title: Level 9-12

scale	1:250 @ A1	project architect	SP / GK	drawn	GH/ MA
job no.	14028	drawing no.	AP12	issue	P22



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north point:

N

key plan:

notes:

- 1 BED UNITS
- 2 BED UNITS
- 3 BED UNITS
- LIVE WORK UNITS

amendments:

Revision	Description	By	Date
P6	Building A Southern podium wing adjustments	MA	03/10/17
P11	Preliminary Consultant Issue	MA	17/01/18
P12	Preliminary Consultant Issue	SB	17.10.18
P13	Pre-DA Issue	SB	05.11.18
P14	Pre-DA Issue	SB	04.06.19
P15	Client unit adjustments	MA	20.04.19
P17	Preliminary Consultant Issue	MB	09.05.19
P18	Preliminary Consultant Issue	SB	20.05.19
P19	Preliminary Consultant Issue	SB	22.05.19
P22	Preliminary Consultant Issue	SB	04.06.19

WORK IN PROGRESS

mpa mosca pserras architects

project: MIXED USE DEVELOPMENT
location: 11-17 Columbia Lane, HOMEBUSH
client: Columbina Lane Development Pty. Ltd

drawing title: Level 13

scale	1:250 @ A1	project architect	SP / GK	drawn	GH/ MA
job no.	14028	drawing no.	AP13	issue	P22

Level 14-16
1:250

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north point:

N

key plan:

notes:

- 1 BED UNITS
- 2 BED UNITS
- 3 BED UNITS
- LIVE WORK UNITS

amendments:

Revision	Description	By	Date
P12	Preliminary Consultant Issue	SB	17.10.18
P13	Pre-DA Issue	SB	05.11.18
P14	Pre-DA Issue	SB	04.06.19
P15	Client unit adjustments	MA	20.04.19
P17	Preliminary Consultant Issue	MR	09.05.19
P18	Preliminary Consultant Issue	SB	20.05.19
P19	Preliminary Consultant Issue	SB	22.05.19
P22	Preliminary Consultant Issue	SB	04.06.19

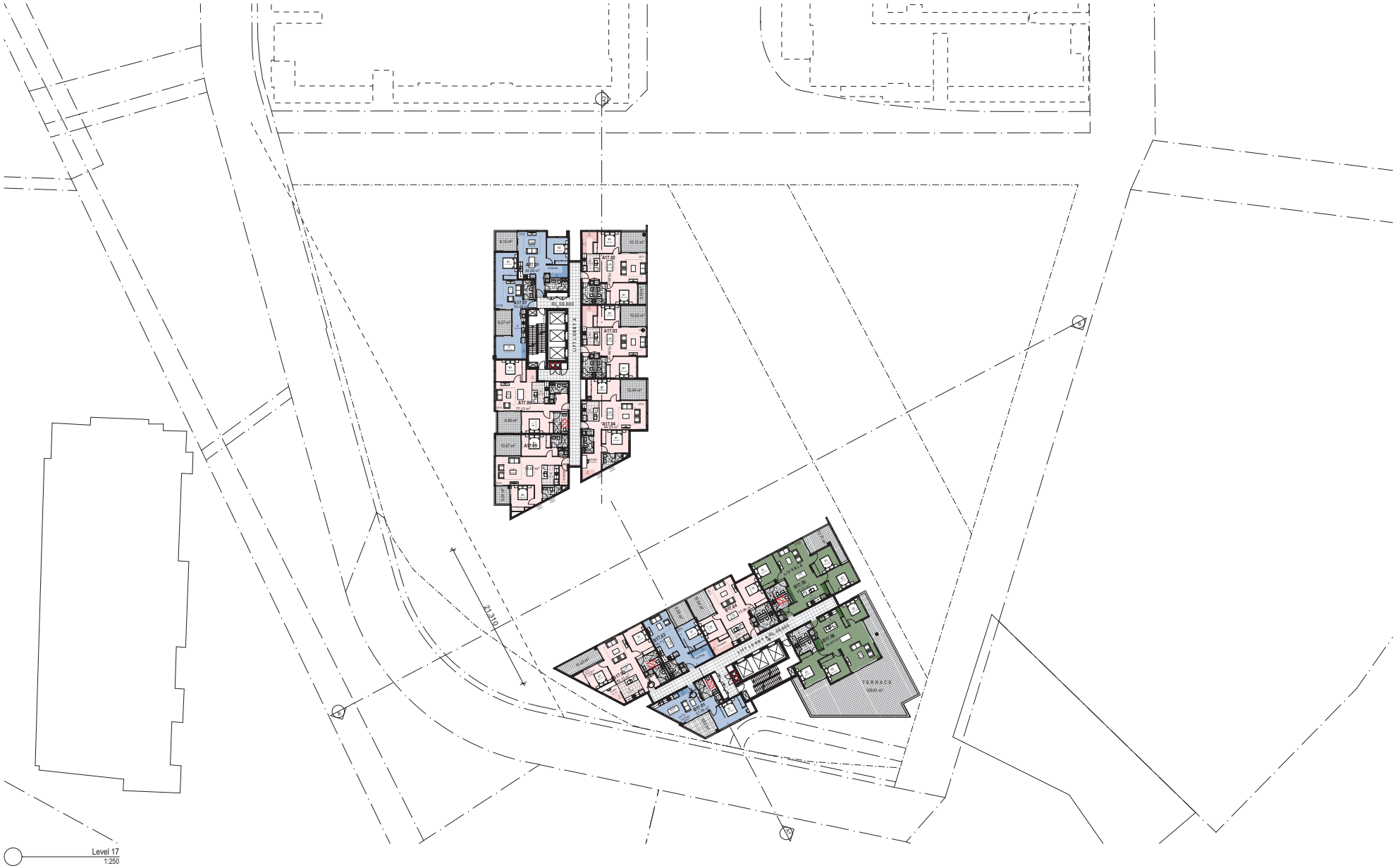
WORK IN PROGRESS

mpa mosca pserras architects

project: MIXED USE DEVELOPMENT
location: 11-17 Columbia Lane, HOMEBUSH
client: Columbina Lane Development Pty. Ltd

drawing title: Level 14-16

scale	1:250 @ A1	project architect	SP / GK	drawn	GH/ MA
job no.	14028	drawing no.	AP14	issue	P22



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north point:

N

key plan:

notes:

- 1 BED UNITS
- 2 BED UNITS
- 3 BED UNITS
- LIVE WORK UNITS

amendments:

Revision	Description	By	Date
P14	Pre-DA Issue	SB	04.06.19
P15	Client unit adjustments	MA	20.04.19
P17	Preliminary Consultant Issue	MR	09.05.19
P18	Preliminary Consultant Issue	SB	20.05.19
P19	Preliminary Consultant Issue	SB	22.05.19
P22	Preliminary Consultant Issue	SB	04.06.19

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project: MIXED USE DEVELOPMENT
location: 11-17 Columbia Lane, HOMEBUSH
client: Columbina Lane Development Pty. Ltd

drawing title: Level 17

scale	1:250 @ A1	project architect	SP / GK	drawn	GH/ MA
job no.	14028	drawing no.	AP15	issue	P22

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north point:

N

key plan:

notes:

- 1 BED UNITS
- 2 BED UNITS
- 3 BED UNITS
- LIVE WORK UNITS

amendments:

Revision	Description	By	Date
P14	Pre-DA Issue	SB	04.06.19
P15	Client unit adjustments	MA	20.04.19
P17	Preliminary Consultant Issue	MR	09.05.19
P18	Preliminary Consultant Issue	SB	20.05.19
P19	Preliminary Consultant Issue	SB	22.05.19
P22	Preliminary Consultant Issue	SB	04.06.19

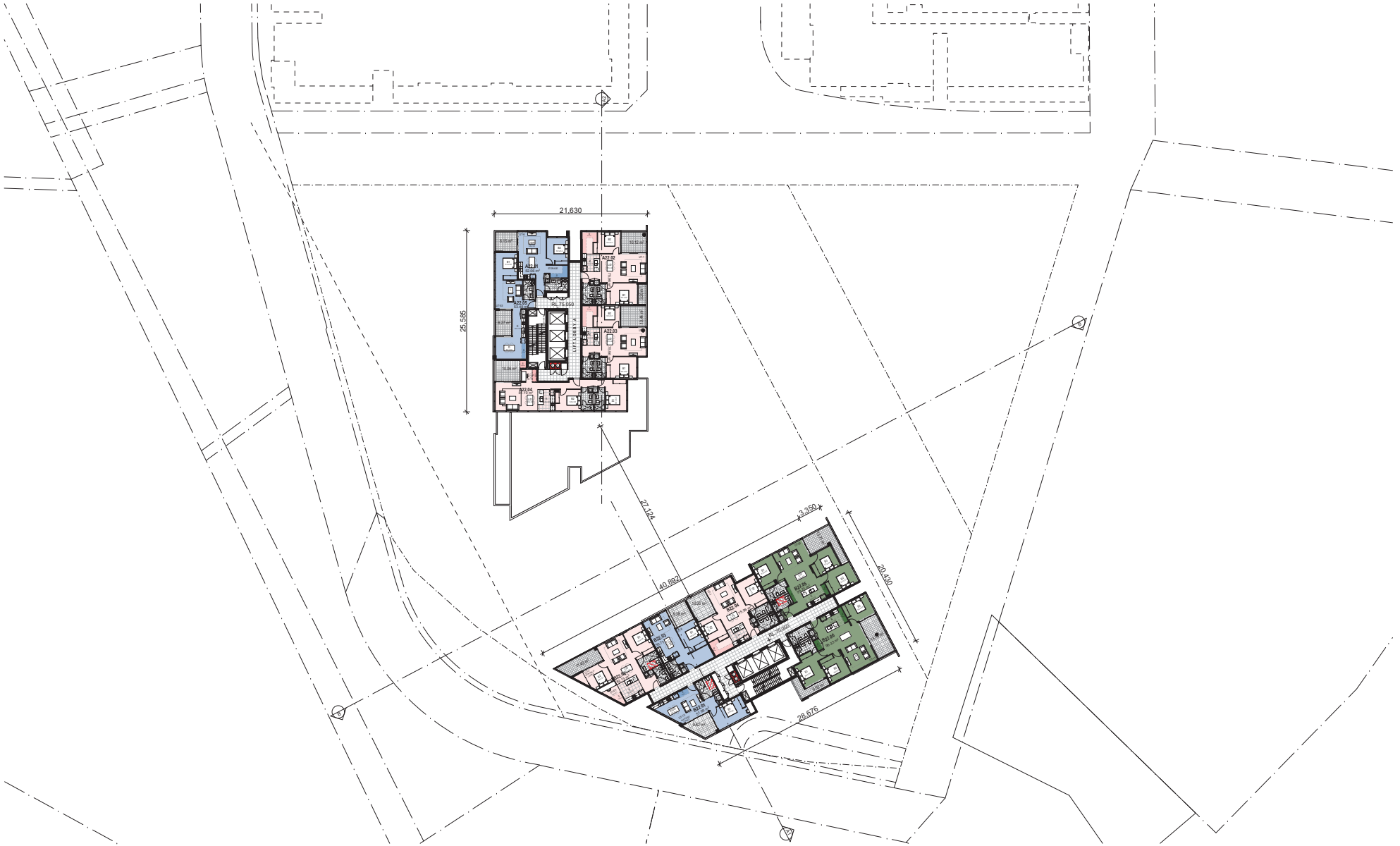
WORK IN PROGRESS

mpa mosca pserras architects

project: MIXED USE DEVELOPMENT
location: 11-17 Columbia Lane, HOMEBUSH
client: Columbina Lane Development Pty. Ltd

drawing title: Level 18-21

scale	1:250 @ A1	project architect	SP / GK	drawn	GH/ MA
job no.	14028	drawing no.	AP16	issue	P22



Level 22
1:250

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north point:

N

key plan:

notes:

- 1 BED UNITS
- 2 BED UNITS
- 3 BED UNITS
- LIVE WORK UNITS

amendments:

Revision	Description	By	Date
P6	Building A Southern podium wing adjustments	MA	03/10/17
P11	Preliminary Consultant Issue	MA	17/01/18
P12	Preliminary Consultant Issue	SB	17.10.18
P13	Pre-DA Issue	SB	05.11.18
P14	Pre-DA Issue	SB	04.06.19
P15	Client unit adjustments	MA	20.04.19
P17	Preliminary Consultant Issue	MR	09.05.19
P18	Preliminary Consultant Issue	SB	20.05.19
P19	Preliminary Consultant Issue	SB	22.05.19
P22	Preliminary Consultant Issue	SB	04.06.19

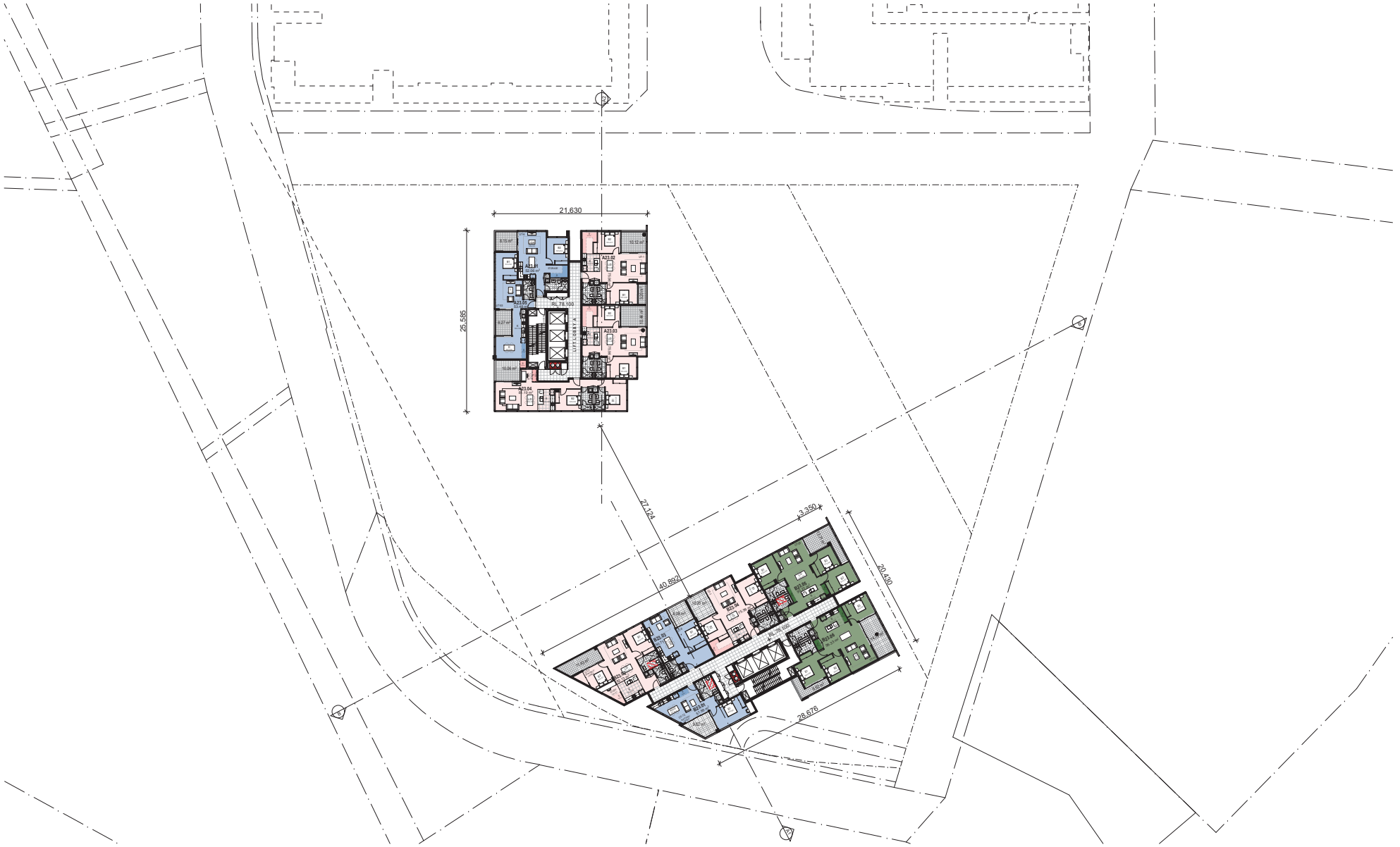
WORK IN PROGRESS

mpa mosca pserras architects

project: MIXED USE DEVELOPMENT
location: 11-17 Columbia Lane, HOMEBUSH
client: Columbina Lane Development Pty. Ltd

drawing title: Levels 22

scale	1:250 @ A1	project architect	SP / GK	drawn	GH/ MA
job no.	14028	drawing no.	AP17	issue	P22



Level 23
1:250

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north point:

N

key plan:

notes:

- 1 BED UNITS
- 2 BED UNITS
- 3 BED UNITS
- LIVE WORK UNITS

amendments:

Revision	Description	By	Date
P6	Building A Southern podium wing adjustments	MA	03/10/17
P11	Preliminary Consultant Issue	MA	17/01/18
P12	Preliminary Consultant Issue	SB	17.10.18
P13	Pre-DA Issue	SB	05.11.18
P14	Pre-DA Issue	SB	04.06.19
P15	Client unit adjustments	MA	20.04.19
P17	Preliminary Consultant Issue	MR	09.05.19
P18	Preliminary Consultant Issue	SB	20.05.19
P19	Preliminary Consultant Issue	SB	22.05.19
P22	Preliminary Consultant Issue	SB	04.06.19

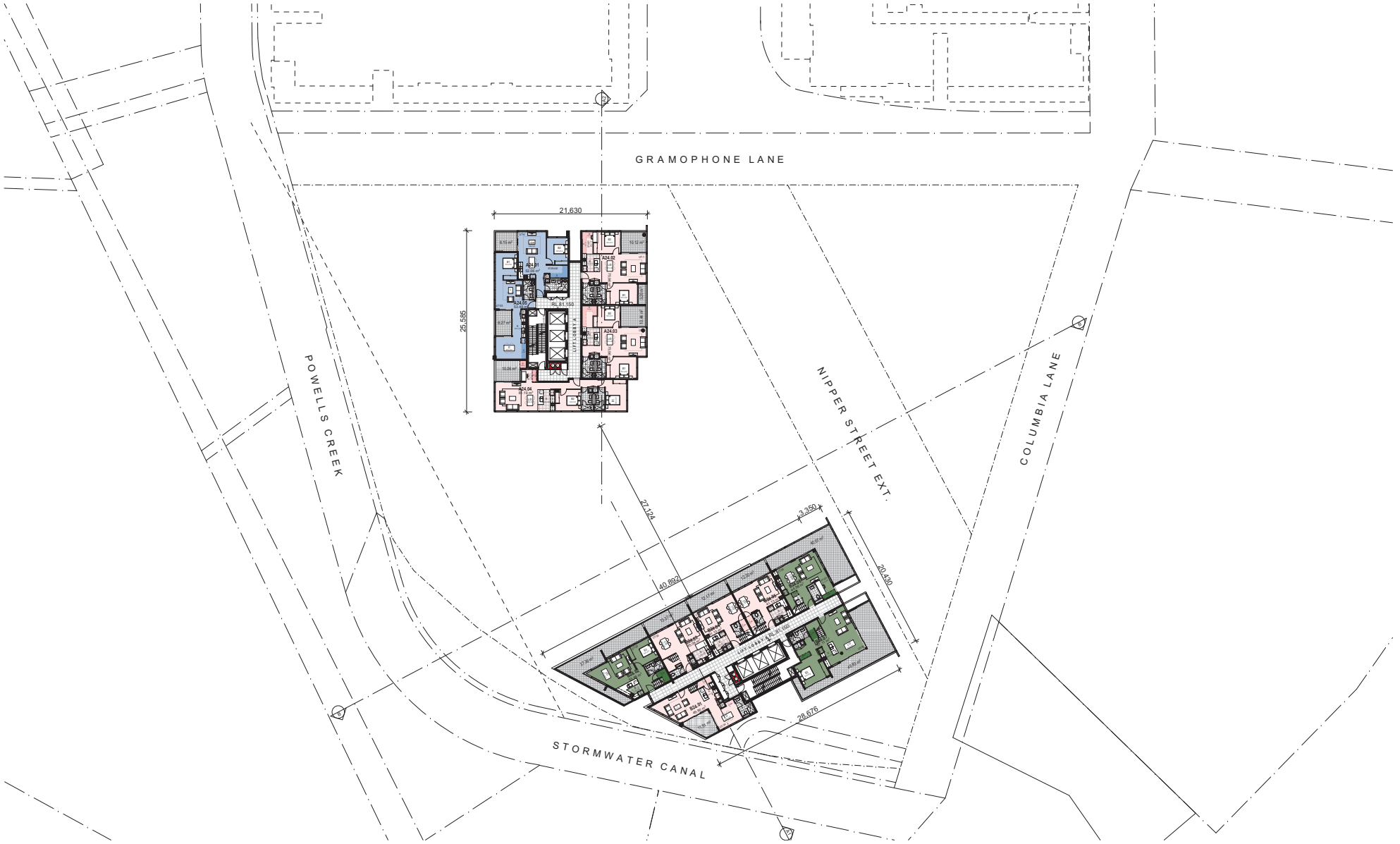
WORK IN PROGRESS

mpa mosca pserras architects

project: MIXED USE DEVELOPMENT
location: 11-17 Columbia Lane, HOMEBUSH
client: Columbina Lane Development Pty. Ltd

drawing title: Level 23

scale	1:250 @ A1	project architect	SP / GK	drawn	GH/ MA
job no.	14028	drawing no.	AP18	issue	P22



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north point:

N

key plan:

notes:

- 1 BED UNITS
- 2 BED UNITS
- 3 BED UNITS
- LIVE WORK UNITS

amendments:

Revision	Description	By	Date
P6	Building A Southern podium wing adjustments	MA	03/10/17
P11	Preliminary Consultant Issue	MA	17/01/18
P12	Preliminary Consultant Issue	SB	17.10.18
P13	Pre-DA Issue	SB	05.11.18
P14	Pre-DA Issue	SB	04.06.19
P15	Client unit adjustments	MA	20.04.19
P17	Preliminary Consultant Issue	MR	09.05.19
P18	Preliminary Consultant Issue	SB	20.05.19
P19	Preliminary Consultant Issue	SB	22.05.19
P22	Preliminary Consultant Issue	SB	04.06.19

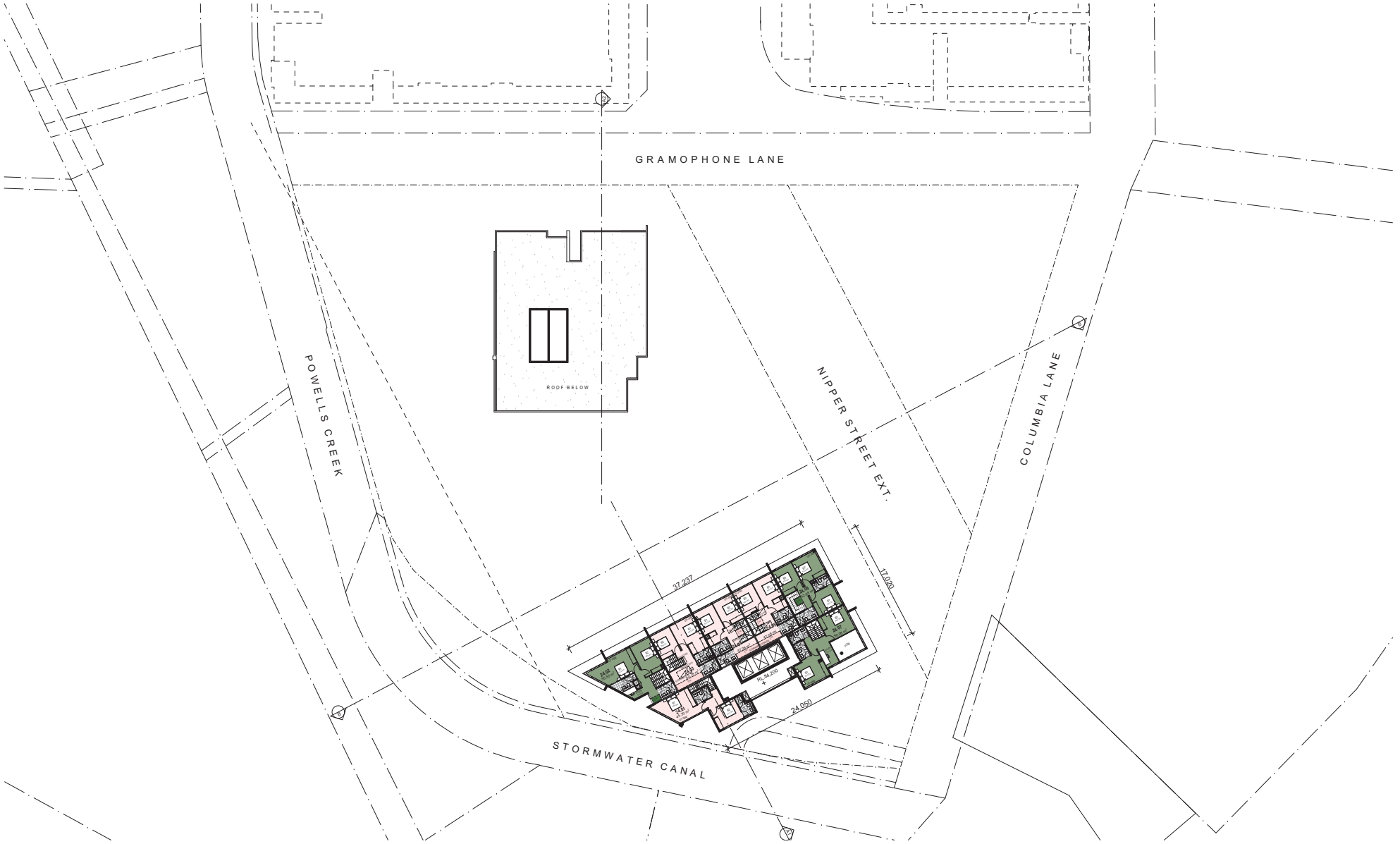
WORK IN PROGRESS

mpa mosca pserras architects

project: MIXED USE DEVELOPMENT
location: 11-17 Columbia Lane, HOMEBUSH
client: Columbina Lane Development Pty. Ltd

drawing title: Level 24

scale	1:250 @ A1	project architect	SP / GK	drawn	GH/ MA
job no.	14028	drawing no.	AP19	issue	P22



Level 25
1:250

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north point:

N

key plan:

notes:

- 1 BED UNITS
- 2 BED UNITS
- 3 BED UNITS
- LIVE WORK UNITS

amendments:

Revision	Description	By	Date
P6	Building A Southern podium wing adjustments	MA	03/10/17
P11	Preliminary Consultant Issue	MA	17/01/18
P12	Preliminary Consultant Issue	SB	17.10.18
P13	Pre-DA Issue	SB	05.11.18
P14	Pre-DA Issue	SB	04.06.19
P15	Client unit adjustments	MA	20.04.19
P17	Preliminary Consultant Issue	MR	09.05.19
P18	Preliminary Consultant Issue	SB	20.05.19
P19	Preliminary Consultant Issue	SB	22.05.19
P22	Preliminary Consultant Issue	SB	04.06.19

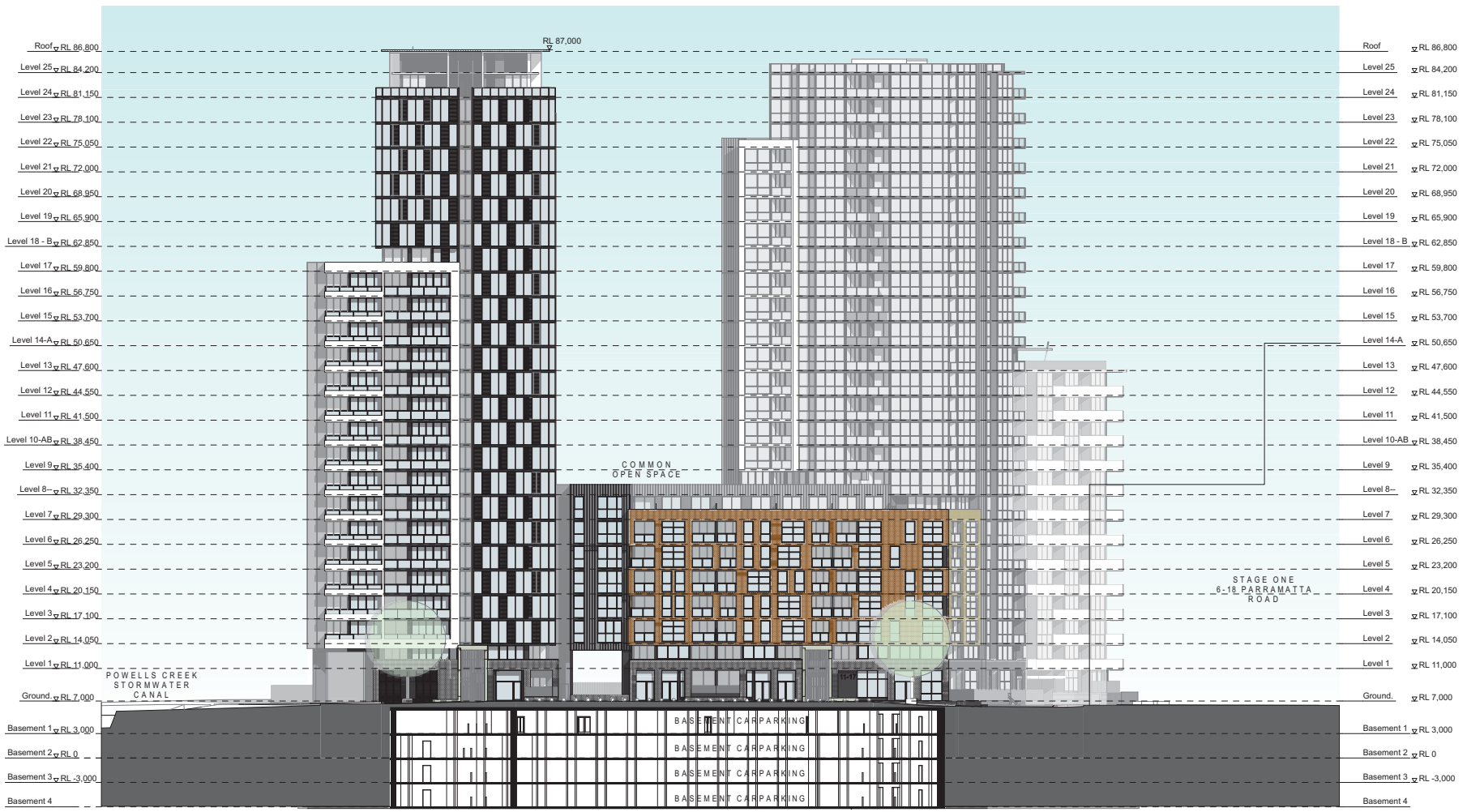
WORK IN PROGRESS

mpa mosca pserras architects

project: MIXED USE DEVELOPMENT
location: 11-17 Columbia Lane, HOMEBUSH
client: Columbina Lane Development Pty. Ltd

drawing title: Level 25

scale	1:250 @ A1	project architect	SP / GK	drawn	GH/ MA
job no.	14028	drawing no.	AP20	issue	P22



North-East Elevation
1:250

1:
Sydney sandstone
Main entry feature wall blades

2:
PGH Bricks 'Macarthur Mix Linear'
Podium feature facade

3:
White powdercoat finish
Feature tower facade

4:
Horizontal interlocking colorbond panel cladding - Basalt
Level 4&5 Podium Facade

5:
Dark grey powdercoat finish
Garage door, open grill commercial door

6:
White paint finish
Balcony upstands and slab edges

7:
Dark grey paint finish
External walls

8:
Duralloy paperbark satin powdercoat finish
Metrix group riverstone screen
External screens

9:
Light grey powdercoat finish
Aluminium door & window frames

10:
Glazing 'Grey Laminated'
Windows, doors & balustrades

11:
Metal vertical blade courtyard fencing
Black powdercoat finish

12:
Door & window style to basix requirements

WORK IN PROGRESS

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north point: N

key plan:

notes:

amendments:

Revision	Description	By	Date
P6	Preliminary	GH	15/08/17
P7	Pre-DA	GH	17/08/17
P11	Preliminary Consultant Issue	MA	17/01/18
P12	Preliminary Consultant Issue	SB	17.10.18
P13	Pre-DA Issue	SB	05.11.18
P14	Pre-DA Issue	SB	04.06.19
P17	Preliminary Consultant Issue	MR	09.05.19
P18	Preliminary Consultant Issue	SB	20.05.19
P19	Preliminary Consultant Issue	SB	22.05.19
P22	Preliminary Consultant Issue	SB	04.06.19

mpa mosca pserras architects

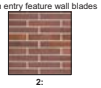
project: MIXED USE DEVELOPMENT
location: 11-17 Columbia Lane, HOMEBUSH
client: Columbina Lane Development Pty. Ltd

drawing title: Elevation NE

scale	1:250 @ A1	project architect	SP / GK	drawn	GH/ MA
job no.	14028	drawing no.	AP21	issue	P22

North Elevation
1:250

1:
Sydney sandstone
Main entry feature wall blades



2:
PGH Bricks 'Macarthur Mix Linear'
Podium feature facade

3:
White powdercoat finish
Feature tower facade

4:
Horizontal interlocking colorbond panel cladding - Basalt
Level 4&5 Podium Facade

5:
Dark grey powdercoat finish
Garage door, open grill commercial door

6:
White paint finish
Balcony upstands and slab edges

7:
Dark grey paint finish
External walls

8:
Duralloy paperbark satin powdercoat finish
Metrix group riverstone screen
External screens

9:
Light grey powdercoat finish
Aluminium door & window frames

10:
Glazing 'Grey Laminated'
Windows, doors & balustrades

11:
Metal vertical blade courtyard fencing
Black powdercoat finish

12:
Door & window style to basix requirements

WORK IN PROGRESS

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north point: N

key plan:

notes:

amendments:

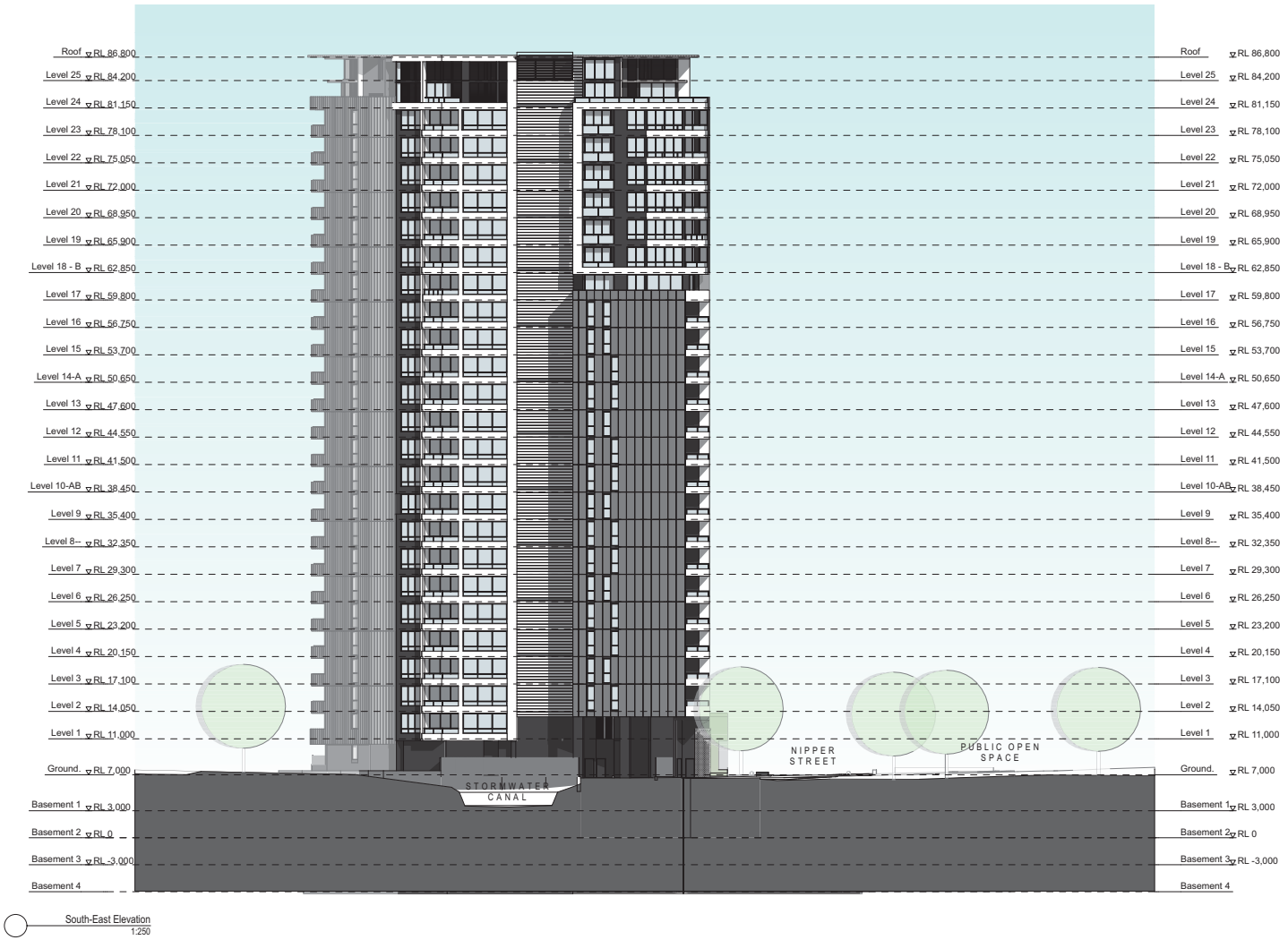
Revision	Description	By	Date
P6	Preliminary	GH	15/08/17
P7	Pre-DA	GH	17/08/17
P11	Preliminary Consultant Issue	MA	17/01/18
P12	Preliminary Consultant Issue	SB	17.10.18
P13	Pre-DA Issue	SB	05.11.18
P14	Pre-DA Issue	SB	04.06.19
P17	Preliminary Consultant Issue	MB	09.05.19
P18	Preliminary Consultant Issue	SB	20.05.19
P19	Preliminary Consultant Issue	SB	22.05.19
P22	Preliminary Consultant Issue	SB	04.06.19

mpa mosca pserras architects

project: MIXED USE DEVELOPMENT
location: 11-17 Columbia Lane, HOMEBUSH
client: Columbina Lane Development Pty. Ltd

drawing title: Elevation N

scale	1:250 @ A1	project architect	SP / GK	drawn	GH/ MA
job no.	14028	drawing no.	AP22	issue	P22



South-East Elevation
1:250

1:
Sydney sandstone
Main entry feature wall blades

2:
PGH Bricks 'Macarthur Mix Linear'
Podium feature facade

3:
White powdercoat finish
Feature tower facade

4:
Horizontal interlocking colorbond panel cladding - Basalt
Level 4&5 Podium Facade

5:
Dark grey powdercoat finish
Garage door, open grill commercial door

6:
White paint finish
Balcony upstands and slab edges

7:
Dark grey paint finish
External walls

8:
Duralloy paperbark satin powdercoat finish
Metrix group riverstone screen
External screens

9:
Light grey powdercoat finish
Aluminium door & window frames

10:
Glazing 'Grey Laminated'
Windows, doors & balustrades

11:
Metal vertical blade courtyard fencing
Black powdercoat finish

12:
Door & window style to basix requirements

WORK IN PROGRESS

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north point: N

key plan:

notes:

amendments:

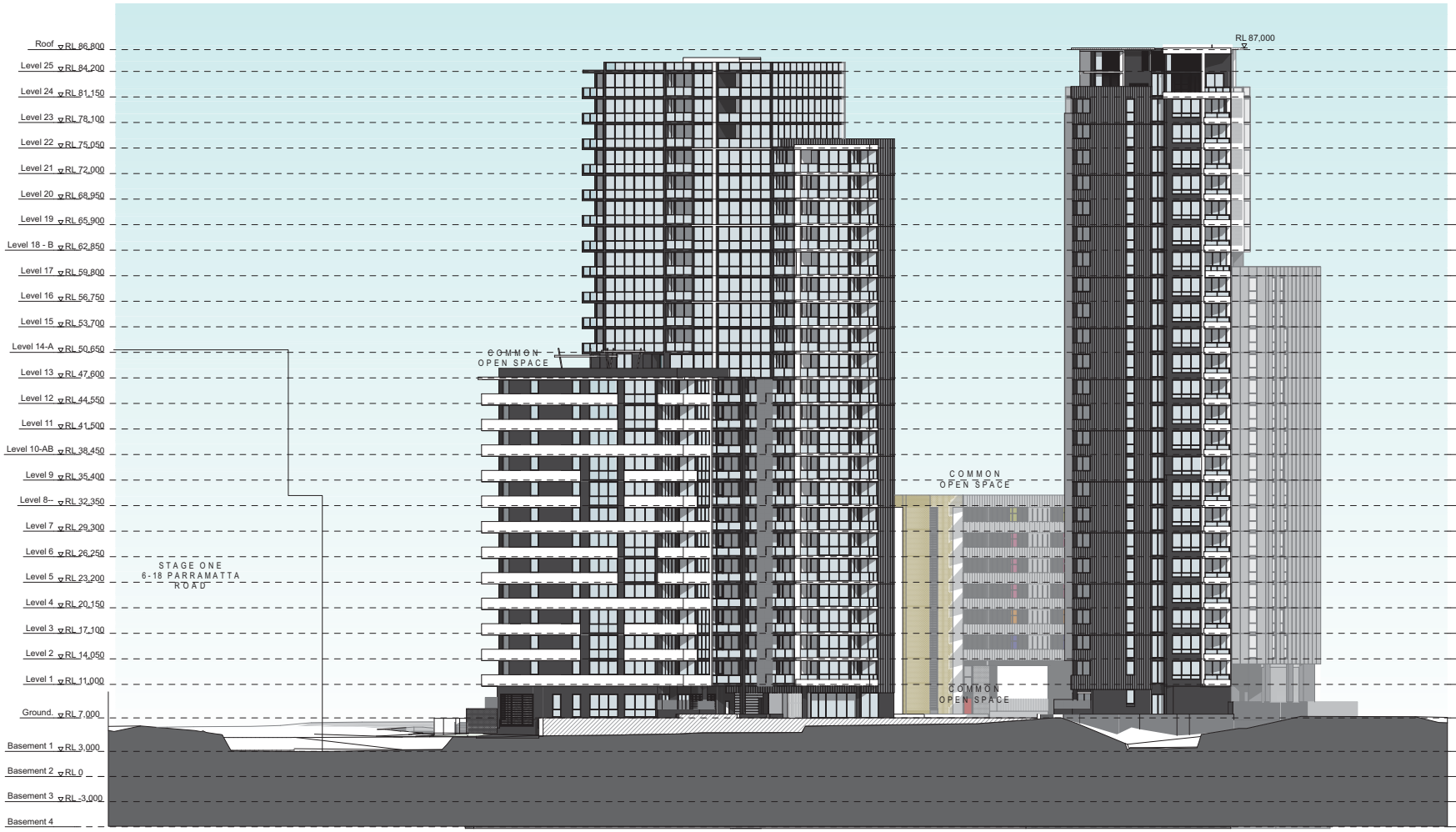
Revision	Description	By	Date
P6	Preliminary	GH	15/08/17
P7	Pre-DA	GH	17/08/17
P11	Preliminary Consultant Issue	MA	17/01/18
P12	Preliminary Consultant Issue	SB	17.10.18
P13	Pre-DA Issue	SB	05.11.18
P14	Pre-DA Issue	SB	04.06.19
P17	Preliminary Consultant Issue	MR	09.05.19
P18	Preliminary Consultant Issue	SB	20.05.19
P19	Preliminary Consultant Issue	SB	22.05.19
P22	Preliminary Consultant Issue	SB	04.06.19

mpa mosca pserras architects

project: MIXED USE DEVELOPMENT
location: 11-17 Columbia Lane, HOMEBUSH
client: Columbina Lane Development Pty. Ltd

drawing title: Elevation SE

scale	1:250 @ A1	project architect	SP / GK	drawn	GH/ MA
job no.	14028	drawing no.	AP23	issue	P22



South-West Elevation
1:250

1:
Sydney sandstone
Main entry feature wall blades

2:
PGH Bricks 'Macarthur Mix Linear'
Podium feature facade

3:
White powdercoat finish
Feature tower facade

4:
Horizontal interlocking colorbond panel cladding - Basalt
Level 4&5 Podium Facade

5:
Dark grey powdercoat finish
Garage door, open grill commercial door

6:
White paint finish
Balcony upstands and slab edges

7:
Dark grey paint finish
External walls

8:
Duralloy paperbark satin powdercoat finish
Metrix group riverstone screen
External screens

9:
Light grey powdercoat finish
Aluminium door & window frames

10:
Glazing 'Grey Laminated'
Windows, doors & balustrades

11:
Metal vertical blade courtyard fencing
Black powdercoat finish

12:
Door & window style to basix requirements

WORK IN PROGRESS

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north point: N

key plan:

notes:

amendments:

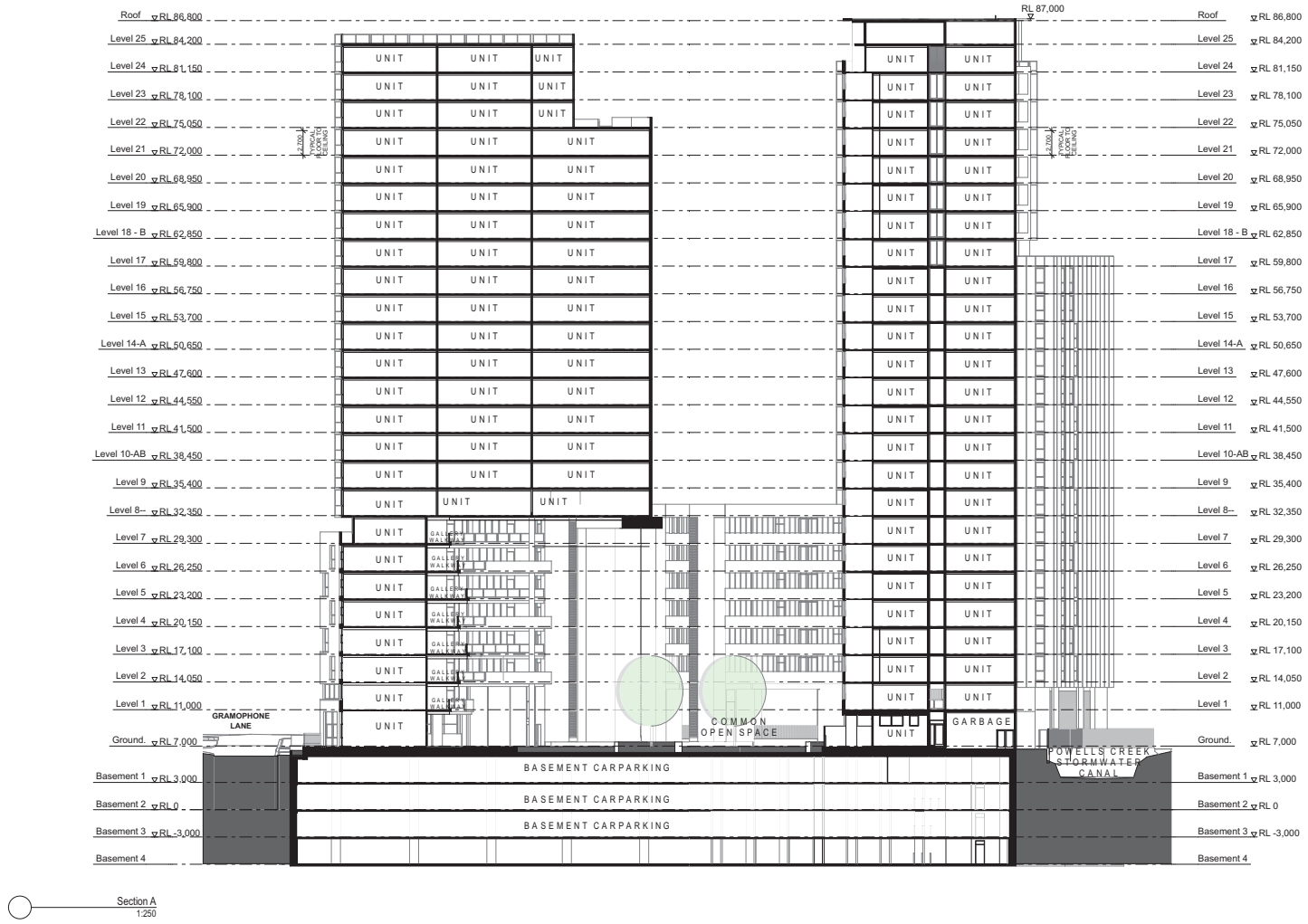
Revision	Description	By	Date
P6	Preliminary	GH	15/08/17
P7	Pre-DA	GH	17/08/17
P11	Preliminary Consultant Issue	MA	17/01/18
P12	Preliminary Consultant Issue	SB	17.10.18
P13	Pre-DA Issue	SB	05.11.18
P14	Pre-DA Issue	SB	04.06.19
P17	Preliminary Consultant Issue	MR	09.05.19
P18	Preliminary Consultant Issue	SB	20.05.19
P19	Preliminary Consultant Issue	SB	22.05.19
P22	Preliminary Consultant Issue	SB	04.06.19

mpa mosca pserras architects

project: MIXED USE DEVELOPMENT
location: 11-17 Columbia Lane, HOMEBUSH
client: Columbina Lane Development Pty. Ltd

drawing title: Elevation SW

scale	1:250 @ A1	project architect	SP / GK	drawn	GH/ MA
job no.	14028	drawing no.	AP24	issue	P22



Section A
1:250

1:
Sydney sandstone
Main entry feature wall blades

2:
PGH Bricks 'Macarthur Mix Linear'
Podium feature facade

3:
White powdercoat finish
Feature tower facade

4:
Horizontal interlocking colorbond panel cladding - Basalt
Level 4&5 Podium Facade

5:
Dark grey powdercoat finish
Garage door, open grill commercial door

6:
White paint finish
Balcony upstands and slab edges

7:
Dark grey paint finish
External walls

8:
Duralloy paperbark satin powdercoat finish
Metrix group riverstone screen
External screens

9:
Light grey powdercoat finish
Aluminium door & window frames

10:
Glazing 'Grey Laminated'
Windows, doors & balustrades

11:
Metal vertical blade courtyard fencing
Black powdercoat finish

12:
Door & window style to basix requirements

WORK IN PROGRESS

e reception@moscapserras.com.au
w www.moscapserras.com.au

north point: N

key plan:

notes:

amendments:

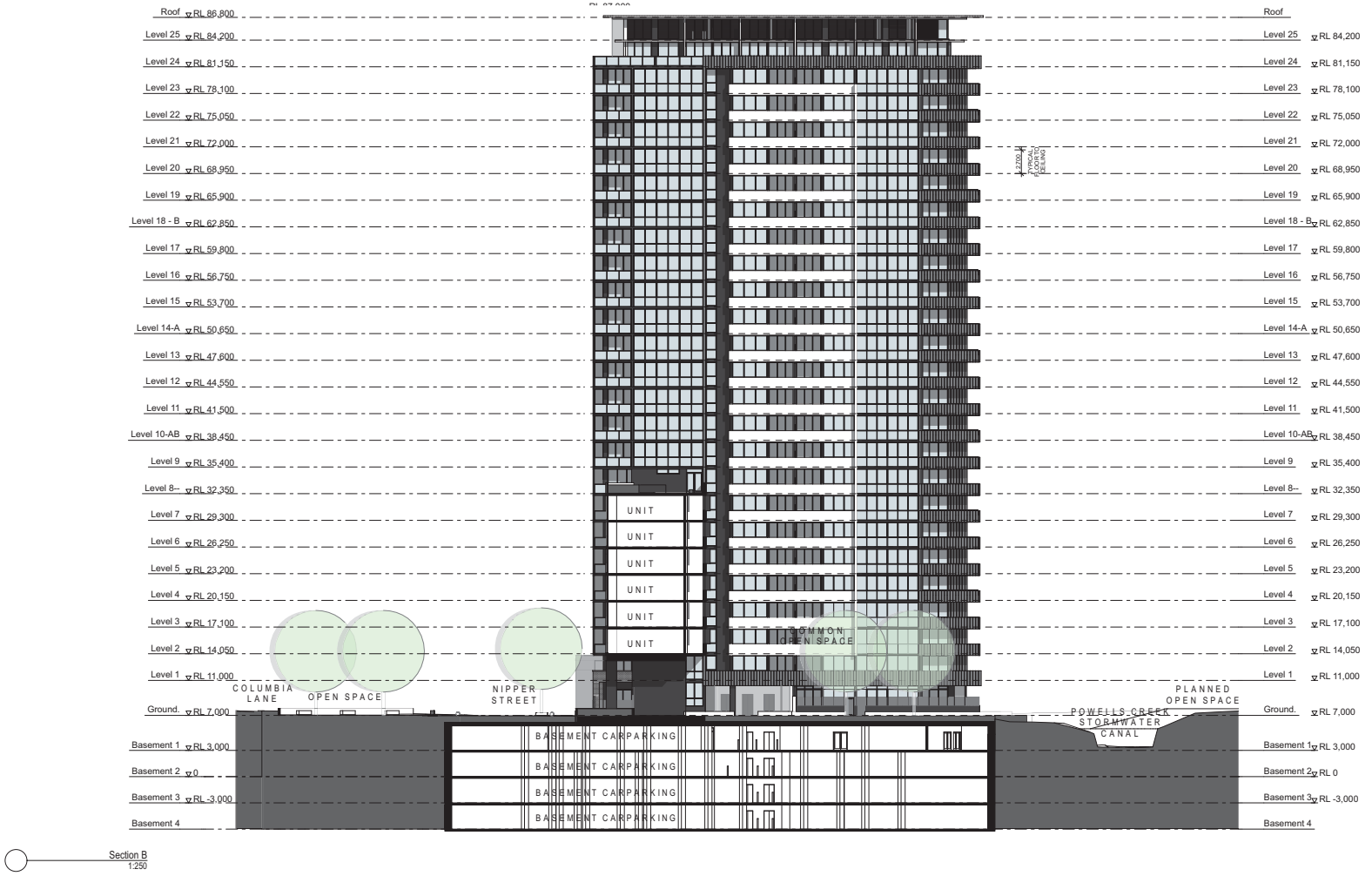
Revision	Description	By	Date
P6	Preliminary	GH	15/08/17
P7	Pre-DA	GH	17/08/17
P11	Preliminary Consultant Issue	MA	17/01/18
P12	Preliminary Consultant Issue	SB	17.10.18
P13	Pre-DA Issue	SB	05.11.18
P14	Pre-DA Issue	SB	04.06.19
P17	Preliminary Consultant Issue	MR	09.05.19
P18	Preliminary Consultant Issue	SB	20.05.19
P19	Preliminary Consultant Issue	SB	22.05.19
P22	Preliminary Consultant Issue	SB	04.06.19

mpa mosca pserras architects

project: MIXED USE DEVELOPMENT
location: 11-17 Columbia Lane, HOMEBUSH
client: Columbina Lane Development Pty. Ltd

drawing title: Section A

scale	1:250 @ A1	project architect	SP / GK	drawn	GH/ MA
job no.	14028	drawing no.	AP25	issue	P22



Section B
1:250

1:
Sydney sandstone
Main entry feature wall blades

2:
PGH Bricks 'Macarthur Mix Linear'
Podium feature facade

3:
White powdercoat finish
Feature tower facade

4:
Horizontal interlocking colorbond panel cladding - Basalt
Level 4&5 Podium Facade

5:
Dark grey powdercoat finish
Garage door, open grill commercial door

6:
White paint finish
Balcony upstands and slab edges

7:
Dark grey paint finish
External walls

8:
Duralloy paperbark satin powdercoat finish
Metrix group riverstone screen
External screens

9:
Light grey powdercoat finish
Aluminium door & window frames

10:
Glazing 'Grey Laminated'
Windows, doors & balustrades

11:
Metal vertical blade courtyard fencing
Black powdercoat finish

12:
Door & window style to basix requirements

WORK IN PROGRESS

e reception@moscapserras.com.au
w www.moscapserras.com.au

north point: N

key plan:

notes:

amendments:

Revision	Description	By	Date
P6	Preliminary	GH	15/08/17
P7	Pre-DA	GH	17/08/17
P11	Preliminary Consultant Issue	MA	17/01/18
P12	Preliminary Consultant Issue	SB	17.10.18
P13	Pre-DA Issue	SB	05.11.18
P14	Pre-DA Issue	SB	04.06.19
P17	Preliminary Consultant Issue	MB	09.05.19
P18	Preliminary Consultant Issue	SB	20.05.19
P19	Preliminary Consultant Issue	SB	22.05.19
P22	Preliminary Consultant Issue	SB	04.06.19

mpa mosca pserras architects

project: MIXED USE DEVELOPMENT
location: 11-17 Columbia Lane, HOMEBUSH
client: Columbina Lane Development Pty. Ltd

drawing title: Section B

scale	1:250 @ A1	project architect	SP / GK	drawn	GH/ MA
job no.	14028	drawing no.	AP26	issue	P22

Appendix C – Borehole Logs & Laboratory Results (STS, 2019a)

STS GeoEnvironmental Pty Ltd

GEOTECHNICAL LOG - NON CORE BOREHOLE

Client: Columbia Lane Development Pty Limited
Project: 11 - 17 Columbia Lane, Homebush
Location: Refer to Drawing No. 19/1315

Project: 21024 / 7145C
Date : 04/07/2016
Logged: MG

BOREHOLE NO.: BH 1

Sheet 1 of 3

WATER TABLE	SAMPLES	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT (Soil type, colour, grain size, plasticity, minor components, observations)	SYMBOL	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	MOISTURE
	S1 @ 0.2 m		SILTY GRAVELLY SAND: dark grey, fine to coarse grained FILL	SP		D
	S2 @ 0.4 m		GRAVELLY SILTY SAND: dark grey, fine grained	CL		D
	SPT 0.5-0.95 m 4, 8, 8 N=16		FILL			
	S3 @ 0.7 m	1.0	GRAVELLY SANDY SILTY CLAY: red brown with brown and grey, some glass/ash/concrete	CL		
	SPT 1.5-1.95 m 4, 5, 6 N=11		FILL			
	S4 @ 1.7 m		SILTY SANDY CLAY: pale grey and mottled orange, low plasticity, MC<PL PP = >600	CL	STIFF	D-M
		2.0				
	S5 @ 3.2 m	3.0	SANDY SILTY CLAY: pale grey and mottled orange, medium plasticity, MC>PL	CL	FIRM TO STIFF	VM
	SPT 3.0-3.45 m 5, 5, 10 N=15		PP = 120			
			GRAVELLY SILTY CLAY: orange and red with mottled grey, medium to high plasticity, ironstone gravel, MC=PL	CH	STIFF TO VERY STIFF	M
		4.0				
	SPT 4.5-4.95 m 4, 7, 11 N=18					
			SILTY CLAY: dark grey with mottled orange, high plasticity, MC=PL	CH	HARD	D-M
		5.0	PP = >600			
			WEATHERED SHALE: dark grey		EXTREMELY LOW STRENGTH	D
			BOREHOLE DISCONTINUED AT 6.0 M For cored details, refer to cored log sheet			

NOTES: D - disturbed sample U - undisturbed tube sample B - bulk sample
WT - level of water table or free water N - Standard Penetration Test (SPT)

See explanation sheets for meaning of all descriptive terms and symbols

Contractor: Terratest
Equipment: Hydropower Scout
Hole Diameter (mm): 100
Angle from Vertical (°) 0

SMEC Testing Services Pty Ltd — **GEOTECHNICAL LOG - CORED BOREHOLE**

Client: Columbia Lane Development Pty Limited
Project: 11-17 Columbia Lane, Homebush
Location: Refer to Drawing No. 19/1315
Project / STS No.: 21024/7145C
Date : 04/07/2016
Logged: MG
Checked By: MG

BOREHOLE NO.: BH 1
Sheet 2 of 3

DRILLING				MATERIAL STRENGTH										DISCONTINUITIES		
						Estimated Rock Strength							Joint Spacing (mm)			
Method	Water	Recovery	Depth (m)	Rock Type (Colour, Grain Size, Structure & Minor Components)	Weathering	Extremely Low	Very Low	Low	Medium	High	Very High	Extremely High	20 40 100 300 1000	Visual	Additional Data (Joints, partings, seams, zones etc. Description, orientation, infilling, or coating, shape, roughness, thickness, other)
N				START CORING AT 6.0 M	Hw										6.15 m, Sm, 0 deg, clay, 10mm
M				For non cored details, refer to non cored log											6.36 m, Pt, 0 deg, 2mm
L				WEATHERED SHALE: pale grey, laminations											6.45 m, Pt, 3 deg, 1mm
C															6.85 m, Sm, 0 deg, Ew, 20mm
C															
O															
R															
I			7.0												
N															7-11 m, HB
G															7.40 m, HB
		100%													7.67 m, HB
															7.82 m, HB
			8.0												
	100%														8.02 m, HB
															8.28 m, HB
															8.54 m, HB
															8.70 m, Sm, 0 deg, carbon, 1mm
															8.81 m, HB
					Fr										
			9.0												
															9.31 m, HB
															9.61 m, Pt x 2, 0 deg, 2mm
															9.86 m, HB
															9.91 m, Pt, 0 deg, 1mm
															9.93 m, Pt, 0 deg, 1mm
															9.96 m, Pt, 0 deg, 3mm
															9.98 m, HB
			10.0												
															10.15 m, HB
		100%													10.3 m, Jt, 65 deg, Pl, Ro
															10.43 m, Jt, 30 deg, Pl, Ro
															10.70 m, Jt, 60 deg, Un, Ro
															10.84 m, Fz, 15 mm
															10.97 m, HB
			11.0												
															11.07 m, Jt, 50 deg, Pl, Ro
															11.20 m, HB
															11.28 m, HB
															11.40 m, Fz, 30 mm
															11.49 m, Jt, 40 deg, Pl, Ro
															11.75 m, Jt, 80 deg, Un, Ro
															11.90 m, Jt, 70 deg, Pl, Ro, Sm
		100%													

Notes:

Contractor: Terratest
Equipment: Hydropower Scout
Hole Diameter (mm):
Angle from Vertical (°):

See explanation sheets for meaning of all descriptive terms and symbols

SMEC Testing Services Pty Ltd — **GEOTECHNICAL LOG - CORED BOREHOLE**

Client: Columbia Lane Development Pty Limited
Project: 11-17 Columbia Lane, Homebush
Location: Refer to Drawing No. 19/1315

Project / STS No.: 21024/7145C
Date : 04/07/2016
Logged: MG — Checked By: MG

BOREHOLE NO.: BH 1
Sheet 3 of 3

DRILLING				MATERIAL STRENGTH										DISCONTINUITIES		
						Estimated Rock Strength							Joint Spacing (mm)			
Method	Water	Recovery	Depth (m)	Rock Type (Colour, Grain Size, Structure & Minor Components)	Weathering	Extremely Low	Very Low	Low	Medium	High	Very High	Extremely High	20 40 100 300 1000	Visual	Additional Data (Joints, partings, seams, zones etc. Description, orientation, infilling, or coating, shape, roughness, thickness, other)
N	100%	100%		WEATHERED SHALE: dark grey with pale grey, laminations	Fr										12.05 m, Jt, 70 deg, Pl, Sm
M															12.17, Jt, 45 deg, Pl, Sm
L															12.20 m, Jt, cut, Sm
C															12.25 m, Jt, 80 deg, Pl, Sm
			13.0												
				END CORING AT 12.94 M											
				Standpipe Piezometer Installed											
			14.0												
			15.0												
			16.0												
			17.0												

Notes:

Contractor: Terratest
Equipment: Hydropower Scout
Hole Diameter (mm):
Angle from Vertical (°):

See explanation sheets for meaning of all descriptive terms and symbols

STS GeoEnvironmental Pty Ltd

GEOTECHNICAL LOG - NON CORE BOREHOLE

Client: Columbia Lane Development Pty Limited
Project: 11 - 17 Columbia Lane, Homebush
Location: Refer to Drawing No. 19/1315

Project: 21024 / 7145C
Date : 04/07/2016
Logged: MG

BOREHOLE NO.: BH 2

Sheet 1 of 4

WATER TABLE	SAMPLES	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT (Soil type, colour, grain size, plasticity, minor components, observations)	SYMBOL	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	MOISTURE
			ASPHALTIC CONCRETE: to 25 mm			
	S6 @ 0.3 m SPT 0.5-0.95 m 3, 5, 3 N = 8		GRAVELLY SILTY SANDY CLAY: grey brown, medium plasticity, concrete/brick/glass/road base	CI/SP		D
	S7 @ 0.6 m		FILL			
			SANDY SILTY CLAY: orange and mottled grey, MC>PL	CH	FIRM TO STIFF	M
	S8 @ 1.2 m SPT 1.5-1.95 2, 3, 3 N=6	1.0	PP = 100			
			SANDY CLAY: pale grey with mottled orange, low to medium plasticity	CI	FIRM	VM
			PP = 70			
		2.0				
	S9 @ 3.0 m SPT	3.0				
WT	3.0-3.45 1, 3, 13 N = 16		GRAVELLY SILTY CLAY: red brown and mottled grey, medium to high plasticity, MC>PL	CH	STIFF TO VERY STIFF	W
			PP = 300			
		4.0				
	SPT 4.5-4.95 m 11, 8, 9 N = 17		PP = 400			
		5.0				
			WEATHERED SHALE: brown and dark grey		EXTREMELY LOW STRENGTH	D

NOTES: D - disturbed sample U - undisturbed tube sample B - bulk sample
WT - level of water table or free water N - Standard Penetration Test (SPT)

See explanation sheets for meaning of all descriptive terms and symbols

Contractor: Terratest
Equipment: Hydropower Scout
Hole Diameter (mm): 100
Angle from Vertical (°) 0

STS GeoEnvironmental Pty Ltd

GEOTECHNICAL LOG - NON CORE BOREHOLE

Client: Columbia Lane Development Pty Limited
Project: 11 - 17 Columbia Lane, Homebush
Location: Refer to Drawing No. 19/1315

Project: 21024 / 7145C
Date : 04/07/2016
Logged: MG

BOREHOLE NO.: BH 2

Sheet 2 of 4

WATER TABLE	SAMPLES	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT (Soil type, colour, grain size, plasticity, minor components, observations)	SYMBOL	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	MOISTURE
	SPT 6.0-3.35 6, 11, >25 N = >36		WEATHERED SHALE: brown to dark grey		EXTREMELY LOW STRENGTH	D
			BOREHOLE DISCONTINUED AT 6.4 M For cored details, refer to cored log sheet			
		7.0				
		8.0				
		9.0				
		10.0				
		11.0				

NOTES: D - disturbed sample U - undisturbed tube sample B - bulk sample
WT - level of water table or free water N - Standard Penetration Test (SPT)

See explanation sheets for meaning of all descriptive terms and symbols

Contractor: Terratest
Equipment: Hydropower Scout
Hole Diameter (mm): 100
Angle from Vertical (°) 0

SMEC Testing Services Pty Ltd — **GEOTECHNICAL LOG - CORED BOREHOLE**

Client: Columbia Lane Development Pty Limited
Project: 11-17 Columbia Lane, Homebush
Location: Refer to Drawing No. 19/1315
Project / STS No.: 21024/7145C
Date : 04/07/2016
Logged: MG
Checked By: MG

BOREHOLE NO.: BH2
Sheet 3 of 4

DRILLING				MATERIAL STRENGTH										DISCONTINUITIES		
						Estimated Rock Strength							Joint Spacing (mm)			
Method	Water	Recovery	Depth (m)	Rock Type (Colour, Grain Size, Structure & Minor Components)	Weathering	Extremely Low	Very Low	Low	Medium	High	Very High	Extremely High	20 40 100 300 1000	Visual	Additional Data (Joints, partings, seams, zones etc. Description, orientation, infilling, or coating, shape, roughness, thickness, other)
				For non cored details, refer to non cored log sheet START CORING AT 6.4 M											
N M L C C O R I N G			7.0	WEATHERED SHALE: dark grey with grey	Ew										6.71 m, Sm, Cy, 10 mm 9.61 m, Sm, Cy, 5 mm
					Fr										7.00 m, HB 7.20 m, HB 7.44 m, HB 7.75 m, HB 7.88 m, Sm, Ew, 30mm
			8.0												8.10 m, HB 8.22 m, HB 8.52 m, HB 8.86 m, Pt, 0 deg, Pl, Ro 8.90 m, Pt, 0 deg, Pl, Ro
			9.0												9.28 m, Jt, 2 deg, Pl, Ro 9.55 m, Pt, 0 deg, Ro 9.89 m, Pt, 0 deg, Pl, Ro
			10.0												10.08-10.11 m, Jt, 4 deg, Pl, Ro 10.21-10.29 m, Cz, veneer 10.31 m, Pl, 0 deg, Pl, Ro 10.39 m, Pl, 0 deg, Pl, Ro 10.75-10.78 m, Jt, Ir, Ro 10.76-10.83 m, Jt, 85 deg, Ir, Ro 10.99-11.08 m, Jt, Ir, Ro, Fractured
			11.0												11.29-11.32 m, Jt, Ir, Ro 11.53 m, Pt, 0 deg, Pl, Sm 11.69 m, Jt, 0 deg, Pl, Ro, Cy veneer 11.76 m, Pt, 0 deg, Pl, Sn 11.85 m, Pt, 0 deg, Pl. Pw

Notes:

Contractor: Terratest
Equipment: Hydropower Scout
Hole Diameter (mm):
Angle from Vertical (°):

See explanation sheets for meaning of all descriptive terms and symbols

SMEC Testing Services Pty Ltd — **GEOTECHNICAL LOG - CORED BOREHOLE**

Client: Columbia Lane Development Pty Limited
Project: 11-17 Columbia Lane, Homebush
Location: Refer to Drawing No. 19/1315

Project / STS No.: 21024/7145C
Date : 04/07/2016
Logged: MG — Checked By: MG

BOREHOLE NO.: BH 2
Sheet 4 of 4

DRILLING				MATERIAL STRENGTH										DISCONTINUITIES		
						Estimated Rock Strength							Joint Spacing (mm)			
Method	Water	Recovery	Depth (m)	Rock Type (Colour, Grain Size, Structure & Minor Components)	Weathering	Extremely Low	Very Low	Low	Medium	High	Very High	Extremely High	20 40 100 300 1000	Visual	Additional Data (Joints, partings, seams, zones etc. Description, orientation, infilling, or coating, shape, roughness, thickness, other)
N M L C				WEATHERED SHALE: dark grey with grey	Fr										12.36 m, Jt, 0 deg, Pl, Ro 12.54 m, Pt, 0 deg, Pl, Sm
			13.0												
			14.0												
			15.0												
			16.0												
			17.0												

Notes:

Contractor: Terratest
Equipment: Hydropower Scout
Hole Diameter (mm):
Angle from Vertical (°):

See explanation sheets for meaning of all descriptive terms and symbols

STS GeoEnvironmental Pty Ltd

GEOTECHNICAL LOG - NON CORE BOREHOLE

Client: Columbia Lane Development Pty Limited
Project: 11 - 17 Columbia Lane, Homebush
Location: Refer to Drawing No. 19/1315

Project: 21024 / 7145C
Date : 05/07/2016
Logged: JK

BOREHOLE NO.: BH 3

Sheet 1 of 4

WATER TABLE	SAMPLES	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT (Soil type, colour, grain size, plasticity, minor components, observations)	SYMBOL	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	MOISTURE
	S10/11/12		ASPHALTIC CONCRETE: to 40 mm			
	@ 0.2 m		CLAYEY SILTY SAND: light brown, fine grained, low plasticity, occasional gravel	CL		D
	S13					
	@ 0.6 m					
	SPT					
	1.0-1.45 m		PP = 50 FILL			
	3, 3, 5		SILTY CLAY: light grey with orange brown, dark grey and red brown, medium to high plasticity, traces of gravel	CL/CH		M
	N=8					
		1.0				
			PP = 400			
			FILL			
	S14		SILTY CLAY: orange brown with light grey and occasional red brown, medium to high plasticity, traces of gravel	CL/CH		M
	@ 1.8 m	2.0				
	SPT					
	2.5-2.95					
	5, 6, 8		PP = 350			
	N=14					
		3.0				
	SPT	4.0				
	4.0-4.30					
	10, 22, R		WEATHERED SHALE: dark grey and brown with light grey, clay seams		EXTREMELY LOW STRENGTH	D
		5.0				
			BOREHOLE DISCONTINUED AT 4.8 M			

NOTES: D - disturbed sample U - undisturbed tube sample B - bulk sample
WT - level of water table or free water N - Standard Penetration Test (SPT)

See explanation sheets for meaning of all descriptive terms and symbols

Contractor: Terratest
Equipment: Hydropower Scout
Hole Diameter (mm): 100
Angle from Vertical (°) 0

SMEC Testing Services Pty Ltd — **GEOTECHNICAL LOG - CORED BOREHOLE**

Client: Columbia Lane Development Pty Limited
Project: 11-17 Columbia Lane, Homebush
Location: Refer to Drawing No. 19/1315

Project / STS No.: 21024/7145C
Date : 05/07/2016
Logged: JK — Checked By: MG

BOREHOLE NO.: BH 3
Sheet 2 of 4

DRILLING				MATERIAL STRENGTH		Estimated Rock Strength							Joint Spacing (mm)						DISCONTINUITIES	
Method	Water	Recovery	Depth (m)	Rock Type (Colour, Grain Size, Structure & Minor Components)	Weathering	Extremely Low	Very Low	Low	Medium	High	Very High	Extremely High	20	40	100	300	1000		Visual	Additional Data (Joints, partings, seams, zones etc. Description, orientation, infilling, or coating, shape, roughness, thickness, other)
			1.0																	
			2.0																	
			3.0																	
			4.0																	
			5.0																	
				For non cored details, refer to non cored log sheet START CORING AT 5.60 M																
N M L C				WEATHERED SHALE: dark grey with light grey	Mw															5.60-6.14 m, Cz + Cy,

Notes:

Contractor: Terratest
Equipment: Hydropower Scout
Hole Diameter (mm):
Angle from Vertical (°):

See explanation sheets for meaning of all descriptive terms and symbols

SMEC Testing Services Pty Ltd — **GEOTECHNICAL LOG - CORED BOREHOLE**

Client: Columbia Lane Development Pty Limited
Project: 11-17 Columbia Lane, Homebush
Location: Refer to Drawing No. 19/1315

Project / STS No.: 21024/7145C
Date : 05/07/2016
Logged: JK — Checked By: MG

BOREHOLE NO.: BH 3
Sheet 3 of 4

DRILLING				MATERIAL STRENGTH											DISCONTINUITIES		
						Estimated Rock Strength							Joint Spacing (mm)				
Method	Water	Recovery	Depth (m)	Rock Type (Colour, Grain Size, Structure & Minor Components)	Weathering	Extremely Low	Very Low	Low	Medium	High	Very High	Extremely High	20 40 100 300 1000				Visual	Additional Data (Joints, partings, seams, zones etc. Description, orientation, infilling, or coating, shape, roughness, thickness, other)
				WEATHERED SHALE: dark grey with light grey	Fr													6.28 m, Jt, 2 deg, Pl, Ro, Cy veneer
																		6.52 m, Jt, 12 deg, Ir, Ro, minor Cy
																		6.69 m, Pt, 0 deg, Pl, Ro
			7.0															
																		7.00-7.05 m, Cz
																		7.17-7.22 m, Jt, Ir, Ro
																		7.26 m, Pt, 0 deg, Pl, Ro
																		7.49-7.68 m, Cz, fractured
																		7.75-7.84 m, Jt, Ir, Ro, Cy
			8.0															
																		8.08 m, Pt, 3 deg, Pl, Ro
																		8.40 m, Pt, 3 deg, Pl, Ro
																		8.48 m, Pt, 3 deg, Pl, Sm
																		8.66 m, Pt, 3 deg, Pl, Sm
																		8.86 m, Jt, 3 deg, Pl, Sm
																		8.94 m, Jt, 0 deg, Pl, Ro
			9.0															
																		9.07 m, Pt, 3 deg, Pl, Sm
																		9.23 m, Jt, 0 deg, Pl, Ro
																		9.39 m, Jt, 0 deg, Pl, Ro
																		9.64-9.67 m, Jt, Ir, Ro
																		9.71 m, Jt, 5 Deg, Pl, Ro
																		9.79 m, Pt, 2 deg, Pl, Sm
																		9.96 m, Pt, 2 deg, Pl, Ro
			10.0															
																		10.17 m, Pt, 2 deg, Pl, Sm
																		10.24 m, Pt, 2 deg, Pl, Sm
																		10.39 m, Pt, 2 deg Pl, Sm
																		10.51 m, Pt, 2 deg, Pl, Sm
																		10.55-10.64 m, Jt, Ir, Ro, Cy
																		10.74 m, Jt, 2 deg, Pl, Ro
																		10.96 m, Pt, 0 deg. Pl, Ro
			11.0															
																		11.17 m, Pt, 2 deg, Pl, Sm
																		11.34 m, Jt, 0 deg, Pl, Ro
																		11.70 m, Jt, 5 deg, Pl, Ro
																		11.92 m, Pt, 0 deg, Pl, Sm

Notes:

Contractor: Terratest
Equipment: Hydropower Scout
Hole Diameter (mm):
Angle from Vertical (°):

See explanation sheets for meaning of all descriptive terms and symbols

SMEC Testing Services Pty Ltd — **GEOTECHNICAL LOG - CORED BOREHOLE**

Client: Columbia Lane Development Pty Limited
Project: 11-17 Columbia Lane, Homebush
Location: Refer to Drawing No. 19/1315
Project / STS No.: 21024/7145C
Date : 05/07/2016
Logged: JK
Checked By: MG

BOREHOLE NO.: BH 3
Sheet 4 of 4

DRILLING				MATERIAL STRENGTH											DISCONTINUITIES		
						Estimated Rock Strength							Joint Spacing (mm)						
Method	Water	Recovery	Depth (m)	Rock Type (Colour, Grain Size, Structure & Minor Components)	Weathering	Extremely Low	Very Low	Low	Medium	High	Very High	Extremely High	20	40	100	300	1000	Visual	Additional Data (Joints, partings, seams, zones etc. Description, orientation, infilling, or coating, shape, roughness, thickness, other)
N				WEATHERED SHALE: dark grey with light grey	Fr														12.03 m, Pt, 0 deg, Pl, Ro
M																			12.19-12.30 m, Cz + Cy
L																			12.36-12.39 m, Jt, 45 deg, Ir, Ro
C																			12.48-12.53 m, Cz + Cy, Fractured
																			12.64-12.92 m, Cz + Cy, Fractured
																			12.95-13.00 m, Jt, 45 deg, Pl, Sm
			13.0																
				CORING DISCONTINUED AT 13.0 M															
			14.0																
			15.0																
			16.0																
			17.0																

Notes:

Contractor: Terratest
Equipment: Hydropower Scout
Hole Diameter (mm):
Angle from Vertical (°):

See explanation sheets for meaning of all descriptive terms and symbols

STS GeoEnvironmental Pty Ltd

GEOTECHNICAL LOG - NON CORE BOREHOLE

Client: Columbia Lane Development Pty Limited
Project: 11 - 17 Columbia Lane, Homebush
Location: Refer to Drawing No. 19/1315

Project: 21024 / 7145C
Date : 06/07/2016
Logged: JK

BOREHOLE NO.: BH 4

Sheet 1 of 3

WATER TABLE	SAMPLES	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT (Soil type, colour, grain size, plasticity, minor components, observations)	SYMBOL	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	MOISTURE
	S15		ASPHALT: to 20 mm			
	@ 0.3 m		SANDY GRAVEL: black, fine grained	GW		M
			FILL			
	S16		SILTY CLAY: light brown, medium plasticity, traces of gravel	CL		M-VM
	@ 0.8 m					
	SPT	1.0	FILL			
	1.50-1.45 m		SILTY CLAY: orange brown with light grey, low plasticity, traces of fine grained sand	CL		M-VM
	2, 2, 1					
	N = 3		PP = 30			
	S17					
	@ 1.2 m					
		2.0				
	SPT		GRAVELLY SILTY CLAY: orange brown with red brown an dlight grey, medium to high plasticity, some gravel	CL/CH		M
	2.5-2.95 m					
	17, 11, 10					
	N = 21		PP = 200			
	S18					
	@ 2.6 m					
		3.0				
			SILTY SANDY CLAY: light grey with orange brown, fine grained sand, medium plaasticity	CL		M
	SPT	4.0				
	4.0-4.45 m					
	3, 3, 3					
	N = 6		PP = 150			
	S19					
	@ 4.1 m					
		5.0				
			WEATHERED SHALE: dark grey with dark brown and orange brown, clay seams		EXTREMELY LOW STRENGTH	M-D
			BOREHOLE DISCONTINUED AT 5.5 M			
			For cored details refer to cored log sheet			

NOTES: D - disturbed sample U - undisturbed tube sample B - bulk sample
WT - level of water table or free water N - Standard Penetration Test (SPT)

See explanation sheets for meaning of all descriptive terms and symbols

Contractor: Terratest
Equipment: Hydropower Scout
Hole Diameter (mm): 100
Angle from Vertical (°) 0

SMEC Testing Services Pty Ltd — **GEOTECHNICAL LOG - CORED BOREHOLE**

Client: Columbia Lane Development Pty Limited
Project: 11-17 Columbia Lane, Homebush
Location: Refer to Drawing No. 19/1315

Project / STS No.: 21024/7145C
Date : 06/07/2016
Logged: JK — Checked By: MG

BOREHOLE NO.: BH 4
Sheet 2 of 3

DRILLING				MATERIAL STRENGTH		Estimated Rock Strength							Joint Spacing (mm)						DISCONTINUITIES	
Method	Water	Recovery	Depth (m)	Rock Type (Colour, Grain Size, Structure & Minor Components)	Weathering	Extremely Low	Very Low	Low	Medium	High	Very High	Extremely High	20	40	100	300	1000		Visual	Additional Data (Joints, partings, seams, zones etc. Description, orientation, infilling, or coating, shape, roughness, thickness, other)
			1.0																	
			2.0																	
			3.0																	
			4.0																	
			5.0																	
				For non cored details, refer to non cored log sheet																
				START CORING AT 5.5 M																
N M L C				WEATHERED SHALE: dark grey with light grey	Fr/ St															5.50-6.15 m, Numerous Jt/Pt, Ir, Ro, some clay infill, Fractured

Notes:

Contractor: Terratest
Equipment: Hydropower Scout
Hole Diameter (mm):
Angle from Vertical (°):

See explanation sheets for meaning of all descriptive terms and symbols

SMEC Testing Services Pty Ltd — **GEOTECHNICAL LOG - CORED BOREHOLE**

Client: Columbia Lane Development Pty Limited
Project: 11-17 Columbia Lane, Homebush
Location: Refer to Drawing No. 19/1315

Project / STS No.: 21024/7145C
Date : 06/07/2016
Logged: JK — Checked By: MG

BOREHOLE NO.: BH 4
Sheet 3 of 3

DRILLING				MATERIAL STRENGTH											DISCONTINUITIES		
						Estimated Rock Strength							Joint Spacing (mm)				
Method	Water	Recovery	Depth (m)	Rock Type (Colour, Grain Size, Structure & Minor Components)	Weathering	Extremely Low	Very Low	Low	Medium	High	Very High	Extremely High	20 40 100 300 1000				Visual	Additional Data (Joints, partings, seams, zones etc. Description, orientation, infilling, or coating, shape, roughness, thickness, other)
				WEATHERED SHALE: dark grey with light grey	Fr/													6.15 m, Jt, 2 deg, Pl, Sm
					St													6.29 m, Jt, 2 deg, Pl, Sm
N																		6.45-6.50 m, Jt, 50 deg
M																		6.58-7.04 m, Jt, Pt, Ir, Ro, Minor clay (Fractured)
L					Fr													
C																		
C																		
O																		
R			7.0															
I																		7.43-7.46 m, Jt, 45 deg, Pl, Ro
N																		7.93 m, Jt, 0 deg, Pl, Ro
G																		7.98-8.04 m, Jt, 60 deg, Pl, Ro
			8.0															
																		8.06 m, Jt, 0 deg, Pl, Ro
																		8.09-8.13 m, Jt, 50 deg, Ir, Ro
																		8.19 m, Jt, 0 deg, Pl, Ro
																		8.24 m, Jt, Ir, Ro
																		8.30-8.35 m, Jt, Pt, Ir, Ro, Clay infill
																		8.58-8.70 m, Jt, 80 deg, Ir, Ro, Fractured
																		8.77-8.80, Pt, Ir, Ro
																		8.88-8.95 m, Jt, 80, Ir, Ro
																		8.98-9.02 m, Jt, 20 deg, Pl, Ro
			9.0															
																		9.09-9.11 m, Jt, 20 deg, Pl, Ro
																		9.13-9.14 m, Jt, 15 deg, Pl, Ro
																		9.18-9.21 m, Jt, 20 deg, Pl, Ro
																		9.30-9.31 m, Jt, 20 deg, Pl, Ro
																		9.40-9.45 m, Jt, Pt, Ir, Ro, fractured
																		9.50-9.55 m, Jt, Ir, Ro
																		9.86 m, Jt, 0 deg, Pl, Ro
																		9.89-9.93 m, Jt, 45 deg, Pl, Sm
			10.0															
																		10.04-10.16 m, Pt, 0 deg, Pl, Ro
																		10.48-10.50 m, Jt, 10 deg, Pl, Ro
																		10.52-10.59 m, Jt, 5 deg, Pl, Ro
																		10.75 m, Jt, 3 deg, Pl, Sm
			11.0															
																		11.14 m, Jt, 3 deg, Pl, Ro
																		11.31-11.62 m, Numerous Jt/Pt, Clay infill
																		11.67-11.73 m, Jt, 85 deg, Pl, Ro
																		11.77 m, Jt, Ir, Ro
				Standpipe Piezometer Installed														
				CORING DISCONTINUED AT 11.93 M														

Notes:

Contractor: Terratest
Equipment: Hydropower Scout
Hole Diameter (mm):
Angle from Vertical (°):

See explanation sheets for meaning of all descriptive terms and symbols

STS GeoEnvironmental Pty Ltd

GEOTECHNICAL LOG - NON CORE BOREHOLE

Client: Columbia Lane Development Pty Limited
Project: 11 - 17 Columbia Lane, Homebush
Location: Refer to Drawing No. 19/1315

Project: 21024 / 7145C
Date : 06/07/2016
Logged: JK

BOREHOLE NO.: BH 5

Sheet 1 of 4

WATER TABLE	SAMPLES	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT (Soil type, colour, grain size, plasticity, minor components, observations)	SYMBOL	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	MOISTURE
			CONCRETE: 340 mm thick			
	S20 @ 0.5 m		Gravelly sandy clay, black, fine grained, low plasticity, some gravel FILL	CL		M
	S21 @ 1.0 m SPT 1.0-1.45 m 1, 2, 2 N = 3	1.0	SILTY CLAY: light grey and brown with orange brown, medium to high plasticity PP = 30	CL/CH		M
		2.0	SILTY CLAY: orange brown with light grey, medium to high plasticity	CL/CH		M
	SPT 2.5-2.95 m 6, 6, 4 N = 10		SILTY CLAY: light grey with orange brown, medium plasticity, traces of fine sand PP = 250	CL		M
		3.0				
	SPT 4.0-4.45 m 3, 2, 2 N = 4	4.0	PP = 100			M-VM
		5.0				
	SPT 5.50-5.95 m 12, 8, 11 N = 19		PP = 300			
			SILTY CLAY: light grey with orange brown and light brown, medium to high plasticity, traces of gravel	CL/CH		M

NOTES: D - disturbed sample U - undisturbed tube sample B - bulk sample
WT - level of water table or free water N - Standard Penetration Test (SPT)

See explanation sheets for meaning of all descriptive terms and symbols

Contractor: Terratest
Equipment: Hydropower Scout
Hole Diameter (mm): 100
Angle from Vertical (°) 0

STS GeoEnvironmental Pty Ltd

GEOTECHNICAL LOG - NON CORE BOREHOLE

Client: Columbia Lane Development Pty Limited
Project: 11 - 17 Columbia Lane, Homebush
Location: Refer to Drawing No. 19/1315

Project: 21024 / 7145C
Date : 06/07/2016
Logged: JK

BOREHOLE NO.: BH 5

Sheet 2 of 4

WATER TABLE	SAMPLES	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT (Soil type, colour, grain size, plasticity, minor components, observations)	SYMBOL	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	MOISTURE
			SILTY CLAY: light grey with orange brown and light brown, medium to high plasticity, traces of gravel	CL/CH		M
			WEATHERED SHALE: dark grey and brown with orange brown, clay seams		EXTREMELY LOW STRENGTH	D
		7.0	BOREHOLE DISCONTINUED AT 7.0 M For cored details, refer to cored log sheet			
		8.0				
		9.0				
		10.0				
		11.0				

NOTES: D - disturbed sample U - undisturbed tube sample B - bulk sample
WT - level of water table or free water N - Standard Penetration Test (SPT)

See explanation sheets for meaning of all descriptive terms and symbols

Contractor: Terratest
Equipment: Hydropower Scout
Hole Diameter (mm): 100
Angle from Vertical (°) 0

SMEC Testing Services Pty Ltd — **GEOTECHNICAL LOG - CORED BOREHOLE**

Client: Columbia Lane Development Pty Limited
Project: 11-17 Columbia Lane, Homebush
Location: Refer to Drawing No. 19/1315

Project / STS No.: 21024/7145C
Date : 07/07/2016
Logged: JK — Checked By: MG

BOREHOLE NO.: BH 5
Sheet 3 of 4

DRILLING				MATERIAL STRENGTH										DISCONTINUITIES		
						Estimated Rock Strength							Joint Spacing (mm)			
Method	Water	Recovery	Depth (m)	Rock Type (Colour, Grain Size, Structure & Minor Components)	Weathering	Extremely Low	Very Low	Low	Medium	High	Very High	Extremely High	20 40 100 300 1000	Visual	Additional Data (Joints, partings, seams, zones etc. Description, orientation, infilling, or coating, shape, roughness, thickness, other)
				For non cored details, refer to non cored log sheet											
			7.0	START CORING AT 7.0 M											
N M L C CORING				WEATHERED SHALE: dark grey with light grey	Fr/St										7.00-9.04 m, Numerous Jt/Pt, Ir, Ro, Fractured -minor clay infill
			8.0		Fr										
			9.0												9.13 m, Pt, 0 deg, Pl, Ro 9.15-9.49 m, Jt, 90 deg, Ir, Ro 9.64 m, Jt, 5 deg, Pl, Sm 9.76-9.83 m, Jt, Und, Ro 9.94 m, Jt, 2 deg, Pl, Sm
			10.0												10.04-10.10, Jt, 90 deg, Ir, Ro 10.26 m, Jt, 0 deg, Pl, Ro 10.37-10.44 m, Jt, Pt, Ir, Ro 10.64 m, Jt, 2 deg, Pl, Sm 10.74 m, Pt, 5 deg, Pl, Sm 10.89 m, Jt, 2 deg, Pl, Sm, Cy veneer 10.93-10.95 m, Jt, 20 deg, Ir, Ro
			11.0												11.04-12.18 m, Numerous Jt/Pt, Ir, Ro

Notes:

Contractor: Terratest
Equipment: Hydropower Scout
Hole Diameter (mm):
Angle from Vertical (°):

See explanation sheets for meaning of all descriptive terms and symbols

SMEC Testing Services Pty Ltd — **GEOTECHNICAL LOG - CORED BOREHOLE**

Client: Columbia Lane Development Pty Limited
Project: 11-17 Columbia Lane, Homebush
Location: Refer to Drawing No. 19/1315

Project / STS No.: 21024/7145C
Date : 07/07/2016
Logged: JK — Checked By: MG

BOREHOLE NO.: BH 5
Sheet 4 of 4

DRILLING				MATERIAL STRENGTH												DISCONTINUITIES	
						Estimated Rock Strength							Joint Spacing (mm)				
Method	Water	Recovery	Depth (m)	Rock Type (Colour, Grain Size, Structure & Minor Components)	Weathering	Extremely Low	Very Low	Low	Medium	High	Very High	Extremely High	20 40 100 300 1000				Visual	Additional Data (Joints, partings, seams, zones etc. Description, orientation, infilling, or coating, shape, roughness, thickness, other)
N M L C				WEATHERED SHALE: dark grey with light grey	Fr													12.26 m, Pt, 0 deg, Pl, Ro 12.55 m, Pt, Ir, Ro 12.63-12.75 m, Jt/Pt, Ir, Ro 12.80-12.92 m, Jt, 0 deg, Pl, Ro
			13.0															
				CORING DISCONTINUED AT 13.00 M														
			14.0															
			15.0															
			16.0															
			17.0															

Notes:

Contractor: Terratest
Equipment: Hydropower Scout
Hole Diameter (mm):
Angle from Vertical (°):

See explanation sheets for meaning of all descriptive terms and symbols

STS GeoEnvironmental Pty Ltd

GEOTECHNICAL LOG - NON CORE BOREHOLE

Client: Columbia Lane Development Pty Limited
Project: 11 - 17 Columbia Lane, Homebush
Location: Refer to Drawing No. 19/1315

Project: 21024 / 7145C
Date : 07/07/2016
Logged: JK

BOREHOLE NO.: BH 6

Sheet 1 of 4

WATER TABLE	SAMPLES	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT (Soil type, colour, grain size, plasticity, minor components, observations)	SYMBOL	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	MOISTURE
			CONCRETE: 160 mm thick			
	S22/23/24 @ 0.3 m		GRAVELLY SILTY CLAY: dark brown with orange brown and light grey, medium plasticity, some gravel	CL		M
	S25 @ 1.0 m	1.0	FILL			
	SPT 1.0-1.45 m, 1, 0, 1 N=1		SILTY CLAY: light brown and orange brown with light grey and occasional black, medium to high plasticity	CL/CH		M-VM
	S26 @ 1.2 m					
		2.0				
WT			CLAYEY SILTY SAND: orange brown with light grey, fine to medium grained	SC		WET
	SPT 2.5-2.95 m 5, 5, 5 N=10		SILTY CLAY: orange brown and orange brown with light grey and occasional black, medium to high plasticity PP = 250	CL/CH		M
		3.0				
			SILTY CLAY: light grey with yellow brown and orange brown, medium to high plasticity	CL/CH		M
	SPT 4.0-4.45 m 4, 5, 6 N=11	4.0	PP = 350			
		5.0				
	SPT 5.5-5.95 m 5, 6, 7 N=13					
	S27 @ 5.6 m					

NOTES: D - disturbed sample U - undisturbed tube sample B - bulk sample
WT - level of water table or free water N - Standard Penetration Test (SPT)

See explanation sheets for meaning of all descriptive terms and symbols

Contractor: Terratest
Equipment: Hydropower Scout
Hole Diameter (mm): 100
Angle from Vertical (°) 0

STS GeoEnvironmental Pty Ltd

GEOTECHNICAL LOG - NON CORE BOREHOLE

Client: Columbia Lane Development Pty Limited
Project: 11 - 17 Columbia Lane, Homebush
Location: Refer to Drawing No. 19/1315

Project: 21024 / 7145C
Date : 07/07/2016
Logged: JK

BOREHOLE NO.: BH 6

Sheet 2 of 4

WATER TABLE	SAMPLES	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT (Soil type, colour, grain size, plasticity, minor components, observations)	SYMBOL	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	MOISTURE
			SILTY CLAY: light grey with yellow brown and orange brown, medium to high plasticity	CL/CH		M
			WEATHERED SHALE: dark grey and brown with orange brown, clay seams		EXTREMELY LOW STRENGTH	M-D
			BOREHOLE DISCONTINUED AT 6.4 M For cored details, refer to cored log sheet			
		7.0				
		8.0				
		9.0				
		10.0				
		11.0				

NOTES: D - disturbed sample U - undisturbed tube sample B - bulk sample
WT - level of water table or free water N - Standard Penetration Test (SPT)

See explanation sheets for meaning of all descriptive terms and symbols

Contractor: Terratest
Equipment: Hydropower Scout
Hole Diameter (mm): 100
Angle from Vertical (°) 0

SMEC Testing Services Pty Ltd — **GEOTECHNICAL LOG - CORED BOREHOLE**

Client: Columbia Lane Development Pty Limited
Project: 11-17 Columbia Lane, Homebush
Location: Refer to Drawing No. 19/1315
Project / STS No.: 21024/7145C
Date : 07/07/2016
Logged: JK
Checked By: MG

BOREHOLE NO.: BH 6
Sheet 3 of 4

DRILLING				MATERIAL STRENGTH											DISCONTINUITIES	
						Estimated Rock Strength							Joint Spacing (mm)			
Method	Water	Recovery	Depth (m)	Rock Type (Colour, Grain Size, Structure & Minor Components)	Weathering	Extremely Low	Very Low	Low	Medium	High	Very High	Extremely High	20 40 100 300 1000	Visual	Additional Data (Joints, partings, seams, zones etc. Description, orientation, infilling, or coating, shape, roughness, thickness, other)
				For non cored details, refer to non cored log sheet											
				START CORING AT 6.4 M											
N				WEATHERED SHALE: dark grey with light grey	Fr										6.40 m, Jt, 0 deg, Pl, Ro
M															6.41 m, Jt, 0 deg, Pl, Ro
L															6.42 m, Jt, 0 deg, Pl, Ro
C															6.50 m, Jt, 0 deg, Pl, Ro, Cy veneer
															6.61 m, Jt, 0 deg, Pl, Ro
C			7.0												6.62 m, Jt, 0 deg, Pl, Ro, Cy veneer
O															6.77 m, Jt, 0 deg, Pl, Ro
R															6.89 m, Jt, 0 deg, Pl, Ro
I															6.93 m, Jt, 0 deg, Pl, Ro
N															7.18 m, Pt, 0 deg, Pl, Sm
G															7.37 m, Pt, 0 deg, Pl, Ro
															7.48-7.56 m, Jt, Ro, minor Cy
															7.78 m, Pt, 0 deg, Pl, Ro
															7.93 m, Pt, 0 deg, Pl, Sm
			8.0												
															8.03 m, Pt, 0 deg, Pl, Sm
															8.30-8.36 m, Jt, 70 deg, Ir, Ro
															8.36-8.50 m, Jt, 85 deg, Ir, Ro
															8.58 m, Pt, 0 deg, Pl, Sm
															8.68 m, Pt, 0 deg, Pl, Sm
															8.81 m, Pt, 0 deg, Pl, Sm
															8.90 m, Pt, 0 deg, Pl, Sm
			9.0												
															9.11-9.16 m, Jt, 50 deg, Pl, Ro
															9.46 m, Pt, 0 deg, Pl, Sm
															9.96 m, Pt, 0 deg, Pl, Sm
			10.0												
															10.08 m, Pt, 0 deg, Pl, Sm
															10.41 m, Pt, 0 deg, Pl, Sm
															10.58 m, Pt, 10 deg, Pl, Sm
															10.90-11.17 m, Jt, 85 deg, Ir, Ro, fractured
			11.0												
															11.23-11.63 m, Jt, 90 deg, Ir, Ro
															11.89 m, Jt, 0 deg, Pl, Sm

Notes:

Contractor: Terratest
Equipment: Hydropower Scout
Hole Diameter (mm):
Angle from Vertical (°):

See explanation sheets for meaning of all descriptive terms and symbols

SMEC Testing Services Pty Ltd — **GEOTECHNICAL LOG - CORED BOREHOLE**

Client: Columbia Lane Development Pty Limited
Project: 11-17 Columbia Lane, Homebush
Location: Refer to Drawing No. 19/1315

Project / STS No.: 21024/7145C
Date : 07/07/2016
Logged: JK — Checked By: MG

BOREHOLE NO.: BH 6
Sheet 4 of 4

DRILLING				MATERIAL STRENGTH										DISCONTINUITIES		
						Estimated Rock Strength							Joint Spacing (mm)			
Method	Water	Recovery	Depth (m)	Rock Type (Colour, Grain Size, Structure & Minor Components)	Weathering	Extremely Low	Very Low	Low	Medium	High	Very High	Extremely High	20 40 100 300 1000	Visual	Additional Data (Joints, partings, seams, zones etc. Description, orientation, infilling, or coating, shape, roughness, thickness, other)
N M L C				WEATHERED SHALE: dark grey with light grey	Fr										12.16 m, Pt, 0 deg, Pl, Sw 12.25 m, Jt, 0 deg, Pl, Ro 12.65 m, Jt, 0 deg, Pl, Ro
			13.0												
				BOREHOLE DISCONTINUED AT 13.0 M											
			14.0												
			15.0												
			16.0												
			17.0												

Notes:

Contractor: Terratest
Equipment: Hydropower Scout
Hole Diameter (mm):
Angle from Vertical (°):

See explanation sheets for meaning of all descriptive terms and symbols

STS GeoEnvironmental Pty Ltd

GEOTECHNICAL LOG - NON CORE BOREHOLE

Client: Columbia Lane Development Pty Limited
Project: 11 - 17 Columbia Lane, Homebush
Location: Refer to Drawing No. 19/1315

Project: 21024 / 7145C
Date : 08/07/2016
Logged: JK

BOREHOLE NO.: BH 7

Sheet 1 of 4

WATER TABLE	SAMPLES	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT (Soil type, colour, grain size, plasticity, minor components, observations)	SYMBOL	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	MOISTURE
			CONCRETE: to 140 mm			
	S28 @ 0.2 m		SILTY CLAY: light brown with orange brown, medium plasticity	CL		M-VM
			SILTY CLAY: red brown and orange brown with light grey, medium to high plasticity	CL/CH		M
	SPT 1.0-1.45 m 3, 4, 5 N=9	1.0	PP = 350			
	S29 @ 1.2 m		SILTY CLAY: light grey with red brown, medium to high plasticity, occasional gravel	CL/CH		M
		2.0				
	SPT 2.5-2.95 m 5, 6, 8 N=14		PP = 380			
		3.0	SILTY CLAY: light grey with orange brown, medium plasticity, traces of gravel	CL		M-D
	SPT 4.0-4.30 m 8, 22 N=22+	4.0				
			WEATHERED SHALE: light grey and dark grey with brown and orange brown, clay seams		EXTREMELY LOW STRENGTH	D
		5.0				
			BOREHOLE DISCONTINUED AT 5.5 M For cored details, refer to cored log sheets			

NOTES: D - disturbed sample U - undisturbed tube sample B - bulk sample
WT - level of water table or free water N - Standard Penetration Test (SPT)

See explanation sheets for meaning of all descriptive terms and symbols

Contractor: Terratest
Equipment: Hydropower Scout
Hole Diameter (mm): 100
Angle from Vertical (°) 0

SMEC Testing Services Pty Ltd — **GEOTECHNICAL LOG - CORED BOREHOLE**

Client: Columbia Lane Development Pty Limited
Project: 11-17 Columbia Lane, Homebush
Location: Refer to Drawing No. 19/1315
Project / STS No.: 21024/7145C
Date : 08/07/2016
Logged: JK
Checked By: MG

BOREHOLE NO.: BH 7
Sheet 2 of 4

DRILLING				MATERIAL STRENGTH										DISCONTINUITIES								
						Estimated Rock Strength							Joint Spacing (mm)									
													20	40	100	300	1000					
Method	Water	Recovery	Depth (m)	Rock Type (Colour, Grain Size, Structure & Minor Components)	Weathering	Extremely Low	Very Low	Low	Medium	High	Very High	Extremely High							Visual	Additional Data (Joints, partings, seams, zones etc. Description, orientation, infilling, or coating, shape, roughness, thickness, other)		
			1.0																			
			2.0																			
			3.0																			
			4.0																			
			5.0																			
				For non cored details, refer to non cored log sheet START CORING AT 5.64 M																			
N M L C				WEATHERED SHALE: dark grey with light grey and orange brown	Sw																5.64-7.13 m, Numerous Jt/Pt, 0-90, Ir, Ro, Clay infill		

Notes:

Contractor: Terratest
Equipment: Hydropower Scout
Hole Diameter (mm):
Angle from Vertical (°):

See explanation sheets for meaning of all descriptive terms and symbols

SMEC Testing Services Pty Ltd — **GEOTECHNICAL LOG - CORED BOREHOLE**

Client: Columbia Lane Development Pty Limited
Project: 11-17 Columbia Lane, Homebush
Location: Refer to Drawing No. 19/1315
Project / STS No.: 21024/7145C
Date : 08/07/2016
Logged: JK
Checked By: MG

BOREHOLE NO.: BH 7
Sheet 3 of 4

DRILLING				MATERIAL STRENGTH											DISCONTINUITIES	
						Estimated Rock Strength							Joint Spacing (mm)			
Method	Water	Recovery	Depth (m)	Rock Type (Colour, Grain Size, Structure & Minor Components)	Weathering	Extremely Low	Very Low	Low	Medium	High	Very High	Extremely High	20 40 100 300 1000		Visual	Additional Data (Joints, partings, seams, zones etc. Description, orientation, infilling, or coating, shape, roughness, thickness, other)
N M L C			7.0	WEATHERED SHALE: dark grey with light grey and orange brown	Fr											
C O R I N G				WEATHERED SHALE: dark grey with light grey	Fr											7.32-7.38 m, Jt, Ir, Ro 7.56 m, Pt, 2 deg, Pl, Sm 7.78 m, Pt, 4 deg, Pl, Sm 7.95 m, Jt, 0 deg. Pl, Ro
			8.0													8.19 m, Jt, 0 deg, Pl, Ro 8.31-8.34 m, Jt, Ir, Ro 8.63 m, Jt, 0 deg, Pl, Ro 8.92 m, Jt, 5 deg, Pl, Ro
			9.0													9.08 m, Jt, 0 deg, Pl, Ro 9.32-9.35 m, Jt, 45 deg, Ir, Ro, Sm 9.42-9.45 m, Jt, Ir, Ro 9.48 m, Jt, 2 deg, Pl, Sm 9.80 m, Pt, 0 deg, Pl, Sm
			10.0													10.19 m, Pt, 0 deg, Pl, Sm 10.31 m, Jt, 0 deg, Pl, Sm 10.44 m, Pt, 0 deg, Pl, Sm 10.68 m, Pt, 0 deg, Pl, Sm 10.79 m, Pt, 0 deg, Pl, Ro 10.95 m, Pt, 0 deg, Pl, Ro
			11.0													11.73 m, Pt, 0 deg, Pl, Sm 11.80 m, Pt, 0 deg, Pl, Ro

Notes:

Contractor: Terratest
Equipment: Hydropower Scout
Hole Diameter (mm):
Angle from Vertical (°):

See explanation sheets for meaning of all descriptive terms and symbols

SMEC Testing Services Pty Ltd — **GEOTECHNICAL LOG - CORED BOREHOLE**

Client: Columbia Lane Development Pty Limited
Project: 11-17 Columbia Lane, Homebush
Location: Refer to Drawing No. 19/1315
Project / STS No.: 21024/7145C
Date : 08/07/2016
Logged: JK
Checked By: MG

BOREHOLE NO.: BH 7
Sheet 4 of 4

DRILLING				MATERIAL STRENGTH										DISCONTINUITIES		
						Estimated Rock Strength							Joint Spacing (mm)			
Method	Water	Recovery	Depth (m)	Rock Type (Colour, Grain Size, Structure & Minor Components)	Weathering	Extremely Low	Very Low	Low	Medium	High	Very High	Extremely High	20 40 100 300 1000	Visual	Additional Data (Joints, partings, seams, zones etc. Description, orientation, infilling, or coating, shape, roughness, thickness, other)
N				WEATHERED SHALE: dark grey with light grey	Fr										12.34-12.37 m, Jt, 45 deg, Pl, Ro
M															12.77 m, Pt, 0 deg, Pl, Ro
L															12.92 m, Jt, Ir, Ro
C															12.95 m, Jt, Ir, Ro
C															
O															
R															
I															13.02 m, Jt, 0 deg, Pl, Ro
N			13.0												13.11 Pt, 0 deg, Pl, Ro
G															13.16 m, Jt, 0 deg, Pl, Ro
															13.20 m, Jt, 0 deg, Pl, Ro
															13.35 m, Pt, 0 deg, Pl, Ro
				CORING DISCONTINUED AT 13.28 M											
				Standpipe Piezometer Installed											
			14.0												
			15.0												
			16.0												
			17.0												

Notes:

Contractor: Terratest
Equipment: Hydropower Scout
Hole Diameter (mm):
Angle from Vertical (°):

See explanation sheets for meaning of all descriptive terms and symbols

STS GeoEnvironmental Pty Ltd

GEOTECHNICAL LOG - NON CORE BOREHOLE

Client: Columbia Lane Development Pty Limited
Project: 11 - 17 Columbia Lane, Homebush
Location: Refer to Drawing No. 19/1315

Project: 21024 / 7145C
Date : 11/07/2016
Logged: JK

BOREHOLE NO.: BH 8

Sheet 1 of 4

WATER TABLE	SAMPLES	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT (Soil type, colour, grain size, plasticity, minor components, observations)	SYMBOL	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	MOISTURE
			CONCRETE: to 100 mm			
	S30 @ 0.2 m		GRAVELLY SILTY CLAY: dark grey with dark brown and light grey, low plasticity, some gravel FILL	CL		M
	S31 @ 0.6 m		SILTY CLAY: light brown and orange brown with light grey, medium to high plasticity	CL/CH		M
	SPT 1.0-1.45 m 2, 3, 4 N=7	1.0				
		2.0	SILTY CLAY: red brown with light grey and orange brown, medium to high plasticity	CL/CH		M
	SPT 2.5-2.95 m 5, 6, 7 N=13		SILTY CLAY: light grey with orange brown and red brown, medium to high plasticity PP = 250	CL/CH		M
	S32 @ 2.6 m	3.0				
	SPT 4.0-4.45 m 3,4,5 N=9	4.0	PP = 280			
		5.0	SILTY CLAY: light grey with dark grey and orange brown, medium plasticity, traces of gravel	CL		M-D
	S33 @ 5.2 m					

NOTES: D - disturbed sample U - undisturbed tube sample B - bulk sample
WT - level of water table or free water N - Standard Penetration Test (SPT)

See explanation sheets for meaning of all descriptive terms and symbols

Contractor: Terratest
Equipment: Hydropower Scout
Hole Diameter (mm): 100
Angle from Vertical (°) 0

STS GeoEnvironmental Pty Ltd

GEOTECHNICAL LOG - NON CORE BOREHOLE

Client: Columbia Lane Development Pty Limited
Project: 11 - 17 Columbia Lane, Homebush
Location: Refer to Drawing No. 19/1315

Project: 21024 / 7145C
Date : 11/07/2016
Logged: JK

BOREHOLE NO.: BH 8

Sheet 2 of 4

WATER TABLE	SAMPLES	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT (Soil type, colour, grain size, plasticity, minor components, observations)	SYMBOL	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	MOISTURE
			SILTY CLAY: light grey with dark grey and orange brown, medium to high plasticity, traces of gravel	CL		M-D
			WEATHERED SHALE: dark grey, clay seams		EXTREMELY LOW STRENGTH	D
			BOREHOLE DISCONTINUED AT 6.6 M For cored details, refer to cored log sheet			
		7.0				
		8.0				
		9.0				
		10.0				
		11.0				

NOTES: D - disturbed sample U - undisturbed tube sample B - bulk sample
WT - level of water table or free water N - Standard Penetration Test (SPT)

See explanation sheets for meaning of all descriptive terms and symbols

Contractor: Terratest
Equipment: Hydropower Scout
Hole Diameter (mm): 100
Angle from Vertical (°) 0

SMEC Testing Services Pty Ltd — **GEOTECHNICAL LOG - CORED BOREHOLE**

Client: Columbia Lane Development Pty Limited
Project: 11-17 Columbia Lane, Homebush
Location: Refer to Drawing No. 19/1315
Project / STS No.: 21024/7145C
Date : 11/07/2016
Logged: JK
Checked By: MG

BOREHOLE NO.: BH 8
Sheet 3 of 4

DRILLING				MATERIAL STRENGTH														DISCONTINUITIES	
						Estimated Rock Strength							Joint Spacing (mm)						
Method	Water	Recovery	Depth (m)	Rock Type (Colour, Grain Size, Structure & Minor Components)	Weathering	Extremely Low	Very Low	Low	Medium	High	Very High	Extremely High	20	40	100	300	1000	Visual	Additional Data (Joints, partings, seams, zones etc. Description, orientation, infilling, or coating, shape, roughness, thickness, other)
				For non cored details, refer to non cored log sheet START CORING AT 6.65 M															
N M L C C O R I N G			7.0 8.0 9.0 10.0 11.0	WEATHERED SHALE: dark grey with light grey	Fr														6.66 m, Jt, 0 deg, Pl, Ro 6.67 m, Jt, 0 deg, Pl, Ro 6.75 m, Jt, 0 deg, Pl, Ro, Cy 6.77-6.78 m, Cy, Sm 6.87 m, Jt, 0 deg, Pl, Ro, Cy 6.93 m, Jt, 0 deg, Pl, Ro, Cy 7.07 m, Jt, 0 deg, Pl, Ro, Cy 7.15 m, Jt, 0 deg, Pl, Ro 7.24 m, Jt, 0 deg, Pl, Ro, Cy veneer 7.29-7.31 m, Cy, Sm 7.39 m, Jt, 0 deg, Pl, Ro 7.56-7.59 m, Jt, 45 deg, Ir, Ro 7.67-7.70 m, Jt, Ir, Ro, Cy 7.82 m, Jt, 0 deg, Pl, Sm 7.90 m, Jt, 0 deg, Pl, Sm 7.95 m, Jt, 0 deg, Pl, Sm 8.14 m, Jt, 0 deg, Pl, Sm 8.50 m, Jt, 0 deg, Ir, Ro 8.70 m, Pt, 0 deg, Pl, Ro 8.77 m, Pt, 0 deg, Pl, Ro 8.82 m, Jt, 0 deg, Pl, Sm, Cy veneer 9.20 m, Pt, 0 deg, Pl, Sm 9.36 m, Pt, 0 deg, Pl, Ro 9.70-9.75 m, Jt, 45 deg, Pl, Ro 9.87 m, Pt, 0 deg, Pl, Sm 10.13 m, Pt, 0 deg, Pl, Sm 10.50 m, Pt, 0 deg, Pl, Sm 11.23 m, Pt, 0 deg, Pl, Ro 11.42 m, Jt, 0 deg, Pl, Ro 11.65 m, Pt, 0 deg, Pl, Ro

Notes:

Contractor: Terratest
Equipment: Hydropower Scout
Hole Diameter (mm):
Angle from Vertical (°):

See explanation sheets for meaning of all descriptive terms and symbols

SMEC Testing Services Pty Ltd — **GEOTECHNICAL LOG - CORED BOREHOLE**

Client: Columbia Lane Development Pty Limited
Project: 11-17 Columbia Lane, Homebush
Location: Refer to Drawing No. 19/1315

Project / STS No.: 21024/7145C
Date : 11/07/2016
Logged: JK — Checked By: MG

BOREHOLE NO.: BH 8
Sheet 4 of 4

DRILLING				MATERIAL STRENGTH											DISCONTINUITIES		
						Estimated Rock Strength							Joint Spacing (mm)				
Method	Water	Recovery	Depth (m)	Rock Type (Colour, Grain Size, Structure & Minor Components)	Weathering	Extremely Low	Very Low	Low	Medium	High	Very High	Extremely High	20 40 100 300 1000				Visual	Additional Data (Joints, partings, seams, zones etc. Description, orientation, infilling, or coating, shape, roughness, thickness, other)
N M L C				WEATHERED SHALE: dark grey with light grey	Fr													12.09 m, Pt, 0 deg, Pl, Sm 12.46 m, Jt, 0 deg, Pl, Ro 12.83 m, Pt, 0 deg, Pl, Ro
			13.0	CORING DISCONTINUED AT 12.87 M														
			14.0															
			15.0															
			16.0															
			17.0															

Notes:

Contractor: Terratest
Equipment: Hydropower Scout
Hole Diameter (mm):
Angle from Vertical (°):

See explanation sheets for meaning of all descriptive terms and symbols

STS GeoEnvironmental Pty Ltd

GEOTECHNICAL LOG - NON CORE BOREHOLE

Client: Columbia Lane Development Pty Limited
Project: 11 - 17 Columbia Lane, Homebush
Location: Refer to Drawing No. 19/1315

Project: 21024 / 7145C
Date : 18/07/2016
Logged: JK

BOREHOLE NO.: BH 9

Sheet 1 of 1

WATER TABLE	SAMPLES	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT (Soil type, colour, grain size, plasticity, minor components, observations)	SYMBOL	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	MOISTURE
	S40 @ 0.2 m		CONCRETE: 130 mm thick			
			SILTY CLAY: light grey with orange brown and dark grey, medium to high plasticity, traces of gravel	CL		M
			FILL			
			CONCRETE: 150 mm thick			
			SANDY GRAVEL: dark grey and black, fine grained	GW		M
	S41 @ 0.8 m	1.0	FILL			
	S42 @ 1.2 m		SILTY CLAY: light grey and brown with orange brown, medium plasticity	CL		M-VM
			BOREHOLE DISCONTINUED AT 1.8 M			
		2.0				
		3.0				
		4.0				
		5.0				

NOTES: D - disturbed sample U - undisturbed tube sample B - bulk sample
WT - level of water table or free water N - Standard Penetration Test (SPT)

See explanation sheets for meaning of all descriptive terms and symbols

Contractor: STS
Equipment: Edson RP70
Hole Diameter (mm): 100
Angle from Vertical (°) 0

STS GeoEnvironmental Pty Ltd

GEOTECHNICAL LOG - NON CORE BOREHOLE

Client: Columbia Lane Development Pty Limited	Project: 21024 / 7145C	**BOREHOLE NO.: BH 9**
Project: 11 - 17 Columbia Lane, Homebush	Date : 18/07/2016	Sheet 1 of 1
Location: Refer to Drawing No. 19/1315	Logged: JK	

WATER TABLE	SAMPLES	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT (Soil type, colour, grain size, plasticity, minor components, observations)	SYMBOL	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	MOISTURE
			CONCRETE: 450 mm thick			
	S43 @ 0.5 m		SILTY CLAY: orange brown with light grey, medium to high plasticity	CL/CH		M
		1.0	BOREHOLE DISCONTINUED AT 0.8 M			
		2.0				
		3.0				
		4.0				
		5.0				

NOTES: D - disturbed sample U - undisturbed tube sample B - bulk sample
WT - level of water table or free water N - Standard Penetration Test (SPT)

See explanation sheets for meaning of all descriptive terms and symbols

Contractor: STS
Equipment: Edson RP70
Hole Diameter (mm): 100
Angle from Vertical (°) 0

STS GeoEnvironmental Pty Ltd

GEOTECHNICAL LOG - NON CORE BOREHOLE

Client: Columbia Lane Development Pty Limited
Project: 11 - 17 Columbia Lane, Homebush
Location: Refer to Drawing No. 19/1315

Project: 21024 / 7145C
Date : 18/07/2016
Logged: JK

BOREHOLE NO.: BH 11

Sheet 1 of 1

WATER TABLE	SAMPLES	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT (Soil type, colour, grain size, plasticity, minor components, observations)	SYMBOL	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	MOISTURE
	S49/50/51 @ 0.2 m		CONCRETE: 190 mm thick			
			SILTY CLAY: grey and green with dark grey and orange brown, medium plasticity, traces of gravel FILL	CL		M
	S52 @ 0.7 m	1.0	SILTY CLAY: orange brown with light brown, medium plasticity	CL		M-VM
	S57 @ 1.5 m		SILTY CLAY: light grey with red brown and orange brown, medium to high plasticity	CL/CH		M
		2.0	SILTY CLAY: orange brown with light grey, medium to high plasticity	CL/CH		M
	S58 @ 3.0 m	3.0	BOREHOLE DISCONTINUED AT 3.0 M			
		4.0				
		5.0				

NOTES: D - disturbed sample U - undisturbed tube sample B - bulk sample
WT - level of water table or free water N - Standard Penetration Test (SPT)

See explanation sheets for meaning of all descriptive terms and symbols

Contractor: STS
Equipment: Edson RP70
Hole Diameter (mm): 100
Angle from Vertical (°) 0

STS GeoEnvironmental Pty Ltd

GEOTECHNICAL LOG - NON CORE BOREHOLE

Client: Columbia Lane Development Pty Limited	Project: 21024 / 7145C	**BOREHOLE NO.: BH 12**
Project: 11 - 17 Columbia Lane, Homebush	Date : 18/07/2016	Sheet 1 of 1
Location: Refer to Drawing No. 19/1315	Logged: JK	

WATER TABLE	SAMPLES	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT (Soil type, colour, grain size, plasticity, minor components, observations)	SYMBOL	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	MOISTURE
			CONCRETE: 300 mm thick			
	S53 @ 0.5 m		SILTY CLAY: dark grey with orange brown	CL/CH		M-VM
WT		1.0				
	S59 @ 1.5 m		SILTY CLAY: red brown with light grey, medium to high plasticity, traces of gravel	CL/CH		M-VM
		2.0				
	S60 @ 3.0 m	3.0	BOREHOLE DISCONTINUED AT 3.0 M			
		4.0				
		5.0				

NOTES: D - disturbed sample U - undisturbed tube sample B - bulk sample
WT - level of water table or free water N - Standard Penetration Test (SPT)

See explanation sheets for meaning of all descriptive terms and symbols

Contractor: STS
Equipment: Edson RP70
Hole Diameter (mm): 100
Angle from Vertical (°) 0

STS GeoEnvironmental Pty Ltd

GEOTECHNICAL LOG - NON CORE BOREHOLE

Client: Columbia Lane Development Pty Limited	Project: 21024 / 7145C	**BOREHOLE NO.: BH 13**
Project: 11 - 17 Columbia Lane, Homebush	Date : 19/07/2016	Sheet 1 of 1
Location: Refer to Drawing No. 19/1315	Logged: JK	

WATER TABLE	SAMPLES	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT (Soil type, colour, grain size, plasticity, minor components, observations)	SYMBOL	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	MOISTURE
			CONCRETE: 450 mm thick			
	S54 @ 0.5 m		SILTY CLAY: light grey and green with orange brown and dark grey, medium plasticity, traces of gravel	CL		M
		1.0	FILL			
	S55 @ 1.5 m		SILTY CLAY: light brown with orange brown, medium to high plasticity	CL/CH		M-VM
		2.0				
			SILTY CLAY: orange brown with light grey, medium to high plasticity	CL/CH		M
	S56 @ 3.0 m	3.0	BOREHOLE DISCONTINUED AT 3.0 M			
		4.0				
		5.0				

NOTES: D - disturbed sample U - undisturbed tube sample B - bulk sample
WT - level of water table or free water N - Standard Penetration Test (SPT)

See explanation sheets for meaning of all descriptive terms and symbols

Contractor: STS
Equipment: Edson RP70
Hole Diameter (mm): 100
Angle from Vertical (°) 0

STS GeoEnvironmental Pty Ltd

GEOTECHNICAL LOG - NON CORE BOREHOLE

Client: Columbia Lane Development Pty Limited	Project: 21024 / 7145C	**BOREHOLE NO.: BH 14**
Project: 11 - 17 Columbia Lane, Homebush	Date : 19/07/2016	Sheet 1 of 1
Location: Refer to Drawing No. 19/1315	Logged: JK	

WATER TABLE	SAMPLES	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT (Soil type, colour, grain size, plasticity, minor components, observations)	SYMBOL	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	MOISTURE
			CONCRETE: 100 mm thick			
	S61 @ 0.2 m		SAND: yellow brown, fine to medium grained	SP		M
						M/VM
WT		1.0	FILL			WET
	S62/63/64 @ 1.5 m		SILTY SAND: dark grey, fine to medium grained	SM		WET
		2.0	FILL			
			SILTY CLAY: light grey with orange brown, medium to high plasticity	CL/CH		M
	S65 @ 3.0 m	3.0	BOREHOLE DISCONTINUED AT 3.0 M			
		4.0				
		5.0				

NOTES: D - disturbed sample U - undisturbed tube sample B - bulk sample
WT - level of water table or free water N - Standard Penetration Test (SPT)

See explanation sheets for meaning of all descriptive terms and symbols

Contractor: STS
Equipment: Edson RP70
Hole Diameter (mm): 100
Angle from Vertical (°) 0

STS GeoEnvironmental Pty Ltd

GEOTECHNICAL LOG - NON CORE BOREHOLE

Client: Columbia Lane Development Pty Limited	Project: 21024 / 7145C	**BOREHOLE NO.: BH 15**
Project: 11 - 17 Columbia Lane, Homebush	Date : 19/07/2016	Sheet 1 of 1
Location: Refer to Drawing No. 19/1315	Logged: JK	

WATER TABLE	SAMPLES	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT (Soil type, colour, grain size, plasticity, minor components, observations)	SYMBOL	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	MOISTURE
			ASPHALT/SANDY GRAVEL: dark grey, fine to medium grained	GW		D
	S66 @ 0.3 m		GRAVELLY CLAYEY SAND: dark grey and black with light grey, fine grained, some gravel FILL	GW/GC		M
	S67 @ 0.7 m	1.0	SILTY CLAY: light brown and orange brown with light grey, medium to high plasticity	CL/CH		M-VM
			BOREHOLE DISCONTINUED AT 1.2 M			
		2.0				
		3.0				
		4.0				
		5.0				

NOTES: D - disturbed sample U - undisturbed tube sample B - bulk sample
WT - level of water table or free water N - Standard Penetration Test (SPT)

See explanation sheets for meaning of all descriptive terms and symbols

Contractor: STS
Equipment: Edson RP70
Hole Diameter (mm): 100
Angle from Vertical (°) 0

STS GeoEnvironmental Pty Ltd

GEOTECHNICAL LOG - NON CORE BOREHOLE

Client: Columbia Lane Development Pty Limited
Project: 11 - 17 Columbia Lane, Homebush
Location: Refer to Drawing No. 19/1315

Project: 21024 / 7145C
Date : 19/07/2016
Logged: JK

BOREHOLE NO.: BH 16
Sheet 1 of 1

WATER TABLE	SAMPLES	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT (Soil type, colour, grain size, plasticity, minor components, observations)	SYMBOL	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	MOISTURE
	S68 @ 0.2 m		SILTY CLAY: dark grey with orange brown, medium plasticity, traces of gravel FILL	CL		M
	S69 @ 0.5 m	1.0	SILTY CLAY: orange brown with light grey, medium to high plasticity	CL/CH		M
		2.0	SILTY CLAY: light grey with orange brown, medium to high plasticity	CL/CH		M
		3.0				
		4.0				M-VM
WT		5.0				WET
			WEATHERED SHALE: dark grey, clay seams		EXTREMELY LOW STRENGTH	M-D
			BOREHOLE DISCONTINUED AT 6.0 M Standpipe Piezometer Installed			

NOTES: D - disturbed sample U - undisturbed tube sample B - bulk sample
WT - level of water table or free water N - Standard Penetration Test (SPT)

See explanation sheets for meaning of all descriptive terms and symbols

Contractor: STS
Equipment: Edson RP70
Hole Diameter (mm): 100
Angle from Vertical (°) 0

STS GeoEnvironmental Pty Ltd

GEOTECHNICAL LOG - NON CORE BOREHOLE

Client: Columbia Lane Development Pty Limited	Project: 21024 / 7145C	**BOREHOLE NO.: BH 17**
Project: 11 - 17 Columbia Lane, Homebush	Date : 19/07/2016	Sheet 1 of 1
Location: Refer to Drawing No. 19/1315	Logged: JK	

WATER TABLE	SAMPLES	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT (Soil type, colour, grain size, plasticity, minor components, observations)	SYMBOL	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	MOISTURE
	S70/71/72 @ 0.2 m		SILTY CLAY: dark brown and red brown with dark grey and light grey, medium plasticity, traces of gravel	CL		D
			FILL			M
	S73 @ 0.8 m		SILTY CLAY: light grey and brown with orange brown, medium plasticity	CL		M-VM
		1.0	BOREHOLE DISCONTINUED AT 1.0 M			
		2.0				
		3.0				
		4.0				
		5.0				

NOTES: D - disturbed sample U - undisturbed tube sample B - bulk sample
WT - level of water table or free water N - Standard Penetration Test (SPT)

See explanation sheets for meaning of all descriptive terms and symbols

Contractor: STS
Equipment: Edson RP70
Hole Diameter (mm): 100
Angle from Vertical (°) 0

STS GeoEnvironmental Pty Ltd

GEOTECHNICAL LOG - NON CORE BOREHOLE

Client: Columbia Lane Development Pty Limited
Project: 11 - 17 Columbia Lane, Homebush
Location: Refer to Drawing No. 19/1315

Project: 21024 / 7145C
Date : 19/07/2016
Logged: JK

BOREHOLE NO.: BH 18

Sheet 1 of 1

WATER TABLE	SAMPLES	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT (Soil type, colour, grain size, plasticity, minor components, observations)	SYMBOL	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	MOISTURE
			ASPHALT/SANDY GRAVEL: dark grey, fine to medium grained	GW		D
	S74 @ 0.2 m		SILTY CLAY: light brown and grey with orange brown, medium plasticity	CL		M
			BOREHOLE DISCONTINUED AT 0.5 M			
		1.0				
		2.0				
		3.0				
		4.0				
		5.0				

NOTES: D - disturbed sample U - undisturbed tube sample B - bulk sample
WT - level of water table or free water N - Standard Penetration Test (SPT)

See explanation sheets for meaning of all descriptive terms and symbols

Contractor: STS
Equipment: Edson RP70
Hole Diameter (mm): 100
Angle from Vertical (°) 0

STS GeoEnvironmental Pty Ltd

GEOTECHNICAL LOG - NON CORE BOREHOLE

Client: Columbia Lane Development Pty Limited
Project: 11 - 17 Columbia Lane, Homebush
Location: Refer to Drawing No. 19/1315

Project: 21024 / 7145C
Date : 19/07/2016
Logged: JK

BOREHOLE NO.: BH 19

Sheet 1 of 1

WATER TABLE	SAMPLES	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT (Soil type, colour, grain size, plasticity, minor components, observations)	SYMBOL	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	MOISTURE
			ASPHALT/SILTY GRAVEL: dark grey, fine to medium grained	GW		D
	S75 @ 0.2 m		GRAVELLY SANDY CLAY: black and dark grey, fine to medium grained, low plasticity, some gravel	CL		M
	S76 @ 0.4 m		SILTY CLAY: orange brown with light grey, medium to high plasticity	CL/CH		M
		1.0	BOREHOLE DISCONTINUED AT 1.0 M			
		2.0				
		3.0				
		4.0				
		5.0				

NOTES: D - disturbed sample U - undisturbed tube sample B - bulk sample
WT - level of water table or free water N - Standard Penetration Test (SPT)

See explanation sheets for meaning of all descriptive terms and symbols

Contractor: STS
Equipment: Edson RP70
Hole Diameter (mm): 100
Angle from Vertical (°) 0

STS GeoEnvironmental Pty Ltd

GEOTECHNICAL LOG - NON CORE BOREHOLE

Client: Columbia Lane Development Pty Limited	Project: 21024 / 7145C	**BOREHOLE NO.: BH 20**
Project: 11 - 17 Columbia Lane, Homebush	Date : 19/07/2016	Sheet 1 of 1
Location: Refer to Drawing No. 19/1315	Logged: JK	

WATER TABLE	SAMPLES	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT (Soil type, colour, grain size, plasticity, minor components, observations)	SYMBOL	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	MOISTURE
			CONCRETE: 180 mm thick			
	S77 @ 0.3 m		GRAVELLY SANDY CLAY: black, fine grained, low plasticity, some gravel	CL		M
			FILL			M-VM
WT	S78 @ 1.0 m	1.0	SILTY CLAY: light grey with orange brown, medium to high plasticity	CL/CH		M-VM WET
		2.0				
		3.0				
		4.0	BOREHOLE DISCONTINUED AT 4.0 M			
		5.0				

NOTES: D - disturbed sample U - undisturbed tube sample B - bulk sample
WT - level of water table or free water N - Standard Penetration Test (SPT)

See explanation sheets for meaning of all descriptive terms and symbols

Contractor: STS
Equipment: Edson RP70
Hole Diameter (mm): 100
Angle from Vertical (°) 0

STS GeoEnvironmental Pty Ltd

GEOTECHNICAL LOG - NON CORE BOREHOLE

Client: Columbia Lane Development Pty Limited
Project: 11-17 Columbia Lane, Homebush
Location: Refer to Drawing No. 19/1315

Project: 21024/1934D-E
Date : May 20, 2019
Logged: JK Checked By: CR

BOREHOLE NO.: BH 21
Sheet 1 of 1

WATER TABLE	SAMPLES	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT (Soil type, colour, grain size, plasticity, minor components, observations)	SYMBOL	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	MOISTURE
	S80		CONCRETE: (120 mm thick)			
	@ 0.2 m		GRAVELLY CLAYEY SAND: light grey, fine grained, some gravel (concrete)	SC		D
	ASS1 @ 0.5 m					
	ASS2 @ 1.0 m	1.0				
	S81/ASS3 @ 1.5 m		FILL			
			SILTY CLAY: light grey with yellow brown and occasional red brown, medium plasticity	CL		M
	S82/ASS4 @ 2.0 m	2.0	SILTY CLAY: orange brown/yellow brown with light grey, medium plasticity, trace of sand	CL		M
	ASS5 @ 2.5 m					
	S83/ASS6 @ 3.0 m	3.0				
			SILTY CLAY: orange brown, medium plasticity, trace of gravel (sub-well rounded)	CL		M-W
	ASS7 @ 3.5 m					
WT 20/5/19						
	ASS8 @ 4.0 m	4.0				
	ASS9 @ 4.5 m					
	ASS10 @ 5.0 m	5.0				
	ASS11 @ 5.5 m					
			WEATHERED SHALE: dark grey with some light grey, clay seams		EXTREMELY LOW STRENGTH	M
			BOREHOLE DISCONTINUED AT 6.0 ON WEATHERED SHALE			

D - disturbed sample
U - undisturbed tube sample
B - bulk sample
WT - level of water table or free water
N - Standard Penetration Test (SPT)
S - jar sample

Contractor: STS
Equipment: Mini Christie
Hole Diameter (mm): 100
Angle from Vertical (°): 0
Drill Bit: Spiral

NOTES: See explanation sheets for meaning of all descriptive terms and symbols

STS GeoEnvironmental Pty Ltd

GEOTECHNICAL LOG - NON CORE BOREHOLE

Client: Columbia Lane Development Pty Limited	Project: 21024/1934D-E	**BOREHOLE NO.: BH 22**
Project: 11-17 Columbia Lane, Homebush	Date : May 20, 2019	Sheet 1 of 1
Location: Refer to Drawing No. 19/1315	Logged: JK Checked By: CR	

WATER TABLE	SAMPLES	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT (Soil type, colour, grain size, plasticity, minor components, observations)	SYMBOL	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	MOISTURE
	S84 @ 0.2 m		CONCRETE: (180 mm thick)			
	S85/ASS12 @ 0.5 m		SILTY CLAY: dark grey with orange brown, medium plasticity, trace of fine sand, trace of gravel FILL	CL		M
			SILTY CLAY: light grey with orange brown, medium to high plasticity	CL/CH		M
	ASS13 @ 1.0 m	1.0				
	S86/ASS14 @ 1.5 m		SILTY CLAY: light grey with orange brown and red brown, medium to high plasticity	CL/CH		M
	S87/ASS15 @ 2.0 m	2.0	SILTY CLAY: light grey with red brown, high plasticity	CH		M
	ASS16 @ 2.5 m					
			SILTY CLAY: light grey with orange brown, high plasticity, trace of shale gravel	CH		M
	S88/ASS17 @ 3.0 m	3.0				
	ASS18 @ 3.5 m					
		4.0	WEATHERED SHALE: dark grey with light grey and orange brown, clay seams		EXTREMELY LOW STRENGTH	D
			BOREHOLE DISCONTINUED AT 45 M ON WEATHERED SHALE			
		5.0				

D - disturbed sample U - undisturbed tube sample B - bulk sample

WT - level of water table or free water N - Standard Penetration Test (SPT)

S - jar sample

NOTES: See explanation sheets for meaning of all descriptive terms and symbols

Contractor: STS

Equipment: Mini Christie

Hole Diameter (mm): 100

Angle from Vertical (°): 0

Drill Bit: Spiral

STS GeoEnvironmental Pty Ltd

GEOTECHNICAL LOG - NON CORE BOREHOLE

Client: Columbia Lane Development Pty Limited
Project: 11-17 Columbia Lane, Homebush
Location: Refer to Drawing No. 19/1315

Project: 21024/1934D-E
Date : May 20, 2019
Logged: JK Checked By: CR

BOREHOLE NO.: BH 23

Sheet 1 of 1

WATER TABLE	SAMPLES	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT (Soil type, colour, grain size, plasticity, minor components, observations)	SYMBOL	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	MOISTURE
	S89/S90/S91 @ 0.2 m ASS19 @ 0.5 m S92 @ 0.8 m ASS20 @ 1.0 m	1.0	GRAVELLY SANDY CLAY: dark grey with orange brown and black, fine grained, low plasticity, some gravel/glass/ash FILL SANDY CLAY: dark brown with orange brown, light grey and dark grey, medium plasticity, trace of gravel FILL	CL CL		D M
	EIL1 0.0-1.0 m S93/ASS21 @ 1.5 m EIL 1.0-2.0 m S94/ASS22 @ 2.0 m	2.0	SILTY CLAY: light grey with orange brown and red brown, medium to high plasticity SILTY CLAY: red brown with light grey, medium to high plasticity	CL/CH CL/CH		M M
	ASS23 @ 2.5 m EIL3 2.0-3.0 m S95/ASS24 @ 3.0 m	3.0	SILTY CLAY: light grey with orange brown and red brown, medium to high plasticity	CL/CH		M
	ASS25 @ 3.5 m ASS26 @ 4.0 m ASS27 @ 4.5 m	4.0	SILTY CLAY: light grey, high plasticity	CH		M
	ASS28 @ 5.0 m ASS29 @ 5.5 m	5.0	SILTY CLAY: orange brown, medium to high plasticity, trace of gravel	CL/CH		M
			WEATHERED SHALE: dark grey with light grey, clay seams BOREHOLE DISCONTINUED AT 6.0 M		EXTREMELY LOW STRENGTH	D

D - disturbed sample
U - undisturbed tube sample
B - bulk sample
WT - level of water table or free water
N - Standard Penetration Test (SPT)
S - jar sample

Contractor: STS
Equipment: Mini Christie
Hole Diameter (mm): 100
Angle from Vertical (°): 0
Drill Bit: Spiral

NOTES: See explanation sheets for meaning of all descriptive terms and symbols

STS GeoEnvironmental Pty Ltd

GEOTECHNICAL LOG - NON CORE BOREHOLE

Client: Columbia Lane Development Pty Limited
Project: 11-17 Columbia Lane, Homebush
Location: Refer to Drawing No. 19/1315

Project: 21024/1934D-E
Date : May 20, 2019
Logged: JK Checked By: CR

BOREHOLE NO.: BH 24

Sheet 1 of 1

WATER	SAMPLES	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT (Soil type, colour, grain size, plasticity, minor components, observations)	SYMBOL	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	MOISTURE
	S96		ASPHALTIC CONCRETE: (50 mm thick)			
	@ 0.2 m		SANDY GRAVEL: dark grey/black, fine to medium grained sand, gravel, ash FILL	GW		D
	S97/ASS30 @ 0.5 m		SILTY CLAY: orange brown with light grey and red brown, medium to high plasticity	CL/CH		M
	ASS31 @ 1.0 m	1.0	SILTY CLAY: light grey with red brown and orange brown, medium to high plasticity	CL/CH		M
	S98/ASS32 @ 1.5 m					
	ASS33 @ 2.0 m	2.0	SILTY SANDY CLAY: light grey with yellow brown/orange brown, fine grained sand, medium plasticity	CL		M
	S99/ASS34 @ 2.5 m					
	S100/ASS35 @ 3.0 m	3.0	SILTY SANDY CLAY: yellow brown with light grey, fine grained sand, medium plasticity	CL		M
	ASS36 @ 3.5 m		SILTY CLAY: orange brown, fine grained sand, medium plasticity, some gravel, cobbles	CL		M-W
WT 20/5/19		4.0	AUGER REFUSAL AT 3.8 M			
		5.0				

D - disturbed sample
U - undisturbed tube sample
B - bulk sample
WT - level of water table or free water
N - Standard Penetration Test (SPT)
S - jar sample

Contractor: STS
Equipment: Mini Christie
Hole Diameter (mm): 100
Angle from Vertical (°): 0
Drill Bit: Spiral

NOTES: See explanation sheets for meaning of all descriptive terms and symbols

STS GeoEnvironmental Pty Ltd

GEOTECHNICAL LOG - NON CORE BOREHOLE

Client: Columbia Lane Development Pty Limited
Project: 11-17 Columbia Lane, Homebush
Location: Refer to Drawing No. 19/1315

Project: 21024/1934D-E
Date : May 21, 2019
Logged: BH Checked By: CR

BOREHOLE NO.: BH 24A
Sheet 1 of 1

WATER TABLE	SAMPLES	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT (Soil type, colour, grain size, plasticity, minor components, observations)	SYMBOL	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	MOISTURE
			ASPHALTIC CONCRETE: (50 mm thick)			
	S107/S108/ S109 @ 0.5 m S110 @ 0.8 m		SILTY CLAY: orange brown, medium plasticity, trace of gravel	CL		M
		1.0	SILTY CLAY: red brown and light grey, medium to high plasticity, trace of gravel	CL/CH		M
	S111 @ 1.5 m		SILTY SANDY CLAY: orange brown and light grey, high plasticity, trace of gravel	CH		M
	S112 @ 2.5 m	2.0				
		3.0	SILTY SANDY CLAY: brown, high plasticity, trace of gravel	CH		M
	S113 @ 3.3 m					
	ASS47 @ 4.0 m	4.0	GRAVELLY SILTY CLAY: brown, high plasticity	CH		M
	ASS48 @ 4.5 m		AUGER REFUSAL AT 4.5 M			
		5.0				

D - disturbed sample
WT - level of water table or free water
S - jar sample
U - undisturbed tube sample
B - bulk sample
N - Standard Penetration Test (SPT)

Contractor: STS
Equipment: Christie
Hole Diameter (mm): 100
Angle from Vertical (°): 0
Drill Bit: Spiral

NOTES: See explanation sheets for meaning of all descriptive terms and symbols

STS GeoEnvironmental Pty Ltd

GEOTECHNICAL LOG - NON CORE BOREHOLE

Client: Columbia Lane Development Pty Limited
Project: 11-17 Columbia Lane, Homebush
Location: Refer to Drawing No. 19/1315

Project: 21024/1934D-E
Date : May 20, 2019
Logged: JK Checked By: CR

BOREHOLE NO.: BH 25
Sheet 1 of 1

WATER TABLE	SAMPLES	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT (Soil type, colour, grain size, plasticity, minor components, observations)	SYMBOL	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	MOISTURE
	S101/S102/ S103/ASS37 @ 0.5 m		CONCRETE: (420 mm thick)			
			GRAVELLY SANDY CLAY: dark grey/black with orange brown, fine grained sand, medium plasticity, some gravel, ash FILL	CL		M
			SILTY CLAY: red brown with orange brown and light grey, medium to high plasticity	CL/CH		M
	S104/ASS38 @ 1.0 m	1.0				
	ASS39 @ 1.5 m					
	S105/ASS40 @ 2.0 m	2.0	SILTY CLAY: light grey with yellow brown, medium plasticity, trace of fine grained sand	CL		M
	ASS41 @ 2.5 m					
	S106/ASS42 @ 3.0 m	3.0	SILTY CLAY: light grey, high plasticity	CH		M
	ASS43 @ 3.5 m					
	ASS44 @ 4.0 m	4.0				
			SILTY CLAY: red brown with light grey, medium to high plasticity, trace of ironstone gravel	CL/CH		M-W
WT 20/5/19	ASS45 @ 4.5 m					
	ASS46 @ 5.0 m	5.0				
			SILTY CLAY: dark grey with light grey, medium to high plasticity, trace of shale gravel (CW Shale)	CL/CH		M
			WEATHERED SHALE: dark grey with light grey, clay seams		EXTREMELY LOW STRENGTH	D
			BOREHOLE DISCONTINUED AT 6.0 M ON WEATHERED SHALE			

D - disturbed sample
U - undisturbed tube sample
B - bulk sample
WT - level of water table or free water
N - Standard Penetration Test (SPT)
S - jar sample

Contractor: STS
Equipment: Mini Christie
Hole Diameter (mm): 100
Angle from Vertical (°): 0
Drill Bit: Spiral

NOTES: See explanation sheets for meaning of all descriptive terms and symbols

STS GeoEnvironmental Pty Ltd

GEOTECHNICAL LOG - NON CORE BOREHOLE

Client: Columbia Lane Development Pty Limited
Project: 11-17 Columbia Lane, Homebush
Location: Refer to Drawing No. 19/1315

Project: 21024/1934D-E
Date : May 21, 2019
Logged: BH Checked By: CR

BOREHOLE NO.: BH 26

Sheet 1 of 1

WATER TABLE	SAMPLES	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT (Soil type, colour, grain size, plasticity, minor components, observations)	SYMBOL	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	MOISTURE
			CONCRETE: (300 mm thick)			
	S114/S115/ S116 @ 0.5 m		SILTY SANDY CLAY: brown, medium to high plasticity, trace of gravel FILL	CL/CH		M
	S117 @ 0.9 m EIL4 @ 0.9 m EIL5 1.5-2.5 m	1.0	GRAVELLY SILTY CLAY: red brown, low plasticity	CL		D-M
	S118 @ 1.8 m	2.0	SILTY CLAY: brown, some orange brown, high plasticity, trace of gravel	CH		M
	S119/S120/ S121 @ 2.6 m EIL6 2.6-2.9 m		SILTY CLAY: red brown and light grey, high plasticity, trace of gravel	CH		M
		3.0	SILTY CLAY: light brown, high plasticity, trace of gravel	CH		M
	S122 @ 3.4 m		SILTY SANDY CLAY: light grey brown, high plasticity, trace of gravel	CH		M
			AUGER REFUSAL AT 3.5 M			
		4.0				
		5.0				

D - disturbed sample
U - undisturbed tube sample
B - bulk sample
WT - level of water table or free water
N - Standard Penetration Test (SPT)
S - jar sample

Contractor: STS
Equipment: Christie
Hole Diameter (mm): 100
Angle from Vertical (°): 0
Drill Bit: Spiral

NOTES: See explanation sheets for meaning of all descriptive terms and symbols

Table A Analytical Results for Soil Samples within Proposed Building Area - 2019 Detailed Site Investigation

Analytes	Borehole No./ Site Location:	BH1	BH1	BH1	BH1	BH1	BH2	BH2	BH2	BH2	BH3	BH3	BH3	BH4	NEPM Background Ranges	NEPM 2013 HIL B / HSL B (High Density Residential)	NEPM 2013 EILs/ ESLs (Urban Residential and Public Open Space)	CRC CARE 2011 HSL-B (High Density Residential) Direct Contact	NEPM 2013 Management Limits (Residential, Parkland & Public Open Space)
	Sample No.:	S1	S2	S3	S4	S5	S6	S7	S8	S9	S12	S13	S14	S15					
	Depth:	0.2 m	0.4 m	0.7 m	1.7 m	3.2 m	0.3 m	0.6 m	1.2 m	3.0 m	0.2 m	0.6 m	1.8 m	0.3 m					
	Date Sampled:	04-Jul-16	04-Jul-16	04-Jul-16	04-Jul-16	04-Jul-16	04-Jul-16	04-Jul-16	04-Jul-16	04-Jul-16	05-Jul-16	05-Jul-16	05-Jul-16	06-Jul-16					
Metals																			
Arsenic		<5	<5	41	9	8	13	8	<5	10	<5	8	<5	<5	1-50	500	100 (b), (i)		
Cadmium		<1	<1	<1	<1	<1	4	2	<1	<1	<1	<1	<1	<1	1	150	3 (d)		
Chromium		48	7	12	36	36	23	16	9	38	23	5	13	12	5-1000	500 (m)	550 (c), (o)		
Copper		78	56	76	16	16	167	239	12	14	52	22	13	87	2-100	30,000	95 (c)		
Lead		24	46	1,040	28	28	126	365	13	42	27	20	19	56	2-200	1,200	1,100 (b), (i)		
Mercury		<0.1	0.2	0.6	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.3	0.03 (n)	120 (n)	1 (d),(n)		
Nickel		85	61	6	19	19	96	22	3	5	28	5	3	46	5-500	1,200	200 (c)		
Zinc		82	41	239	41	41	199	240	11	45	42	52	8	251	10-300	60,000	510 (c)		
Monocyclic Aromatic Hydrocarbons (MAHs)																			
Benzene		<0.2	<0.2	-	<0.2	-	<0.2	<0.2	<0.2	-	<0.2	<0.2	-	<0.2		0.7 (g)	65 (h)	140	
Toluene		<0.5	<0.5	-	<0.5	-	<0.5	<0.5	<0.5	-	<0.5	<0.5	-	<0.5		480 (g)	105 (h)	21,000	
Ethylbenzene		<0.5	<0.5	-	<0.5	-	<0.5	<0.5	<0.5	-	<0.5	<0.5	-	<0.5		NL (g), (l)	125 (h)	5,900	
Xylenes		<0.5	<0.5	-	<0.5	-	<0.5	<0.5	<0.5	-	<0.5	<0.5	-	<0.5		110 (g)	45 (h)	17,000	
Napthalene		<1	<1	-	<1	-	<1	<1	<1	-	<1	<1	-	<1		5 (q)	170 (b), (h	2,200	
Total MAHs above detection limits		ND	ND	-	ND	-	ND	ND	ND	-	ND	ND	-	ND					
Volatile Organic Compounds																			
Total VOCs above detection limits		-	-	-	-	-	-	-	ND	-	-	ND	-	-					
Total Petroleum Hydrocarbons (TPHs)																			
Total C_6-C_{10}		<10	<10	-	<10	-	<10	<10	<10	-	<10	<10	-	<10					800 (h)
Total C_{10}-C_{16}		<50	<50	-	<50	-	<50	<50	<50	-	<50	<50	-	<50			120		1,000 (h)
F1 C_6-C_{10}[1] (d)		<10	<10	-	<10	-	<10	<10	<10	-	<10	<10	-	<10		50 (g)	180	5,600	
F2 C_{10}-C_{16}[1] (e)		<50	<50	-	<50	-	<50	<50	<50	-	<50	<50	-	<50		280 (g)		4,200	
F3 >C_{16}-C_{34}		160	<100	-	250	-	120	1,280	<100	-	<100	<100	-	<100			1,300 (h)	5,800	3,500 (h)
F4 >C_{34}-C_{40}		<100	<100	-	<100	-	<100	650	150	-	<100	<100	-	<100			5,600 (h)	8,100	10,000 (h)
Total C_{10}-C_{40}		160	ND	-	250	-	120	1,930	150	-	ND	ND	-	ND					
Polycyclic Aromatic Hydrocarbons (PAHs)																			
Benzo(a)pyrene		0.7	<0.5	-	4.6	-	1.1	17	<0.5	-	<0.5	<0.5	-	<0.5			0.7 (h)		
Carcinogenic PAHs [2]		0.9	<0.5	-	6.0	-	1.4	24	<0.5	-	<0.5	<0.5	-	<0.5		4			
Total PAHs above detection limits		7.2	ND	-	59.7	-	11.8	170	ND	-	ND	ND	-	ND		400			
Organochlorine Pesticides (OCPs)																			
DDT+DDE+DDE		-	<0.05	-	-	-	<0.05	-	-	-	<0.05	-	-	0.17		600	180 (b), (k)		
Aldrin + Dieldrin		-	<0.05	-	-	-	<0.05	-	-	-	<0.05	-	-	<0.05		10			
Chlordane		-	<0.05	-	-	-	<0.05	-	-	-	<0.05	-	-	<0.05		90			
Endosulfan		-	<0.05	-	-	-	<0.05	-	-	-	<0.05	-	-	<0.05		400			
Endrin		-	<0.05	-	-	-	<0.05	-	-	-	<0.05	-	-	<0.05		20			
Heptachlor		-	<0.05	-	-	-	<0.05	-	-	-	<0.05	-	-	<0.05		10			
HCB		-	<0.05	-	-	-	<0.05	-	-	-	<0.05	-	-	<0.05		15			
Methoxychlor		-	<0.2	-	-	-	<0.2	-	-	-	<0.2	-	-	<0.2		500			
Mirex		-	-	-	-	-	-	-	-	-	-	-	-	-		20			
Total OCPs above detection limits		-	ND	-	-	-	ND	-	-	-	ND	-	-	0.17					
Organophosphorus Pesticides (OPPs)																			
Chlorpyrifos			<0.05				<0.05				<0.05			<0.05		340			
Total OPPs above detection limits		-	ND	-	-	-	ND	-	-	-	ND	-	-	ND					
Polychlorinated Biphenyls (PCB)																			
Total PCBs above detection limits		-	ND	-	-	-	ND	-	-	-	ND	-	-	ND		1			
Phenolic Compounds																			
Phenol		-	<0.5	-	-	-	<0.5	-	-	-	<0.5	-	-	<0.5		45,000			
Pentachlorophenol		-	<2	-	-	-	<2	-	-	-	<2	-	-	<2		130			
Cresols		-	<1.5	-	-	-	<1.5	-	-	-	<1.5	-	-	<1.5		4,700			
Total Phenols		-	ND	-	-	-	ND	-	-	-	ND	-	-	ND					
Asbestos																			
Bonded ACM (w/w) (%)		-	-	-	-	-	-	-	-	-	-	-	-	-		0.04			
Friable asbestos (fibrous and fines)(w/w) (%)		<0.001	-	-	-	-	<0.001	-	<0.001	-	-	-	-	<0.001		0.001			
Asbestos Type		No	-	-	-	-	No	-	No	-	-	-	-	No					

Notes: Results in mg/kg unless specified otherwise.

ND = No individual species detected above laboratory detection limits.

No* = No asbestos found at the reporting limit of 0.1 g/kg by polarised light microscopy. Asbestos material detected and identified at conc. below 0.1 g/kg.

[1] Calculated in accordance with Table 1A(3) of NEPM 2013

[2] Combined carcinogenic PAHs with relative potency to benzo(a)pyrene

[3] Duplicate value adopted due to RPD exceedance

Results shaded red exceed the NEPM 2013 HIL B /HSL B (High Density Residential) criteria

Results shaded blue exceed the NEPM 2013 EIL/ESL criteria for an urban residential and public open space setting

Results shaded green exceed the CRC CARE 2011 HSL B (High Density Residential) criteria for direct contact with soil

Results shaded yellow exceed the NEPM 2013 management limits for a residential, parkland and public open space land setting

Results shaded purple exceed both the NEPM 2013 HIL/HSL B (High Density Residential) and the NEPM 2013 EIL/ESL criteria

(a) ANZECC 1992 background ranges used where no NEPM criteria available

(b) NEPM 2013 generic EIL

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(d) NEPM 1999 EIL used where no generic NEPM 2013 criteria are available

(e) F1 TPH = TPH (C6-C10) minus BTEX fraction

(f) F2 TPH = TPH (C10-C16) minus naphthalene fraction

(g) NEPM 2013 HSL criterion for vapour intrusion, 0m to <1m depth in Clay

(h) Criterion for fine texture grade soils

(i) Criterion for 'aged' contamination

(j) Insufficient data available to calculate 'aged' contamination. The values for fresh contamination should be used

(k) Criterion for DDT

(l) NL= Contaminant is not considered to pose a risk to human health through vapour inhalation regardless the concentration

(m) Criterion for chromium VI

(n) Criterion for inorganic mercury

(o) Criterion for chromium III

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Table A Analytical Results for Soil Samples within Proposed Building Area - 2019 Detailed Site Investigation

Analytes	Borehole No./ Site Location:	BH4	BH4	BH4	BH4	BH5	BH5	BH6	BH6	BH6	BH6	BH9	BH9	BH9	NEPM Background Ranges	NEPM 2013 HIL B / HSL B (High Density Residential)	NEPM 2013 EILs/ ESLs (Urban Residential and Public Open Space)	CRC CARE 2011 HSL-B (High Density Residential) Direct Contact	NEPM 2013 Management Limits (Residential, Parkland & Public Open Space)
	Sample No.:	S16	S17	S18	S19	S20	S21	S22	S25	S26	S27	S40	S41	S42					
	Depth:	0.8 m	1.2 m	2.6 m	4.1 m	0.5 m	1.0 m	0.3 m	1.0 m	1.2 m	5.6 m	0.2 m	0.8 m	1.2 m					
	Date Sampled:	06-Jul-16	06-Jul-16	06-Jul-16	06-Jul-16	06-Jul-16	06-Jul-16	07-Jul-16	07-Jul-16	07-Jul-16	07-Jul-16	18-Jul-16	18-Jul-16	18-Jul-16					
Metals																			
Arsenic		8	6	-	-	7	<5	7	5	<5	-	10	<5	<5	1-50	500	100 (b), (i)		
Cadmium		<1	<1	-	-	2	<1	<1	<1	<1	-	<1	<1	<1	1	150	3 (d)		
Chromium		24	11	-	-	11	11	12	10	10	-	15	68	11	5-1000	500 (m)	550 (c), (o)		
Copper		28	13	-	-	89	9	23	26	7	-	9	66	18	2-100	30,000	95 (c)		
Lead		116	15	-	-	101	10	28	36	12	-	56	8	19	2-200	1,200	1,100 (b), (i)		
Mercury		0.1	<0.1	-	-	0.1	<0.1	<0.1	<0.1	<0.1	-	<0.1	<0.1	<0.1	0.03 (n)	120 (n)	1 (d),(n)		
Nickel		12	3	-	-	84	<2	9	12	<2	-	7	44	6	5-500	1,200	200 (c)		
Zinc		52	9	-	-	222	7	37	52	6	-	25	127	14	10-300	60,000	510 (c)		
Monocyclic Aromatic Hydrocarbons (MAHs)																			
Benzene		<0.2	<0.2	-	-	<0.2	<0.2	<0.2	<0.2	<0.2	-	<0.2	-	<0.2		0.7 (g)	65 (h)	140	
Toluene		<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	-	<0.5		480 (g)	105 (h)	21,000	
Ethylbenzene		<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	-	<0.5		NL (g), (l)	125 (h)	5,900	
Xylenes		<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	-	<0.5		110 (g)	45 (h)	17,000	
Napthalene		<1	<1	-	-	<1	<1	<1	<1	<1	-	<1	-	<1		5 (q)	170 (b), (h	2,200	
Total MAHs above detection limits		ND	ND	-	-	ND	ND	ND	ND	ND	-	ND	-	ND					
Volatile Organic Compounds																			
Total VOCs above detection limits		-	-	-	-	-	-	-	-	-	-	-	-	ND					
Total Petroleum Hydrocarbons (TPHs)																			
Total C_6-C_{10}		<10	<10	-	-	<10	<10	<10	<10	<10	-	<10	-	<10					800 (h)
Total C_{10}-C_{16}		<50	<50	-	-	<50	<50	<50	<50	<50	-	<50	-	<50			120		1,000 (h)
F1 C_6-C_{10} [1] (d)		<10	<10	-	-	<10	<10	<10	<10	<10	-	<10	-	<10		50 (g)	180	5,600	
F2 C_{10}-C_{16} [1] (e)		<50	<50	-	-	<50	<50	<50	<50	<50	-	<50	-	<50		280 (g)		4,200	
F3 $>C_{16}$-C_{34}		<100	180	-	-	<100	<100	<100	<100	<100	-	<100	-	<100			1,300 (h)	5,800	3,500 (h)
F4 $>C_{34}$-C_{40}		<100	<100	-	-	<100	<100	<100	<100	<100	-	<100	-	<100			5,600 (h)	8,100	10,000 (h)
Total C_{10}-C_{40}		ND	180	-	-	ND	ND	ND	ND	ND	-	ND	-	ND					
Polycyclic Aromatic Hydrocarbons (PAHs)																			
Benzo(a)pyrene		1.0	0.6	-	-	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	-	<0.5			0.7 (h)		
Carcinogenic PAHs [2]		1.3	0.7	-	-	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	-	<0.5		4			
Total PAHs above detection limits		7.0	4.0	-	-	4	ND	ND	ND	ND	-	ND	-	ND		400			
Organochlorine Pesticides (OCPs)																			
DDT+DDE+DDE		-	-	-	-	<0.05	-	-	-	-	-	-	-	-		600	180 (b), (k)		
Aldrin + Dieldrin		-	-	-	-	<0.05	-	-	-	-	-	-	-	-		10			
Chlordane		-	-	-	-	<0.05	-	-	-	-	-	-	-	-		90			
Endosulfan		-	-	-	-	<0.05	-	-	-	-	-	-	-	-		400			
Endrin		-	-	-	-	<0.05	-	-	-	-	-	-	-	-		20			
Heptachlor		-	-	-	-	<0.05	-	-	-	-	-	-	-	-		10			
HCB		-	-	-	-	<0.05	-	-	-	-	-	-	-	-		15			
Methoxychlor		-	-	-	-	<0.2	-	-	-	-	-	-	-	-		500			
Mirex		-	-	-	-	-	-	-	-	-	-	-	-	-		20			
Total OCPs above detection limits		-	-	-	-	ND	-	-	-	-	-	-	-	-					
Organophosphorus Pesticides (OPPs)																			
Chlorpyrifos				-	-	<0.05					-					340			
Total OPPs above detection limits		-	-	-	-	ND	-	-	-	-	-	-	-	-					
Polychlorinated Biphenyls (PCB)																			
Total PCBs above detection limits		-	-	-	-	ND	-	-	-	-	-	-	-	-		1			
Phenolic Compounds																			
Phenol		-	-	-	-	<0.5	-	-	-	-	-	-	-	-		45,000			
Pentachlorophenol		-	-			<2	-	-	-	-		-	-	-		130			
Cresols		-	-	-	-	<1.5	-	-	-	-	-	-	-	-		4,700			
Total Phenols		-	-	-	-	ND	-	-	-	-	-	-	-	-					
Asbestos																			
Bonded ACM (w/w) (%)		-	-	-	-	-	-	-	-	-	-	-	-	-		0.04			
Friable asbestos (fibrous and fines)(w/w) (%)		-	-	-	-	<0.001	-	<0.001	-	-	-	0.0005	-	-		0.001			
Asbestos Type		-	-	-	-	No	-	No	-	-	-	CH	-	-					

Notes Results in mg/kg unless specified otherwise.

ND = No individual species detected above laboratory detection limits.

No* = No asbestos found at the reporting limit of 0.1 g/kg by polarised light microscopy. Asbestos material detected and identified at conc. below 0.1 g/kg.

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Results shaded red exceed the NEPM 2013 HIL B /HSL B (High Density Residential) criteria

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Results shaded yellow exceed the NEPM 2013 management limits for a residential, parkland and public open space land setting

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(b) NEPM 2013 generic EIL

(c) NEPM 2013 site-specific EIL

(d) NEPM 1999 EIL used where no generic NEPM 2013 criteria are available

(e) F1 TPH = TPH (C6-C10) minus BTEX fraction

(f) F2 TPH = TPH (C10-C16) minus naphthalene fraction

(g) NEPM 2013 HSL criterion for vapour intrusion, 0m to <1m depth in Clay

(h) Criterion for fine texture grade soils

(i) Criterion for 'aged' contamination

(j) Insufficient data available to calculate 'aged' contamination. The values for fresh contamination should be used

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Table A Analytical Results for Soil Samples within Proposed Building Area - 2019 Detailed Site Investigation

Analytes	Borehole No./ Site Location:	BH10	BH13	BH13	BH13	BH14	BH14	BH14	BH15	BH15	BH16	BH16	BH17	BH17	NEPM Background Ranges	NEPM 2013 HIL B / HSL B (High Density Residential)	NEPM 2013 EILs/ ESLs (Urban Residential and Public Open Space)	CRC CARE 2011 HSL-B (High Density Residential) Direct Contact	NEPM 2013 Management Limits (Residential, Parkland & Public Open Space)
	Sample No.:	S43	S54	S55	S56	S61	S62	S65	S66	S67	S68	S69	S70	S73					
	Depth:	0.5 m	0.5 m	1.5 m	3.0 m	0.2 m	1.5 m	3.0 m	0.3 m	0.7m	0.2 m	0.5 m	0.2 m	0.8 m					
	Date Sampled:	18-Jul-16	19-Jul-16	19-Jul-16	19-Jul-16	19-Jul-16	19-Jul-16	19-Jul-16	19-Jul-16	19-Jul-16	19-Jul-16	19-Jul-16	19-Jul-16	19-Jul-16					
Metals																			
Arsenic		<5	<5	<5	6	8	7	<5	12	<5	6	6	<5	<5	1-50	500	100 (b), (i)		
Cadmium		<1	<1	<1	<1	<1	<1	<1	<1	<1	1	<1	<1	<1	1	150	3 (d)		
Chromium		17	8	12	13	6	12[3]	11	19	9	14	14	31	10	5-1000	500 (m)	550 (c), (o)		
Copper		14	25	10	11	<5	<5	6	63	30	129	12	47	10	2-100	30,000	95 (c)		
Lead		14	27	19	18	<5	<5	9	117	25	106	14	25	47	2-200	1,200	1,100 (b), (i)		
Mercury		<0.1	<0.1	<0.1	<.01	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.03 (n)	120 (n)	1 (d),(n)		
Nickel		5	3	3	<2	<2	7[3]	<2	45	5	50	2	36	4	5-500	1,200	200 (c)		
Zinc		5	18	6	<5	20	14[3]	<5	259	37	198	10	88	67	10-300	60,000	510 (c)		
Monocyclic Aromatic Hydrocarbons (MAHs)																			
Benzene		<0.2	<0.2	<0.2	<0.2	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	-		0.7 (g)	65 (h)	140	
Toluene		<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-		480 (g)	105 (h)	21,000	
Ethylbenzene		<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-		NL (g), (l)	125 (h)	5,900	
Xylenes		<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-		110 (g)	45 (h)	17,000	
Napthalene		<1	<1	<1	<1	-	<1	<1	<1	<1	<1	<1	<1	-		5 (q)	170 (b), (h	2,200	
Total MAHs above detection limits		ND	ND	ND	ND	-	ND	ND	ND	ND	ND	ND	ND	-					
Volatile Organic Compounds																			
Total VOCs above detection limits		ND	-	ND	-	-	-	ND	-	-	-	ND	ND	-					
Total Petroleum Hydrocarbons (TPHs)																			
Total C_6-C_{10}		<10	<10	<10	<10	-	<10	<10	<10	<10	<10	<10	<10	-					800 (h)
Total C_{10}-C_{16}		<50	<50	<50	<50	-	<50	<50	<50	<50	<50	<50	<50	-			120		1,000 (h)
F1 C_6-C_{10}[1] (d)		<10	<10	<10	<10	-	<10	<10	<10	<10	<10	<10	<10	-		50 (g)	180	5,600	
F2 C_{10}-C_{16}[1] (e)		<50	<50	<50	<50	-	<50	<50	<50	<50	<50	<50	<50	-		280 (g)		4,200	
F3 $>C_{16}$-C_{34}		<100	<100	<100	<100	-	<100	<100	<100	<100	320	<100	160	-			1,300 (h)	5,800	3,500 (h)
F4 $>C_{34}$-C_{40}		<100	<100	<100	<100	-	<100	<100	<100	<100	100	<100	<100	-			5,600 (h)	8,100	10,000 (h)
Total C_{10}-C_{40}		ND	ND	ND	ND	-	ND	ND	ND	ND	420	ND	160	-					
Polycyclic Aromatic Hydrocarbons (PAHs)																			
Benzo(a)pyrene		<0.5	0.9	<0.5	<0.5	-	<0.5	<0.5	0.6	<0.5	2.8	<0.5	1 q[3]	-			0.7 (h)		
Carcinogenic PAHs [2]		<0.5	1.1	<0.5	<0.5	-	<0.5	<0.5	0.7	<0.5	3.7	<0.5	2.5[3]	-		4			
Total PAHs above detection limits		ND	8.1	ND	ND	-	ND	ND	4.5	ND	30.6	ND	22.1[3]	-		400			
Organochlorine Pesticides (OCPs)																			
DDT+DDE+DDE		<0.05	-	<0.05	-	-	-	-	-	<0.05	-	<0.05	-	-		600	180 (b), (k)		
Aldrin + Dieldrin		<0.05	-	<0.05	-	-	-	-	-	<0.05	-	<0.05	-	-		10			
Chlordane		<0.05	-	<0.05	-	-	-	-	-	<0.05	-	<0.05	-	-		90			
Endosulfan		<0.05	-	<0.05	-	-	-	-	-	<0.05	-	<0.05	-	-		400			
Endrin		<0.05	-	<0.05	-	-	-	-	-	<0.05	-	<0.05	-	-		20			
Heptachlor		<0.05	-	<0.05	-	-	-	-	-	<0.05	-	<0.05	-	-		10			
HCB		<0.05	-	<0.05	-	-	-	-	-	<0.05	-	<0.05	-	-		15			
Methoxychlor		<0.2	-	<0.2	-	-	-	-	-	<0.2	-	<0.2	-	-		500			
Mirex		-	-	-	-	-	-	-	-	-	-	-	-	-		20			
Total OCPs above detection limits		ND	-	ND	-	-	-	-	-	ND	-	ND	-	-					
Organophosphorus Pesticides (OPPs)																			
Chlorpyrifos		<0.05		<0.05	-	-	-	-	-	<0.05		<0.05		-		340			
Total OPPs above detection limits		ND	-	ND	-	-	-	-	-	ND	-	ND	-	-					
Polychlorinated Biphenyls (PCB)																			
Total PCBs above detection limits		ND	-	ND	-	-	-	-	-	ND	-	ND	-	-		1			
Phenolic Compounds																			
Phenol		<0.5	-	<0.5	-	-	-	-	-	<0.5	-	<0.5	-	-		45,000			
Pentachlorophenol		<2	-	<2	-	-	-	-	-	<2	-	<2	-	-		130			
Cresols		<1.5	-	<1.5	-	-	-	-	-	<1.5	-	<1.5	-	-		4,700			
Total Phenols		ND	-	ND	-	-	-	-	-	ND	-	ND	-	-					
Asbestos																			
Bonded ACM (w/w) (%)		-	-	-	-	-	-	-	-	-	-	-	-	-		0.04			
Friable asbestos (fibrous and fines)(w/w) (%)		<0.001	<0.001	-	-	-	-	-	-	-	<0.001	-	-	-		0.001			
Asbestos Type		No	No	-	-	-	-	-	-	-	No	-	-	-					

Notes Results in mg/kg unless specified otherwise.

ND = No individual species detected above laboratory detection limits.

No* = No asbestos found at the reporting limit of 0.1 g/kg by polarised light microscopy. Asbestos material detected and identified at conc. below 0.1 g/kg.

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Results shaded purple exceed both the NEPM 2013 HIL/HSL B (High Density Residential) and the NEPM 2013 EIL/ESL criteria

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Table A Analytical Results for Soil Samples within Proposed Building Area - 2019 Detailed Site Investigation

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	Sample No.:	S74	S75	S76	S77	S78	S80	S81	S82	S83	S96	S97	S98	S99					
	Depth:	0.2 m	0.2 m	0.4 m	0.3 m	1.0 m	0.2 m	1.5 m	2.0 m	3.0 m	0.2 m	0.5 m	1.5 m	2.5 m					
	Date Sampled:	19-Jul-16	19-Jul-16	19-Jul-16	19-Jul-16	19-Jul-16	20-May-19	20-May-19	20-May-19	20-May-19	20-May-19	20-May-19	20-May-19	20-May-19					
Metals																			
Arsenic		<5	<5	<5	-	-	2	3	-	3	6	4	3	-	1-50	500	100 (b), (i)		
Cadmium		<1	2	<1	-	-	<0.3	<0.3	-	<0.3	1.2	<0.3	<0.3	-	1	150	3 (d)		
Chromium		10	23	14	-	-	30	27	-	3.9	18	15	6.5	-	5-1000	500 (m)	550 (c), (o)		
Copper		8	360	15	-	-	21	39	-	5.2	73	19	4.9	-	2-100	30,000	95 (c)		
Lead		19	148	15	-	-	5	6	-	6	46	14	4	-	2-200	1,200	1,100 (b), (i)		
Mercury		<0.1	<0.1	<0.1	-	-	<0.05	<0.05	-	<0.05	<0.05	<0.05	<0.05	-	0.03 (n)	120 (n)	1 (d),(n)		
Nickel		3	49	2	-	-	41	30	-	3.1	37	7.1	2.4	-	5-500	1,200	200 (c)		
Zinc		11	215	11	-	-	36	35	-	5.6	57	12	4.7	-	10-300	60,000	510 (c)		
Monocyclic Aromatic Hydrocarbons (MAHs)																			
Benzene		<0.2	<0.2	-	-	-	<0.1	<0.1	-	<0.1	<0.1	-	<0.1	-		0.7 (g)	65 (h)	140	
Toluene		<0.5	<0.5	-	-	-	<0.1	<0.1	-	<0.1	<0.1	-	<0.1	-		480 (g)	105 (h)	21,000	
Ethylbenzene		<0.5	<0.5	-	-	-	<0.1	<0.1	-	<0.1	<0.1	-	<0.1	-		NL (g), (l)	125 (h)	5,900	
Xylenes		<0.5	<0.5	-	-	-	<0.3	<0.3	-	<0.3	<0.3	-	<0.3	-		110 (g)	45 (h)	17,000	
Napthalene		<1	<1	-	-	-	<0.1	<0.1	-	<0.1	<0.1	-	<0.1	-		5 (q)	170 (b), (h	2,200	
Total MAHs above detection limits		ND	ND	-	-	-	ND	ND	-	ND	ND	-	ND	-					
Volatile Organic Compounds																			
Total VOCs above detection limits		-	-	-	-	-	-	-	-	-	-	-	-	-					
Total Petroleum Hydrocarbons (TPHs)																			
Total C_6-C_{10}		<10	<10	-	-	-	<25	<25	-	<25	<25	-	<25	-					800 (h)
Total C_{10}-C_{16}		<50	<50	-	-	-	<25	<25	-	<25	<25	-	<25	-			120		1,000 (h)
F1 C_6-C_{10} [1] (d)		<10	<10	-	-	-	<25	<25	-	<25	<25	-	<25	-		50 (g)	180	5,600	
F2 C_{10}-C_{16} [1] (e)		<50	<50	-	-	-	<25	<25	-	<25	<25	-	<25	-		280 (g)		4,200	
F3 $>C_{16}$-C_{34}		<100	170	-	-	-	<90	<90	-	<90	<90	-	<90	-			1,300 (h)	5,800	3,500 (h)
F4 $>C_{34}$-C_{40}		<100	140	-	-	-	<120	<120	-	<120	<120	-	<120	-			5,600 (h)	8,100	10,000 (h)
Total C_{10}-C_{40}		ND	310	-	-	-	ND	ND	-	ND	ND	-	ND	-					
Polycyclic Aromatic Hydrocarbons (PAHs)																			
Benzo(a)pyrene		<0.5	<0.5	-	-	-	<0.1	<0.1	-	<0.1	0.4	-	<0.1	-			0.7 (h)		
Carcinogenic PAHs [2]		<0.5	<0.5	-	-	-	<0.2	<0.2	-	<0.2	0.6	-	<0.2	-		4			
Total PAHs above detection limits		ND	ND	-	-	-	0.1	ND	-	ND	4.1	-	ND	-		400			
Organochlorine Pesticides (OCPs)																			
DDT+DDE+DDE		<0.05	-	-	-	-	-	<0.6	-	-	-	-		-		600	180 (b), (k)		
Aldrin + Dieldrin		<0.05	-	-	-	-	-	<0.3	-	-	-	-		-		10			
Chlordane		<0.05	-	-	-	-	-	<0.2	-	-	-	-		-		90			
Endosulfan		<0.05	-	-	-	-	-	<0.5	-	-	-	-		-		400			
Endrin		<0.05	-	-	-	-	-	<0.2	-	-	-	-		-		20			
Heptachlor		<0.05	-	-	-	-	-	<0.1	-	-	-	-		-		10			
HCB		<0.05	-	-	-	-	-	<0.1	-	-	-	-		-		15			
Methoxychlor		<0.2	-	-	-	-	-	<0.1	-	-	-	-		-		500			
Mirex		-	-	-	-	-	-	<0.1	-	-	-	-		-		20			
Total OCPs above detection limits		ND	-	-	-	-	-	ND	-	-	-	-		-					
Organophosphorus Pesticides (OPPs)																			
Chlorpyrifos		<0.05			-	-	-	<0.2	-	-	-	-		-		340			
Total OPPs above detection limits		ND	-	-	-	-	-	ND	-	-	-	-		-					
Polychlorinated Biphenyls (PCB)																			
Total PCBs above detection limits		ND	-	-	-	-	-	ND	-	-	-	-		-		1			
Phenolic Compounds																			
Phenol		<0.5	-	-	-	-	-	<0.5	-	-	-	-		-		45,000			
Pentachlorophenol		<2	-	-				<0.5								130			
Cresols		<1.5	-	-	-	-	-	<1.5	-	-	-	-		-		4,700			
Total Phenols		ND	-	-	-	-	-	ND	-	-	-	-		-					
Asbestos																			
Bonded ACM (w/w) (%)		-	-	-	-	-	<0.01	<0.01	-	-	-	<0.01	<0.01	-		0.04			
Friable asbestos (fibrous and fines)(w/w) (%)		<0.001	-	-	-	-	<0.001	<0.001	-	-	-	<0.001	<0.001	-		0.001			
Asbestos Type		No	-	-	-	-	No	No	-	-	-	No	No	-					

Notes Results in mg/kg unless specified otherwise.

ND = No individual species detected above laboratory detection limits.

No* = No asbestos found at the reporting limit of 0.1 g/kg by polarised light microscopy. Asbestos material detected and identified at conc. below 0.1 g/kg.

[1] Calculated in accordance with Table 1A(3) of NEPM 2013

[2] Combined carcinogenic PAHs with relative potency to benzo(a)pyrene

[3] Duplicate value adopted due to RPD exceedance

Results shaded red exceed the NEPM 2013 HIL B /HSL B (High Density Residential) criteria

Results shaded blue exceed the NEPM 2013 EIL/ESL criteria for an urban residential and public open space setting

Results shaded green exceed the CRC CARE 2011 HSL B (High Density Residential) criteria for direct contact with soil

Results shaded yellow exceed the NEPM 2013 management limits for a residential, parkland and public open space land setting

Results shaded purple exceed both the NEPM 2013 HIL/HSL B (High Density Residential) and the NEPM 2013 EIL/ESL criteria

(a) ANZECC 1992 background ranges used where no NEPM criteria available

(b) NEPM 2013 generic EIL

(c) NEPM 2013 site-specific EIL

(d) NEPM 1999 EIL used where no generic NEPM 2013 criteria are available

(e) F1 TPH = TPH (C6-C10) minus BTEX fraction

(f) F2 TPH = TPH (C10-C16) minus naphthalene fraction

(g) NEPM 2013 HSL criterion for vapour intrusion, 0m to <1m depth in Clay

(h) Criterion for fine texture grade soils

(i) Criterion for 'aged' contamination

(j) Insufficient data available to calculate 'aged' contamination. The values for fresh contamination should be used

(k) Criterion for DDT

(l) NL= Contaminant is not considered to pose a risk to human health through vapour inhalation regardless the concentration

(m) Criterion for chromium VI

(n) Criterion for inorganic mercury

(o) Criterion for chromium III

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Table A Analytical Results for Soil Samples within Proposed Building Area - 2019 Detailed Site Investigation

Analytes	Borehole No./ Site Location:	BH24	BH24A	BH24A	BH24A	BH24A	BH24A	NEPM Background Ranges	NEPM 2013 HIL B / HSL B (High Density Residential)	NEPM 2013 EILs/ ESLs (Urban Residential and Public Open Space)	CRC CARE 2011 HSL-B (High Density Residential) Direct Contact	NEPM 2013 Management Limits (Residential, Parkland & Public Open Space)
	Sample No.:	S100	S107	S110	S111	S112	S113					
	Depth:	3.0 m	0.5 m	0.8 m	1.5 m	2.5 m	3.3 m					
	Date Sampled:	20-May-19	21-May-19	21-May-19	21-May-19	21-May-19	21-May-19					
Metals												
Arsenic		-	-	4	-	3	11	1-50	500	100 (b), (i)		
Cadmium		-	-	<0.3	-	<0.3	<0.3	1	150	3 (d)		
Chromium		-	-	12	-	6.4	15	5-1000	500 (m)	550 (c), (o)		
Copper		-	-	15	-	5.3	14	2-100	30,000	95 (c)		
Lead		-	-	13	-	6	31	2-200	1,200	1,100 (b), (i)		
Mercury		-	-	<0.05	-	<0.05	<0.05	0.03 (n)	120 (n)	1 (d),(n)		
Nickel		-	-	1.4	-	2.3	12	5-500	1,200	200 (c)		
Zinc		-	-	7.6	-	6.4	28	10-300	60,000	510 (c)		
Monocyclic Aromatic Hydrocarbons (MAHs)												
Benzene		-	-	<0.1	-	<0.1	-		0.7 (g)	65 (h)	140	
Toluene		-	-	<0.1	-	<0.1	-		480 (g)	105 (h)	21,000	
Ethylbenzene		-	-	<0.1	-	<0.1	-		NL (g), (l)	125 (h)	5,900	
Xylenes		-	-	<0.3	-	<0.3	-		110 (g)	45 (h)	17,000	
Napthalene		-	-	<0.1	-	<0.1	-		5 (g)	170 (b), (h	2,200	
Total MAHs above detection limits		-	-	ND	-	ND	-					
Volatile Organic Compounds												
Total VOCs above detection limits		-	-	-	-	-	-					
Total Petroleum Hydrocarbons (TPHs)												
Total C_6-C_{10}		-	-	<25	-	<25	-					800 (h)
Total C_{10}-C_{16}		-	-	<25	-	<25	-			120		1,000 (h)
F1 C_6-C_{10}[1] (d)		-	-	<25	-	<25	-		50 (g)	180	5,600	
F2 C_{10}-C_{16}[1] (e)		-	-	<25	-	<25	-		280 (g)		4,200	
F3 >C_{16}-C_{34}		-	-	<90	-	<90	-			1,300 (h)	5,800	3,500 (h)
F4 >C_{34}-C_{40}		-	-	<120	-	<120	-			5,600 (h)	8,100	10,000 (h)
Total C_{10}-C_{40}		-	-	ND	-	ND	-					
Polycyclic Aromatic Hydrocarbons (PAHs)												
Benzo(a)pyrene		-	-	<0.1	-	<0.1	-			0.7 (h)		
Carcinogenic PAHs [2]		-	-	<0.2	-	<0.2	-		4			
Total PAHs above detection limits		-	-	ND	-	ND	-		400			
Organochlorine Pesticides (OCPs)												
DDT+DDE+DDE		-	-	<0.6	-	<0.6	-		600	180 (b), (k)		
Aldrin + Dieldrin		-	-	<0.3	-	<0.3	-		10			
Chlordane		-	-	<0.2	-	<0.2	-		90			
Endosulfan		-	-	<0.5	-	<0.5	-		400			
Endrin		-	-	<0.2	-	<0.2	-		20			
Heptachlor		-	-	<0.1	-	<0.1	-		10			
HCB		-	-	<0.1	-	<0.1	-		15			
Methoxychlor		-	-	<0.1	-	<0.1	-		500			
Mirex		-	-	<0.1	-	<0.1	-		20			
Total OCPs above detection limits		-	-	ND	-	ND	-					
Organophosphorus Pesticides (OPPs)												
Chlorpyrifos		-	-	<0.2	-	<0.2	-		340			
Total OPPs above detection limits		-	-	ND	-	ND	-					
Polychlorinated Biphenyls (PCB)												
Total PCBs above detection limits		-	-	ND	-	ND	-		1			
Phenolic Compounds												
Phenol		-	-	<0.5	-	<0.5	-		45,000			
Pentachlorophenol				<0.5		<0.5			130			
Cresols		-	-	<1.5	-	<1.5	-		4,700			
Total Phenols		-	-	ND	-	ND	-					
Asbestos												
Bonded ACM (w/w) (%)		-	-	-	-		-		0.04			
Friable asbestos (fibrous and fines)(w/w) (%)		-	-	-	-		-		0.001			
Asbestos Type		-	-	-	-		-					

Notes Results in mg/kg unless specified otherwise.

ND = No individual species detected above laboratory detection limits.

No* = No asbestos found at the reporting limit of 0.1 g/kg by polarised light microscopy. Asbestos material detected and identified at conc. below 0.1 g/kg.

[1] Calculated in accordance with Table 1A(3) of NEPM 2013

[2] Combined carcinogenic PAHs with relative potency to benzo(a)pyrene

[3] Duplicate value adopted due to RPD exceedance

Results shaded red exceed the NEPM 2013 HIL B /HSL B (High Density Residential) criteria

Results shaded blue exceed the NEPM 2013 EIL/ESL criteria for an urban residential and public open space setting

Results shaded green exceed the CRC CARE 2011 HSL B (High Density Residential) criteria for direct contact with soil

Results shaded yellow exceed the NEPM 2013 management limits for a residential, parkland and public open space land setting

Results shaded purple exceed both the NEPM 2013 HIL/HSL B (High Density Residential) and the NEPM 2013 EIL/ESL criteria

(a) ANZECC 1992 background ranges used where no NEPM criteria available

(b) NEPM 2013 generic EIL

(c) NEPM 2013 site-specific EIL

(d) NEPM 1999 EIL used where no generic NEPM 2013 criteria are available

(e) F1 TPH = TPH (C6-C10) minus BTEX fraction

(f) F2 TPH = TPH (C10-C16) minus naphthalene fraction

(g) NEPM 2013 HSL criterion for vapour intrusion, 0m to <1m depth in Clay

(h) Criterion for fine texture grade soils

(i) Criterion for 'aged' contamination

(j) Insufficient data available to calculate 'aged' contamination. The values for fresh contamination should be used

(k) Criterion for DDT

(l) NL= Contaminant is not considered to pose a risk to human health through vapour inhalation regardless the concentration

(m) Criterion for chromium VI

(n) Criterion for inorganic mercury

(o) Criterion for chromium III

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Table B Analytical Results for Soil Samples within Proposed Public Park Area - 2019 Detailed Site Investigation

Analytes	Borehole No./ Site Location:	BH7	BH7	BH8	BH8	BH8	BH8	BH11	BH11	BH11	BH11	BH12	BH12	BH12	NEPM Background Ranges	NEPM 2013 HIL C / HSL C (Recreational / Public Open Space)	NEPM 2013 EILs/ ESLs (Urban Residential and Public Open Space)	CRC CARE 2011 HSL-C (Recreational / Open Space) Direct Contact	NEPM 2013 Management Limits (Residential, Parkland & Public Open Space)
	Sample No.:	S28	S29	S30	S31	S32	S33	S49	S52	S57	S58	S53	S59	S60					
	Depth:	0.2 m	1.2 m	0.2 m	0.6 m	2.6 m	5.2 m	0.2 m	0.7 m	1.5 m	3 m	0.5 m	1.5 m	3 m					
	Date Sampled:	08-Jul-16	08-Jul-16	11-Jul-16	11-Jul-16	11-Jul-16	11-Jul-16	18-Jul-16	18-Jul-16	18-Jul-16	18-Jul-16	18-Jul-16	18-Jul-16	18-Jul-16					
Metals																			
Arsenic		6	6	8	<5	<5	-	<5	<5	7	<5	5	8	5	1-50	300	100 (b), (i)		
Cadmium		<1	<1	<1	<1	<1	-	<1	<1	<1	<1	<1	<1	<1	1	90	3 (d)		
Chromium		14	29	16	13	8	-	7	18	18	10	22	24	16	5-1000	300 (m)	550 (c), (o)		
Copper		20	10	173	8	8	-	20	12	15	15	13	29	24	2-100	30,000	95 (c)		
Lead		102	16	116	19	17	-	48	16	19	11	21	29	18	2-200	600	1,100 (b), (i)		
Mercury		0.3	<0.1	<0.1	<0.1	<0.1	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.03 (n)	80 (n)	1 (d),(n)		
Nickel		13	6	30	4	<2	-	<2	3	2	<2	5	3	2	5-500	1,200	200 (c)		
Zinc		45	10	188	13	<5	-	15	7	5	9	47	22	17	10-300	30,000	510 (c)		
Monocyclic Aromatic Hydrocarbons (MAHs)																			
Benzene		<0.2	<0.2	<0.2	-	<0.2	-	-	<0.2	-	<0.2	<0.2	<0.2	<0.2		NL (g), (l)	65 (h)	120	
Toluene		<0.5	<0.5	<0.5	-	<0.5	-	-	<0.5	-	<0.5	<0.5	<0.5	<0.5		NL (g), (l)	105 (h)	18,000	
Ethylbenzene		<0.5	<0.5	<0.5	-	<0.5	-	-	<0.5	-	<0.5	<0.5	<0.5	<0.5		NL (g), (l)	125 (h)	5,300	
Xylenes		<0.5	<0.5	<0.5	-	<0.5	-	-	<0.5	-	<0.5	<0.5	<0.5	<0.5		NL (g), (l)	45 (h)	15,000	
Napthalene		<1	<1	<1	-	<1	-	-	<1	-	<1	<1	<1	<1		NL (g), (l)	170 (b), (i)	1,900	
Total MAHs above detection limits		ND	ND	ND	-	ND	-	-	ND	-	ND	ND	ND	ND					
Volatile Organic Compounds																			
Total VOCs above detection limits		-	-	-	-	-	-	-	-	-	-	-	-	ND					
Total Petroleum Hydrocarbons (TPHs)																			
Total C_6-C_{10}		<10	<10	<10	-	<10	-	-	<10	-	<10	<10	<10	<10					800 (h)
Total C_{10}-C_{16}		<50	<50	<50	-	<50	-	-	<50	-	<50	<50	<50	<50			120		1,000 (h)
F1 C_6-C_{10} [1] (d)		<10	<10	<10	-	<10	-	-	<10	-	<10	<10	<10	<10		NL (g), (l)	180	5,100	
F2 C_{10}-C_{16} [1] (e)		<50	<50	<50	-	<50	-	-	<50	-	<50	<50	<50	<50		NL (g), (l)		3,800	
F3 >C_{16}-C_{34}		<100	<100	160	-	<100	-	-	<100	-	<100	<100	<100	<100			1,300 (h)	5,300	3,500 (h)
F4 >C_{34}-C_{40}		<100	<100	<100	-	<100	-	-	<100	-	<100	<100	<100	<100			5,600 (h)	7,400	10,000 (h)
Total C_{10}-C_{40}		ND	ND	160	-	ND	-	-	ND	-	ND	ND	ND	ND					
Polycyclic Aromatic Hydrocarbons (PAHs)																			
Benzo(a)pyrene		1.5	<0.5	1.8	-	<0.5	-	-	<0.5	-	<0.5	<0.5	<0.5	<0.5			0.7 (h)		
Carcinogenic PAHs [2]		2.0	<0.5	2.4	-	<0.5	-	-	<0.5	-	<0.5	<0.5	<0.5	<0.5		3			
Total PAHs above detection limits		18.6	<0.5	21.2	-	<0.5	-	-	<0.5	-	<0.5	<0.5	<0.5	<0.5		300			
Organochlorine Pesticides (OCPs)																			
DDT+DDE+DDE		-	-	<0.05	-	<0.05	-	-	-	-	-	-	-	<0.05		400	180 (b), (k)		
Aldrin + Dieldrin		-	-	<0.05	-	<0.05	-	-	-	-	-	-	-	<0.05		10			
Chlordane		-	-	<0.05	-	<0.05	-	-	-	-	-	-	-	<0.05		70			
Endosulfan		-	-	<0.05	-	<0.05	-	-	-	-	-	-	-	<0.05		340			
Endrin		-	-	<0.05	-	<0.05	-	-	-	-	-	-	-	<0.05		20			
Heptachlor		-	-	<0.05	-	<0.05	-	-	-	-	-	-	-	<0.05		10			
HCB		-	-	<0.05	-	<0.05	-	-	-	-	-	-	-	<0.05		10			
Methoxychlor		-	-	<0.2	-	<0.2	-	-	-	-	-	-	-	<0.2		400			
Mirex		-	-	-	-	-	-	-	-	-	-	-	-	-		20			
Total OCPs above detection limits		-	-	ND	-	ND	-	-	-	-	-	-	-	ND					
Organophosphorus Pesticides (OPPs)																			
Chlorpyrifos		-	-	<0.05	-	<0.05	-	-	-	-	-	-	-	<0.05		250			
Total OPPs above detection limits		-	-	ND	-	ND	-	-	-	-	-	-	-	ND					
Polychlorinated Biphenyls (PCB)																			
Total PCBs above detection limits		-	-	ND	-	ND	-	-	-	-	-	-	-	ND		1			
Phenolic Compounds																			
Phenol		-	-	<0.5	-	<0.5	-	-	-	-	-	-	-	<0.5		40,000			
Pentachlorophenol		-	-	<2	-	<2	-	-	-	-	-	-	-	<2		120			
Cresols		-	-	<1.5	-	<1.5	-	-	-	-	-	-	-	<1.5		4,000			
Total Phenols		-	-	ND	-	ND	-	-	-	-	-	-	-	ND					
Asbestos																			
Bonded ACM (w/w) (%)		-	-	0.11	-	-	-	-	-	-	-	-	-	-		0.02			
Friable asbestos (fibrous and fines)(w/w) (%)		<0.001	-	0.0011	-	-	-	-	-	-	-	<0.001	-	-		0.001			
Asbestos Type		ND	-	CH	-	-	-	-	-	-	-	CH	-	-					

Notes Results in mg/kg unless specified otherwise.

ND = No individual species detected above laboratory detection limits.

No* = No asbestos found at the reporting limit of 0.1 g/kg by polarised light microscopy. Asbestos material detected and identified at conc. below 0.1 g/kg.

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(e) F1 TPH = TPH (C6-C10) minus BTEX fraction

(f) F2 TPH = TPH (C10-C16) minus naphthalene fraction

(g) NEPM 2013 HSL criterion for vapour intrusion, 0m to <1m depth in clay

(h) Criterion for fine texture grade soils

(i) Criterion for 'aged' contamination

(j) Insufficient data available to calculate 'aged' contamination. The values for fresh contamination should be used

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(l) NL= Contaminant is not considered to pose a risk to human health through vapour inhalation regardless the concentration

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Table B Analytical Results for Soil Samples within Proposed Public Park Area - 2019 Detailed Site Investigation

Analytes	Borehole No./ Site Location:	BH22	BH22	BH22	BH22	BH22	BH23	BH23	BH23	BH23	BH23	BH25	BH25	BH25	NEPM Background Ranges	NEPM 2013 HIL C / HSL C (Recreational / Public Open Space)	NEPM 2013 EILs/ ESLs (Urban Residential and Public Open Space)	CRC CARE 2011 HSL-C (Recreational / Open Space) Direct Contact	NEPM 2013 Management Limits (Residential, Parkland & Public Open Space)
	Sample No.:	S84	S85	S86	S87	S88	S89	S92	S93	S94	S95	S101	S104	S105					
	Depth:	0.2 m	0.5 m	1.5 m	2.0 m	3.0 m	0.2 m	0.8 m	1.5 m	2.0 m	3.0 m	0.5 m	1.0 m	2.0 m					
	Date Sampled:	20-May-19	20-May-19	20-May-19	20-May-19	20-May-19	20-May-19	20-May-19	20-May-19	20-May-19	20-May-19	20-May-19	20-May-19	20-May-19					
Metals																			
Arsenic		5	4	-	-	2	3	6	-	5	6	7	6	2	1-50	300	100 (b), (i)		
Cadmium		<0.3	<0.3	-	-	<0.3	0.4	0.6	-	<0.3	<0.3	<0.3	<0.3	<0.3		90	3 (d)		
Chromium		6.6	10	-	-	3.9	84[3]	10	-	11	7.2	12	14	3.3	5-1000	300 (m)	550 (c), (o)		
Copper		24	8.2	-	-	16	52	28	-	12	9.4	18	7.3	3.0	2-100	30,000	95 (c)		
Lead		55	12	-	-	7	20	73	-	19	9	19	11	2	2-200	600	1,100 (b), (i)		
Mercury		0.07	<0.05	-	-	<0.05	<0.05	0.12	-	<0.05	<0.05	<0.05	<0.05	<0.05	0.03 (n)	80 (n)	1 (d),(n)		
Nickel		6.1	1.9	-	-	7.1	46	9.8	-	2.5	2.4	15	4.3	<0.5	5-500	1,200	200 (c)		
Zinc		50	4.6	-	-	15	110	87	-	8.6	7.6	28	6.7	<2.0	10-300	30,000	510 (c)		
Monocyclic Aromatic Hydrocarbons (MAHs)																			
Benzene		<0.2	-	-	-	<0.1	<0.1	<0.1	-	-	<0.1	<0.1	<0.1	<0.1		NL (g), (l)	65 (h)	120	
Toluene		<0.5	-	-	-	<0.1	<0.1	<0.1	-	-	<0.1	<0.1	<0.1	<0.1		NL (g), (l)	105 (h)	18,000	
Ethylbenzene		<0.5	-	-	-	<0.1	<0.1	<0.1	-	-	<0.1	<0.1	<0.1	<0.1		NL (g), (l)	125 (h)	5,300	
Xylenes		<0.5	-	-	-	<0.3	<0.3	<0.3	-	-	<0.3	<0.3	<0.3	<0.3		NL (g), (l)	45 (h)	15,000	
Napthalene		<1	-	-	-	<0.1	<0.1	<0.1	-	-	<0.1	<0.1	<0.1	<0.1		NL (g), (l)	170 (b), (h	1,900	
Total MAHs above detection limits		ND	-	-	-	ND	ND	ND	-	-	ND	ND	ND	ND					
Volatile Organic Compounds																			
Total VOCs above detection limits		-	-	-	-	-	-	-	-	-	-	-	-	-					
Total Petroleum Hydrocarbons (TPHs)																			
Total C_6-C_{10}		<25	-	-	-	<25	<25	<25	-	-	<25	<25	<25	<25					800 (h)
Total C_{10}-C_{16}		<25	-	-	-	<25	<25	<25	-	-	<25	<25	<25	<25			120		1,000 (h)
F1 C_6-C_{10}[1] (d)		<25	-	-	-	<25	<25	<25	-	-	<25	<25	<25	<25		NL (g), (l)	180	5,100	
F2 C_{10}-C_{16}[1] (e)		<25	-	-	-	<25	<25	<25	-	-	<25	<25	<25	<25		NL (g), (l)		3,800	
F3 >C_{16}-C_{34}		220	-	-	-	<90	<90	110	-	-	<90	<90	<90	<90			1,300 (h)	5,300	3,500 (h)
F4 >C_{34}-C_{40}		<120	-	-	-	<120	<120	<120	-	-	<120	<120	<120	<120			5,600 (h)	7,400	10,000 (h)
Total C_{10}-C_{40}		220	-	-	-	ND	ND	110	-	-	ND	ND	ND	ND					
Polycyclic Aromatic Hydrocarbons (PAHs)																			
Benzo(a)pyrene		7.3	-	-	-	<0.1	2.5[3]	4.0	-	-	<0.1	1.5	<0.1	<0.1			0.7 (h)		
Carcinogenic PAHs [2]		9.4	-	-	-	<0.2	3.6[3]	5.7	-	-	<0.2	2.0	<0.2	<0.2		3			
Total PAHs above detection limits		92	-	-	-	ND	41.4[3]	53.0	-	-	0.8	15	ND	ND		300			
Organochlorine Pesticides (OCPs)																			
DDT+DDE+DDE		-	-	-	-	-	-	<0.6	-	-	<0.6	-	<0.6	-		400	180 (b), (k)		
Aldrin + Dieldrin		-	-	-	-	-	-	<0.3	-	-	<0.3	-	<0.3	-		10			
Chlordane		-	-	-	-	-	-	<0.2	-	-	<0.2	-	<0.2	-		70			
Endosulfan		-	-	-	-	-	-	<0.5	-	-	<0.5	-	<0.5	-		340			
Endrin		-	-	-	-	-	-	<0.2	-	-	<0.2	-	<0.2	-		20			
Heptachlor		-	-	-	-	-	-	<0.1	-	-	<0.1	-	<0.1	-		10			
HCB		-	-	-	-	-	-	<0.1	-	-	<0.1	-	<0.1	-		10			
Methoxychlor		-	-	-	-	-	-	<0.1	-	-	<0.1	-	<0.1	-		400			
Mirex		-	-	-	-	-	-	<0.1	-	-	<0.1	-	<0.1	-		20			
Total OCPs above detection limits		-	-	-	-	-	-	ND	-	-	ND	-	ND	-					
Organophosphorus Pesticides (OPPs)																			
Chlorpyrifos		-	-	-	-	-	-	<0.2	-	-	<0.2	-	<0.2	-		250			
Total OPPs above detection limits		-	-	-	-	-	-	ND	-	-	ND	-	ND	-					
Polychlorinated Biphenyls (PCB)																			
Total PCBs above detection limits		-	-	-	-	-	-	ND	-	-	ND	-	ND	-		1			
Phenolic Compounds																			
Phenol		-	-	-	-	-	-	<0.5	-	-	<0.5	-	<0.5	-		40,000			
Pentachlorophenol		-	-	-	-	-	-	<0.5	-	-	<0.5	-	<0.5	-		120			
Cresols		-	-	-	-	-	-	<1.5	-	-	<1.5	-	<1.5	-		4,000			
Total Phenols		-	-	-	-	-	-	ND	-	-	ND	-	ND	-					
Asbestos																			
Bonded ACM (w/w) (%)		<0.01	<0.01	-	-	-	<0.01	<0.01	-	-	-	<0.01	<0.01	-		0.02			
Friable asbestos (fibrous and fines)(w/w) (%)		<0.001	<0.001	-	-	-	<0.001	<0.001	-	-	-	<0.001	<0.001	-		0.001			
Asbestos Type		ND	ND	-	-	-	ND	ND	-	-	-	ND	ND	-					

Notes Results in mg/kg unless specified otherwise.

ND = No individual species detected above laboratory detection limits.

No* = No asbestos found at the reporting limit of 0.1 g/kg by polarised light microscopy. Asbestos material detected and identified at conc. below 0.1 g/kg.

[1] Calculated in accordance with Table 1A(3) of NEPM 2013

[2] Combined carcinogenic PAHs with relative potency to benzo(a)pyrene

[3] Duplicate value adopted due to RPD exceedance

Results shaded red exceed the NEPM 2013 HIL C/HSL C (Recreational / Public Open Space) criteria

Results shaded blue exceed the NEPM 2013 EIL/ESL criteria for an urban residential and public open space setting

Results shaded green exceed the CRC CARE 2011 HSL C Open Space) criteria for direct contact with soil

Results shaded yellow exceed the NEPM 2013 management limits for a residential, parkland and public open space land setting

Results shaded purple exceed both the NEPM 2013 HIL/HSL C (Recreational / Public Open Space) and the NEPM 2013 EIL/ESL criteria

(a) ANZECC 1992 background ranges used where no NEPM criteria available

(b) NEPM 2013 generic EIL

(c) NEPM 2013 site-specific EIL

(d) NEPM 1999 EIL used where no generic NEPM 2013 criteria are available

(e) F1 TPH = TPH (C6-C10) minus BTEX fraction

(f) F2 TPH = TPH (C10-C16) minus naphthalene fraction

(g) NEPM 2013 HSL criterion for vapour intrusion, 0m to <1m depth in clay

(h) Criterion for fine texture grade soils

(i) Criterion for 'aged' contamination

(j) Insufficient data available to calculate 'aged' contamination. The values for fresh contamination should be used

(k) Criterion for DDT

(l) NL= Contaminant is not considered to pose a risk to human health through vapour inhalation regardless the concentration

(m) Criterion for chromium VI

(n) Criterion for inorganic mercury

(o) Criterion for chromium III

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Table B Analytical Results for Soil Samples within Proposed Public Park Area - 2019 Detailed Site Investigation

Analytes	Borehole No./ Site Location:	BH25	BH26	BH26	BH26	BH26	BH26	NEPM Background Ranges	NEPM 2013 HIL C / HSL C (Recreational / Public Open Space)	NEPM 2013 EILs/ ESLs (Urban Residential and Public Open Space)	CRC CARE 2011 HSL-C (Recreational / Open Space) Direct Contact	NEPM 2013 Management Limits (Residential, Parkland & Public Open Space)
	Sample No.:	S106	S114	S117	S118	S119	S122					
	Depth:	3.0 m	0.5 m	0.9 m	1.8 m	2.6 m	3.4 m					
	Date Sampled:	20-May-19	21-May-19	21-May-19	21-May-19	21-May-19	21-May-19					
Metals												
Arsenic		3	5	6	-	9	3	1-50	300	100 (b), (i)		
Cadmium		<0.3	<0.3	<0.3	-	<0.3	<0.3	1	90	3 (d)		
Chromium		7.3	14	11	-	16	5.9	5-1000	300 (m)	550 (c), (o)		
Copper		5.1	64	18	-	12	5.3	2-100	30,000	95 (c)		
Lead		4	58	21	-	17	4	2-200	600	1,100 (b), (i)		
Mercury		<0.05	0.08	<0.05	-	<0.05	<0.05	0.03 (n)	80 (n)	1 (d),(n)		
Nickel		0.8	9.6	5.8	-	3.0	0.7	5-500	1,200	200 (c)		
Zinc		2.3	33	16	-	7.5	3.1	10-300	30,000	510 (c)		
Monocyclic Aromatic Hydrocarbons (MAHs)												
Benzene		-	-	<0.1	-	<0.1	<0.1		NL (g), (l)	65 (h)	120	
Toluene		-	-	<0.1	-	<0.1	<0.1		NL (g), (l)	105 (h)	18,000	
Ethylbenzene		-	-	<0.1	-	<0.1	<0.1		NL (g), (l)	125 (h)	5,300	
Xylenes		-	-	<0.3	-	<0.3	<0.3		NL (g), (l)	45 (h)	15,000	
Napthalene		-	-	<0.1	-	<0.1	<0.1		NL (g), (l)	170 (b), (h	1,900	
Total MAHs above detection limits		-	-	ND	-	ND	ND					
Volatile Organic Compounds												
Total VOCs above detection limits		-	-	-	-	-	-					
Total Petroleum Hydrocarbons (TPHs)												
Total C_6-C_{10}		-	-	<25	-	<25	<25					800 (h)
Total C_{10}-C_{16}		-	-	<25	-	<25	<25			120		1,000 (h)
F1 C_6-C_{10}[1] (d)		-	-	<25	-	<25	<25		NL (g), (l)	180	5,100	
F2 C_{10}-C_{16}[1] (e)		-	-	<25	-	<25	<25		NL (g), (l)		3,800	
F3 >C_{16}-C_{34}		-	-	<90	-	<90	<90			1,300 (h)	5,300	3,500 (h)
F4 >C_{34}-C_{40}		-	-	<120	-	<120	<120			5,600 (h)	7,400	10,000 (h)
Total C_{10}-C_{40}		-	-	ND	-	ND	ND					
Polycyclic Aromatic Hydrocarbons (PAHs)												
Benzo(a)pyrene		-	-	1.0	-	<0.1	<0.1			0.7 (h)		
Carcinogenic PAHs[2]		-	-	1.4	-	<0.2	<0.2		3			
Total PAHs above detection limits		-	-	12	-	ND	ND		300			
Organochlorine Pesticides (OCPs)												
DDT+DDE+DDE		-	-	-	-	<0.6	<0.6		400	180 (b), (k)		
Aldrin + Dieldrin		-	-	-	-	<0.3	<0.3		10			
Chlordane		-	-	-	-	<0.2	<0.2		70			
Endosulfan		-	-	-	-	<0.5	<0.5		340			
Endrin		-	-	-	-	<0.2	<0.2		20			
Heptachlor		-	-	-	-	<0.1	<0.1		10			
HCB		-	-	-	-	<0.1	<0.1		10			
Methoxychlor		-	-	-	-	<0.1	<0.1		400			
Mirex		-	-	-	-	<0.1	<0.1		20			
Total OCPs above detection limits		-	-	-	-	ND	ND					
Organophosphorus Pesticides (OPPs)												
Chlorpyrifos		-	-	-	-	<0.2	<0.2		250			
Total OPPs above detection limits		-	-	-	-	ND	ND					
Polychlorinated Biphenyls (PCB)												
Total PCBs above detection limits		-	-	-	-	ND	ND		1			
Phenolic Compounds												
Phenol		-	-	-	-	<0.5	<0.5		40,000			
Pentachlorophenol		-	-	-	-	<0.5	<0.5		120			
Cresols		-	-	-	-	<1.5	<1.5		4,000			
Total Phenols		-	-	-	-	ND	ND					
Asbestos												
Bonded ACM (w/w) (%)		-	<0.01	<0.01	-	-	-		0.02			
Friable asbestos (fibrous and fines)(w/w) (%)		-	<0.001	<0.001	-	-	-		0.001			
Asbestos Type		-	ND	ND	-	-	-					

Notes Results in mg/kg unless specified otherwise.

ND = No individual species detected above laboratory detection limits.

No* = No asbestos found at the reporting limit of 0.1 g/kg by polarised light microscopy. Asbestos material detected and identified at conc. below 0.1 g/kg.

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(b) NEPM 2013 generic EIL

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(e) F1 TPH = TPH (C6-C10) minus BTEX fraction

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(g) NEPM 2013 HSL criterion for vapour intrusion, 0m to <1m depth in clay

(h) Criterion for fine texture grade soils

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(j) Insufficient data available to calculate 'aged' contamination. The values for fresh contamination should be used

(k) Criterion for DDT

(l) NL= Contaminant is not considered to pose a risk to human health through vapour inhalation regardless the concentration

(m) Criterion for chromium VI

(n) Criterion for inorganic mercury

(o) Criterion for chromium III

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Table C Analytical Results for Soil Samples - 2019 Detailed Site Investigation

Analytes	Borehole No./ Site Location:	BH1/MW1	BH16/MW2	MW3	MW4	BH7/MW5	NEPM 2013 Groundwater HSLs for Vapour Intrusion		Australian & New Zealand Guidelines for Fresh and Marine Water Quality 2018 Marine Water Values	NHRMC/NRMMC Australian Drinking Water Guidelines 2011 (2018 updated) Health Guidance Value	NHRMC/NRMMC Australian Drinking Water Guidelines 2011 (2018 updated) Aesthetics Value
	Sample No.:	GW1-1	GW2-1	GW3-1	GW4-1	GW5-1					
	Date Sampled:	20-May-19	20-May-19	20-May-19	20-May-19	20-May-19					
Metals											
Arsenic		<1	<1	1	2	<1			2.3 (a), (b)		
Cadmium		<0.1	<0.1	<0.1	<0.1	1.1			5.5	2	
Chromium (Total)		<1	<1	<1	<1	<1			4.4 (c)	50 (c)	
Copper		<1	1	<1	<1	<1			1.3	2,000	
Lead		<1	<1	<1	<1	<1			4.4	10	
Mercury		<0.1	<0.1	<0.1	<0.1	<0.1			0.4 (d)	1	
Nickel		3	<1	11	2	50			70	20	
Zinc		7	8	45	<5	39			15		3,000
Volatile Organic Compounds (VOCs)											
Total Xylenes		<1.5	<1.5	<1.5	<1.5	<1.5		NL (f), (g)		600	20
Total BTEX		<3	<3	<3	<3	<3					
Total VOCs		ND	ND	11	ND	ND					
Fumigants (VOCs)											
2,2-dichloropropane		<0.5	<0.5	<0.5	<0.5	<0.5					
1,2-dichloropropane		<0.5	<0.5	<0.5	<0.5	<0.5			900		
cis-1,3-dichloropropene		<0.5	<0.5	<0.5	<0.5	<0.5			0.8 (l)	100 (l)	
trans-1,3-dichloropropene		<0.5	<0.5	<0.5	<0.5	<0.5			0.8 (l)	100 (l)	
1,2-dibromoethane (EDB)		<0.5	<0.5	<0.5	<0.5	<0.5				1	
Halogenated Aliphatics (VOCs)											
Dichlorodifluromethane (CFC-12)		<5	<5	<5	<5	<5					
Chloromethane		<5	<5	<5	<5	<5					
Chloroethene (Vinyl Chloride)		<0.3	<0.3	<0.3	<0.3	<0.3			100	0.3	
Bromomethane		<10	<10	<10	<10	<10					
Chloroethane		<5	<5	<5	<5	<5					
Trichlorofluoromethane		<1	<1	<1	<1	<1					
Iodomethane		<5	<5	<5	<5	<5					
1,1-dichloroethene		<0.5	<0.5	<0.5	<0.5	<0.5			700	30	
Dichloromethane (Methylene Chloride)		<5	<5	<5	<5	<5			4,000	4	
Allyl Chloride		<2	<2	<2	<2	<2					
trans-1,2-dichloroethene		<0.5	<0.5	<0.5	<0.5	<0.5				60 (m)	
1,1-dichloroethane		<0.5	<0.5	<0.5	<0.5	<0.5					
cis-1,2-dichloroethene		<0.5	<0.5	<0.5	<0.5	<0.5				60 (m)	
Bromochloromethane		<0.5	<0.5	<0.5	<0.5	<0.5					
1,2-dichloroethane		<0.5	<0.5	<0.5	<0.5	<0.5			1,900	3	
1,1,1-Trichloroethane (1,1,1-TCA)		<0.5	<0.5	<0.5	<0.5	<0.5			270		
1,1-dichloropropene		<0.5	<0.5	<0.5	<0.5	<0.5					
Carbon Tetrachloride		<0.5	<0.5	<0.5	<0.5	<0.5			240	3	
Trichloroethene (TCE)		<0.5	<0.5	<0.5	<0.5	<0.5					
1,1,2-trichloroethane		<0.5	<0.5	<0.5	<0.5	<0.5			1,900		
1,3-dichloropropane		<0.5	<0.5	<0.5	<0.5	<0.5			1,100	100	
Tetrachloroethene (PCE)		<0.5	<0.5	<0.5	<0.5	<0.5				50	
1,1,1,2-tetrachloroethane		<0.5	<0.5	<0.5	<0.5	<0.5					
cis-1,4-dichloro-2-butene		<1	<1	<1	<1	<1					
1,1,2,2-tetrachloroethane		<0.5	<0.5	<0.5	<0.5	<0.5			400 (h)		
1,2,3-trichloropropane		<0.5	<0.5	<0.5	<0.5	<0.5					
trans-1,4-dichloro-2-butene		<1	<1	<1	<1	<1					
1,2-dibromo-3-chloropropane		<0.5	<0.5	<0.5	<0.5	<0.5					
Hexachlorobutadiene		<0.5	<0.5	<0.5	<0.5	<0.5				0.7	
Halogenated Aromatics (VOCs)											
Chlorobenzene		<0.5	<0.5	<0.5	<0.5	<0.5				300	
Bromobenzene		<0.5	<0.5	<0.5	<0.5	<0.5					
2-Chlorotoluene		<0.5	<0.5	<0.5	<0.5	<0.5					
4-Chlorotoluene		<0.5	<0.5	<0.5	<0.5	<0.5					
1,3-dichlorobenzene		<0.5	<0.5	<0.5	<0.5	<0.5			260		
1,4-dichlorobenzene		<0.3	<0.3	<0.3	<0.3	<0.3			60	40	
1,2-dichlorobenzene		<0.5	<0.5	<0.5	<0.5	<0.5			160	1,500	
1,2,4-trichlorobenzene		<0.5	<0.5	<0.5	<0.5	<0.5			20	30 (n)	
1,2,3-trichlorobenzene		<0.5	<0.5	<0.5	<0.5	<0.5			3	30 (n)	
Monocyclic Aromatic Hydrocarbons (VOCs)											
Benzene		<0.5	<0.5	<0.5	<0.5	<0.5		5,000	700	1	
Toluene		<0.5	<0.5	<0.5	<0.5	<0.5		NL (f), (g)	180	800	25
Ethylbenzene		<0.5	<0.5	<0.5	<0.5	<0.5		NL (f), (g)	5	300	3
m/p-xylene		<1	<1	<1	<1	<1			75 (e)		
o-xylene		<0.5	<0.5	<0.5	<0.5	<0.5			350		
Vinyl benzene (Styrene)		<0.5	<0.5	<0.5	<0.5	<0.5				30	4
Isopropylbenzene (Cumene)		<0.5	<0.5	<0.5	<0.5	<0.5			30		
n-propylbenzene		<0.5	<0.5	<0.5	<0.5	<0.5					
1,3,5-trimethylbenzene		<0.5	<0.5	<0.5	<0.5	<0.5					
tert-butylbenzene		<0.5	<0.5	<0.5	<0.5	<0.5					
1,2,4-trimethylbenzene		<0.5	<0.5	<0.5	<0.5	<0.5					
sec-butylbenzene		<0.5	<0.5	<0.5	<0.5	<0.5					
p-isopropyltoluene		<0.5	<0.5	<0.5	<0.5	<0.5					
n-butylbenzene		<0.5	<0.5	<0.5	<0.5	<0.5					
Nitrogenous Compounds (VOCs)											
Acrylonitrile		<0.5	<0.5	<0.5	<0.5	<0.5			8		
2-nitropropane		<100	<100	<100	<100	<100					
Oxygenated Compounds (VOCs)											
2-propanone (Acetone)		<10	<10	<10	<10	<10					
Methyl-tert butyl ether (MTBE)		<2	<2	<2	<2	<2					
Vinyl acetate		<10	<10	<10	<10	<10					
2-butanone (MEK)		<10	<10	<10	<10	<10					
4-methyl-2-pentanone (MIBK)		<5	<5	<5	<5	<5					
2-hexanone (MBK)		<5	<5	<5	<5	<5					
Polycyclic VOCs											
naphthalene		<0.5	<0.5	<0.5	<0.5	<0.5					
Sulphonated Compounds (VOCs)											
carbon disulfide		<2	<2	<2	<2	<2			20		
Trihalomethanes (VOCs)											
Chloroform		<0.5	<0.5	<0.5	<0.5	<0.5			370		
Bromodichloromethane		<0.5	<0.5	<0.5	<0.5	<0.5					
Dibromochloromethane		<0.5	<0.5	<0.5	<0.5	<0.5					
Bromoform		<0.5	<0.5	<0.5	<0.5	<0.5					
Trihalomethanes (total)		ND	ND	ND	ND	ND				250	
Total Petroleum Hydrocarbons (TPHs)											
Total C_6-C_{10}		<50	<50	100	50	<50			7 (b)		
Total C_{10}-C_{16}		<60	<60	<60	95	<60					
F1 C_6-C_{10}		<50	<50	100	<50	<50		NL (f), (g)			
F2 C_{10}-C_{16}		<60	<60	<60	94	<60		NL (f), (g)			
F3 >C_{16}-C_{34}		<500	<500	<500	<500	<500					
F4 >C_{34}-C_{40}		<500	<500	<500	<500	<500					
Total C_{10}-C_{40}		ND	ND	100	386	ND			7 (b)		
Polycyclic Aromatic Hydrocarbons (PAHs)											
Naphthalene		<0.1	<0.1	<0.1	<0.1	<0.1			70		
2-methylnaphthalene		<0.1	<0.1	<0.1	<0.1	<0.1					
1-methylnaphthalene		<0.1	<0.1	<0.1	<0.1	<0.1					
Acenaphthylene		<0.1	<0.1	<0.1	<0.1	<0.1					
Acenaphthene		<0.1	<0.1	<0.1	<0.1	<0.1					
Fluorene		<0.1	<0.1	<0.1	<0.1	<0.1					
Phenanthrene		<0.1	<0.1	<0.1	0.3	<0.1			0.6		
Anthracene		<0.1	<0.1	<0.1	<0.1	<0.1			0.1		
Fluorathene		<0.1	<0.1	<0.1	<0.1	<0.1			1		
Pyrene		<0.1	<0.1	<0.1	0.2	<0.1					
Benzo(a)anthracene		<0.1	<0.1	<0.1	0.4	<0.1				0.1 (k)	
Chrysene		<0.1	<0.1	<0.1	0.2	<0.1				1 (k)	
Benzo(bß)fluorathene		<0.1	<0.1	<0.1	0.1	<0.1				0.1 (k)	
Benzo(k)fluorathene		<0.1	<0.1	<0.1	<0.1	<0.1				0.1 (k)	
Benzo(a)pyrene		<0.1	<0.1	<0.1	<0.1	<0.1			0.1	0.01	
Indeno(1,2,3-cd)pyrene		<0.1	<0.1	<0.1	<0.1	<0.1				0.1 (k)	
dibenzo(ah)anthracene		<0.1	<0.1	<0.1	<0.1	<0.1				0.01 (k)	
Benzo(ghi)perylene		<0.1	<0.1	<0.1	<0.1	<0.1				1 (k)	
Total PAHs above detection limits		ND	ND	ND	1.2	ND					

Notes Results in µg/L unless specified otherwise.

ND = No individual species detected above laboratory detection limits.

[1] Duplicate value adopted due to RPD exceedance

Results shaded Olive exceed the NEPM 2013 Vapour Intrusion GILs HSLA & HSLB for Low-High Desnsity Residentia

Results shaded red exceed the Australian & New Zealand Guidelines for Fresh and Marine Water Quality 2018 - Marine Water Values

Results shaded blue exceed the NHRMC/NRMMC Australian Drinking Water Guidelines 2011 (2018 updated) - Health Guidance Value

Results shaded green exceed the NHRMC/NRMMC Australian Drinking Water Guidelines 2011 (2018 updated) - Aesthetics Value

Results shaded yellow exceed both the Fresh and Marine Water Quality 2018 and the Australian Drinking Water 2011 - Health Guidance Values

Results shaded purple exceed both the Fresh and Marine Water Quality 2018 and the Australian Drinking Water 2011 - Aesthetics Values

Results shaded dark blue exceed both the Australian Drinking Water 2011 - Health Guidance and Aesthetics Values

Results shaded black exceed all assessment criteria

(a) Criterion for Arsenic (As III)
(b) Low reliability criterion (ANZECC 20
(c) Criterion for Chromium (Cr VI)
(d) Criterion for inorganic mercury
(e) Criterion for m-xylene
(f) criterion for clay soils, 2m - <4m
(g) NL = Contaminant is not considered to pose a risk to human health through vapour inhalation regardless the concentration
(h) Freshwater criterion value adopted in lieu of marine water value
(i) F1 = TPH (C_6-C_{10}) minus BTEX fraction
(j) F2 = TPH (C_{10}-C_{16}) minus BTEX fraction
(k) Risk assessment criteria based on carcinogenic potency relative to Benzo(a)pyrene
(l) Criterion for 1,3-dichloropropene (total)
(m) Criterion for 1,2-dichloroethene (total)
(n) Criterion for trichlorobenzene (total)

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Table D Analytical Results for Soil Samples - 2019 Acid Sulfate Soil Assessment

Analytes	Borehole No./ Site Location:	BH21	BH21	BH21	BH21	BH21	BH21	BH21	BH21	BH21	BH21	BH21	BH22	BH22	BH22	BH22	Field ASS Indicator[1]	Acid Sulfate Soil Action Criteria[2]
	Sample No.:	ASS1	ASS2	ASS3	ASS4	ASS5	ASS6	ASS7	ASS8	ASS9	ASS10	ASS11	ASS12	ASS13	ASS14	ASS15		
	Depth:	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	0.5	1.0	1.5	2.0		
	Date Sampled:	20-May-19	20-May-19	20-May-19	20-May-19	20-May-19	20-May-19	20-May-19	20-May-19	20-May-19	20-May-19	20-May-19	20-May-19	20-May-19	20-May-19	20-May-19		
Field ASS / PASS Indicators																		
pH_f (pH units)		10.6	11.0	9.4	10.1	-	9.5	8.4	8.4	8.8	8.4	9.1	7.1	5.7	5.7	5.4	< 4	-
pH_{ox} (pH units)		10.0	10.0	7.1	8.1	-	7.3	6.5	7.0	7.1	6.6	6.9	3.3	2.9	3.1	3.9	< 3	-
Reaction Rate (No unit)		XXXX	XXXX	XXX	XXX	-	XXX	XXX	XX	XX	XXX	XXX	XXX	XXX	XXX	XX	XXX	-
pH Difference (pH units)		0.6	1.0	2.3	2.0	-	2.1	1.9	1.4	1.7	1.8	2.2	3.8	2.8	2.6	1.5	> 1	-
Chromium Reducible Sulphur Suite																		
Chromium Reducible Sulfur (%)		-	-	-	-	-	-	<0.005	-	-	<0.005	-	0.014	0.063	0.022	<0.005	-	-
Net Acidity (Sulfur units) %S		-	-	-	-	-	-	<0.01	-	-	<0.01	-	0.03	0.16	0.08	0.01	-	0.03
Net Acidity (Acidity units) Mol H^+/tonne		-	-	-	-	-	-	<5	-	-	<5	-	21	99	51	9	-	18
Net Acidity Excluding ANC (Acidity units) Mol H^+/tonne		-	-	-	-	-	-	<5	-	-	<5	-	21	99	51	9	-	18
Liming Rate Inc. ANC (kg $CaCO_3$/tonne)		-	-	-	-	-	-	<0.1	-	-	<0.1	-	1.6	7.4	3.8	N/A	-	-
Liming Rate Exc ANC (kg $CaCO_3$/tonne)		-	-	-	-	-	-	<0.1	-	-	<0.1	-	1.6	7.4	3.8	N/A	-	-

Notes : [1] Sullivan et al (2018) *National Acid Sulfate Soils Guidance: National acid sulfate soils sampling and identification methods manual* ; Indicators of ASS materials

[2] ASSMAC *Acid Sulfate Soil Manual (1998)* ; Action Criteria for coarse texture grade soils

Results shaded red exhibit possible field indications of Actual or Potential Acid Sulfate Soils

Results shaded blue exceed the Action Criteria for Acid Sulfate Soils

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Table D Analytical Results for Soil Samples - 2019 Acid Sulfate Soil Assessment

Analytes	Borehole No./ Site Location:	BH22	BH22	BH22	BH23	BH23	BH23	BH23	BH23	BH23	BH23	BH23	BH23	BH23	BH23	BH24	Field ASS Indicator[1]	Acid Sulfate Soil Action Criteria[2]
	Sample No.:	ASS16	ASS17	ASS18	ASS19	ASS20	ASS21	ASS22	ASS23	ASS24	ASS25	ASS26	ASS27	ASS28	ASS29	ASS30		
	Depth:	2.5	3.0	3.5	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	0.5		
	Date Sampled:	20-May-19	20-May-19	20-May-19	20-May-19	20-May-19	20-May-19	20-May-19	20-May-19	20-May-19	20-May-19	20-May-19	20-May-19	20-May-19	20-May-19	20-May-19		
Field ASS / PASS Indicators																		
pH_f (pH units)		6.1	6.4	6.5	7.0	7.8	6.7	5.7	8.2	5.5	6.6	7.1	7.4	7.1	7.3	5.7	< 4	-
pH_{ox} (pH units)		5.6	5.5	6.0	5.3	6.4	3.8	3.5	6.2	4.1	5.7	5.8	6.0	5.9	6.0	4.1	< 3	-
Reaction Rate (No unit)		XX	XX	XX	XX	XX	XXX	XXX	XX	XX	XX	XX	XX	XX	XX	XX	XXX	-
pH Difference (pH units)		0.5	0.9	0.5	1.7	1.3	3.1	2.2	2.0	1.4	0.9	1.3	1.4	1.2	1.4	1.6	> 1	-
Chromium Reducible Sulphur Suite																		
Chromium Reducible Sulfur (%)		-	-	-	-	<0.005	0.014	0.006	-	<0.005	-	-	-	-	-	-	-	-
Net Acidity (Sulfur units) %S		-	-	-	-	<0.01	0.04	0.05	-	0.04	-	-	-	-	-	-	-	0.03
Net Acidity (Acidity units) Mol H^+/tonne		-	-	-	-	<5	26	29	-	25	-	-	-	-	-	-	-	18
Net Acidity Excluding ANC (Acidity units) Mol H^+/tonne		-	-	-	-	<5	26	29	-	25	-	-	-	-	-	-	-	18
Liming Rate Inc. ANC (kg $CaCO_3$/tonne)		-	-	-	-	<0.1	2.0	2.1	-	1.9	-	-	-	-	-	-	-	-
Liming Rate Exc ANC (kg $CaCO_3$/tonne)		-	-	-	-	<0.1	2.0	2.1	-	1.9	-	-	-	-	-	-	-	-

Notes : [1] Sullivan et al (2018) *National Acid Sulfate Soils Guidance: National acid sulfate soils sampling and identification methods manual* ; Indicators of ASS materials

[2] ASSMAC *Acid Sulfate Soil Manual (1998)* ; Action Criteria for coarse texture grade soils

Results shaded red exhibit possible field indications of Actual or Potential Acid Sulfate Soils

Results shaded blue exceed the Action Criteria for Acid Sulfate Soils

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Table D Analytical Results for Soil Samples - 2019 Acid Sulfate Soil Assessment

Analytes	Borehole No./ Site Location:	BH24	BH24	BH24	BH24	BH24	BH24	BH24A	BH24A	BH25	BH25	BH25	BH25	BH25	BH25	BH25	Field ASS Indicator[1]	Acid Sulfate Soil Action Criteria[2]
	Sample No.:	ASS31	ASS32	ASS33	ASS34	ASS35	ASS36	ASS47	ASS48	ASS37	ASS38	ASS39	ASS40	ASS41	ASS42	ASS43		
	Depth:	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	0.5	1.0	1.5	2.0	2.5	3.0	3.5		
	Date Sampled:	20-May-19	20-May-19	20-May-19	20-May-19	20-May-19	20-May-19	20-May-19	20-May-19	20-May-19	20-May-19	20-May-19	20-May-19	20-May-19	20-May-19	20-May-19		
Field ASS / PASS Indicators																		
pH_f (pH units)		5.0	5.9	7.2	7.5	6.9	7.5	7.4	7.5	7.1	6.9	5.1	5.2	5.5	6.5	6.1	< 4	-
pH_{ox} (pH units)		4.0	4.9	5.9	5.9	5.6	6.5	8.0	8.0	4.7	5.0	3.5	4.1	4.6	5.5	5.6	< 3	-
Reaction Rate (No unit)		XX	XX	XX	XX	XX	XXX	XXXX	XXXX	XXX	XX	XX	XX	XX	XX	X	XXX	-
pH Difference (pH units)		1.0	0.7	1.4	1.5	1.3	1.0	-0.6	-0.5	2.4	2.0	1.5	1.1	0.9	1.0	0.4	> 1	-
Chromium Reducible Sulphur Suite																		
Chromium Reducible Sulfur (%)		-	-	-	-	-	-	-	-	-	-	<0.005	<0.005	-	-	-	-	-
Net Acidity (Sulfur units) %S		-	-	-	-	-	-	-	-	-	-	0.18	0.02	-	-	-	-	0.03
Net Acidity (Acidity units) Mol H^+/tonne		-	-	-	-	-	-	-	-	-	-	110	12	-	-	-	-	18
Net Acidity Excluding ANC (Acidity units) Mol H^+/tonne		-	-	-	-	-	-	-	-	-	-	110	12	-	-	-	-	18
Liming Rate Inc. ANC (kg $CaCO_3$/tonne)		-	-	-	-	-	-	-	-	-	-	8.3	N/A	-	-	-	-	-
Liming Rate Exc ANC (kg $CaCO_3$/tonne)		-	-	-	-	-	-	-	-	-	-	8.3	N/A	-	-	-	-	-

Notes : [1] Sullivan et al (2018) *National Acid Sulfate Soils Guidance: National acid sulfate soils sampling and identification methods manual* ; Indicators of ASS materials

[2] ASSMAC *Acid Sulfate Soil Manual (1998)* ; Action Criteria for coarse texture grade soils

Results shaded red exhibit possible field indications of Actual or Potential Acid Sulfate Soils

Results shaded blue exceed the Action Criteria for Acid Sulfate Soils

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Table D Analytical Results for Soil Samples - 2019 Acid Sulfate Soil Assessment

Analytes	Borehole No./ Site Location:	BH25	BH25	BH25	Field ASS Indicator[1]	Acid Sulfate Soil Action Criteria[2]
	Sample No.:	ASS44	ASS45	ASS46		
	Depth:	4.0	4.5	5.0		
	Date Sampled:	20-May-19	20-May-19	20-May-19		
Field ASS / PASS Indicators						
pH_f (pH units)		6.7	6.7	7.2	< 4	-
pH_{ox} (pH units)		5.3	5.8	5.8	< 3	-
Reaction Rate (No unit)		XX	X	XX	XXX	-
pH Difference (pH units)		1.4	1.0	1.4	> 1	-
Chromium Reducible Sulphur Suite						
Chromium Reducible Sulfur (%)		-	-	-	-	-
Net Acidity (Sulfur units) %S		-	-	-	-	0.03
Net Acidity (Acidity units) Mol H^+/tonne		-	-	-	-	18
Net Acidity Excluding ANC (Acidity units) Mol H^+/tonne		-	-	-	-	18
Liming Rate Inc. ANC (kg $CaCO_3$/tonne)		-	-	-	-	-
Liming Rate Exc ANC (kg $CaCO_3$/tonne)		-	-	-	-	-

Notes : [1] Sullivan et al (2018) *National Acid Sulfate Soils Guidance: National acid sulfate soils sampling and identification methods manual* ; Indicators of ASS materials

[2] ASSMAC *Acid Sulfate Soil Manual (1998)* ; Action Criteria for coarse texture grade soils

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Results shaded blue exceed the Action Criteria for Acid Sulfate Soils

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Table F: Results of Quality Control - Intra and Inter-Laboratory Duplicate Groundwater Samples

Analytes	Sample No.:	GW2-1	GW2-2[1]	RPD (%)	GW2-1*	GW2-3[2]	RPD (%)
	Date Sampled:	20-May-19	20-May-19		20-May-19	20-May-19	
Metals							
Arsenic		<1	<1	<50	<1	<1	<50
Cadmium		<0.1	<0.1	<50	<0.1	<0.1	<50
Chromium (Total)		<1	<1	<50	<1	<1	<50
Copper		1	2	<50	1	<1	<50
Lead		<1	<1	<50	<1	<1	<50
Mercury		<0.1	<0.1	<50	<0.1	<0.1	<50
Nickel		<1	<1	<50	<1	<1	<50
Zinc		8	6	29	8	<5	<50
Monocyclic Aromatic Hydrocarbons (MAHs)							
Benzene		<0.5	<0.5	<70	<0.5	<1	<70
Toluene		<0.5	<0.5	<70	<0.5	<2	<70
Ethylbenzene		<0.5	<0.5	<70	<0.5	<2	<70
m/p-xylene		<1	<1	<70	<1	<2	<70
o-xylene		<0.5	<0.5	<70	<0.5	<2	<70
Xylenes (total)		<1.5	<1.5	<70	<1.5	<2	<70
Total Petroleum Hydrocarbons (TPHs)							
Total C_6-C_{10}		<40	<40	<70	<40	<20	<70
Total C_{10}-C_{16}		<60	<60	<70	<60	<100	<70
F1 C_6-C_{10}		<50	<50	<70	<50	<20	<70
F2 C_{10}-C_{16}		<60	<60	<70	<60	<100	<70
F3 >C_{16}-C_{34}		<500	<500	<70	<500	<100	<70
F4 >C_{34}-C_{40}		<500	<500	<70	<500	<100	<70
Total C_{10}-C_{40}		<650	<650	<70	<650	<100	<70
Polycyclic Aromatic Hydrocarbons (PAHs)							
Naphthalene		<0.1	<0.1	<70	<0.1	<1.0	<70
Acenaphthylene		<0.1	<0.1	<70	<0.1	<1.0	<70
Acenaphthene		<0.1	<0.1	<70	<0.1	<1.0	<70
Fluorene		<0.1	<0.1	<70	<0.1	<1.0	<70
Phenanthrene		<0.1	<0.1	<70	<0.1	<1.0	<70
Anthracene		<0.1	<0.1	<70	<0.1	<1.0	<70
Fluoranthene		<0.1	<0.1	<70	<0.1	<1.0	<70
Pyrene		<0.1	<0.1	<70	<0.1	<1.0	<70
Benzo(a)anthracene		<0.1	<0.1	<70	<0.1	<1.0	<70
Chrysene		<0.1	<0.1	<70	<0.1	<1.0	<70
Benzo(b&j)fluoranthene		<0.1	<0.1	<70	<0.1	<1.0	<70
Benzo(k)fluoranthene		<0.1	<0.1	<70	<0.1	<1.0	<70
Benzo(a)pyrene		<0.1	<0.1	<70	<0.1	<0.5	<70
Indeno(1,2,3-cd)pyrene		<0.1	<0.1	<70	<0.1	<1.0	<70
Dibenzo(ah)anthracene		<0.1	<0.1	<70	<0.1	<1.0	<70
Benzo(ghi)perylene		<0.1	<0.1	<70	<0.1	<1.0	<70
Total PAHs above detection limits		<1	<1	<70	<1	<0.5	<70

Notes : Results expressed as µg/L unless otherwise indicated

[1] Denotes intra-laboratory field duplicate sample analysed by SGS Sydney

[2] Denotes inter-laboratory field duplicate sample analysed by ALS Sydney

RPDs shaded grey exceed the acceptance criteria

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Table G Results of Quality Control - Trip Spike and Trip Blank Samples

		Sample Numbers					
	Sample No.:	**Trip Spike**	**Trip Blank**	**Trip Spike**	**Trip Blank**	**Trip Spike**	**Trip Blank**
	Medium:	**Soil**	**Soil**	**Water**	**Water**	**Water**	**Water**
	Unit of Measure:	**%**	**mg/kg**	**%**	**µg/L**	**%**	**mg/kg**
Analyte	**Date Sampled:**	**20-May-19**	**20-May-19**	**20-May-19**	**20-May-19**	**21-May-19**	**21-May-19**
Monocyclic Aromatic Hydrocarbons (MAHs)							
Benzene		97	<0.1	100	<0.5	91	<0.1
Toluene		96	<0.1	93	<0.5	98	<0.1
Ethylbenzene		96	<0.1	98	<0.5	98	<0.1
m/p-Xylenes		96	<0.2	96	<1	92	<0.2
o-Xylenes		91	<0.1	98	<0.5	83	<0.1

Note:

Values that have been shaded exceed the acceptance criteria

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Table H Soil-Specific Ecological Investigation levels

		Sample Numbers					
	Borehole No./ Site Location:	**BH23**	**BH23**	**BH23**	**BH26**	**BH26**	**BH26**
	Sample No.:	**EIL 1**	**EIL 2**	**EIL 3**	**EIL 4**	**EIL 5**	**EIL 6**
	Depth:	**0.0 - 1.0 m**	**1.0 - 2.0 m**	**2.0 - 3.0 m**	**0.9 m**	**1.5 - 2.5 m**	**2.6 - 2.9 m**
	Soil Profile	**Sandy Clay**	**Silty Clay**	**Silty Clay**	**Gravelly Clay**	**Silty Clay**	**Silty Clay**
Analyte	**Date Sampled:**	**20-May-19**	**20-May-19**	**20-May-19**	**21-May-19**	**21-May-19**	**21-May-19**
Clay Content							
Clay Content % (estimate) (b)		25	30	30	25	30	30
Power of Hydrogen							
pH ($CaCl_2$)		7.3	6.1	4.2	8.8	6.6	4.1
Cation Exchange Capacity							
CEC		15	13	9.9	14	14	11
Total Organic Carbon							
TOC %		0.90	0.40	0.22	0.43	0.33	0.24
Soil-Specific Ecological Investigation Levels							
Chromium III		550	580	580	550	580	580
Copper		220	95	30	220	100	30
Nickel		220	200	170	210	210	180
Zinc		630	510	180	600	600	170

Notes:

(a) Results in mg/kg unless specified otherwise.

(b) Clay content estimated based on soil description

(c) EILs are generally applicable to a maximum depth of 2m

Values adopted as soil-specific Ecological Investigation Levels

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Appendix D – Remediation Assessment Criteria

Table D-1 Soil Remediation Criteria

Chemical	Unit	HIL B [1a]	HIL C [1b]	HSL C [2]	HSL D [3]	EIL [3a]	ESL [3b]
Metals							
Arsenic – As	mg / kg	500[4]	300	-	-	100	-
Cadmium - Cd	mg / kg	150	300	-	-	100	-
Chromium(VI) – Cr(VI)	mg / kg	500	300	-	-	415	-
Copper – Cu	mg / kg	30,000	17,000	-	-	125	-
Lead – Pb	mg / kg	1,200	600	-	-	1260	-
Mercury – Hg (inorganic)	mg / kg	120	80	-	-	NA	-
Nickel – Ni	mg / kg	1,200	1,200	-	-	135	-
Zinc – Zn	mg / kg	60,000	30,000	-	-	350	-
Petroleum Hydrocarbons							
F1 [5]	mg / kg	-	-	45	45	-	180
F2 [6]	mg / kg	-	-	110	110	-	120
F3 [7]	mg / kg	-	-	-	-	-	300
F4 [8]	mg / kg	-	-	-	-	-	2800
Polycyclic Aromatic Hydrocarbons (PAH)							
Naphthalene	mg / kg	-	-	3	3	170	-
Benzo(α)pyrene	mg / kg	-	-	-	-	-	0.7
Carcinogenic PAHs (as B(α)P TEQ) [9]	TEQ	4	3	-	-	-	-
Total PAHs [10]	mg / kg	400	300	-	-	-	-
Monocyclic Aromatic Hydrocarbons (BTEX)							
Benzene	mg / kg	-	-	0.5	3	-	50
Toluene	mg / kg	-	-	160	NL	-	85
Ethylbenzene	mg / kg	-	-	55	NL	-	70

Xylenes (total)	mg / kg	-	-	40	230	-	105
Organochlorine Pesticides[11]							
DDT+DDE+DDD	mg/kg	240	400	-	-	-	-
Other							
Organophosphorus Pesticides (OPP)[11]	mg/kg	N/A	N/A	-	-	-	-
PCBs	mg/kg	1	1	-	-	-	-
Asbestos							
Asbestos (friable or fines)	w / w	0.001%	0.001%	-	-	-	-
Asbestos (bonded)	w / w	0.04%	0.04%	-	-	-	-

Notes:

N/A – Not Available

NL – 'Not Limiting' - The contaminant cannot exceed the maximum allowable vapour risk due to its specific chemical solubility limit.

1. Health-based investigation levels:
   a. HIL B - Residential with minimal opportunities for soil access; includes dwellings with fully and permanently paved yard space such as high-rise buildings and apartments, Ref. NEPM 2013, Schedule B1, Table 1A(1).
   b. HIL C –Public open space such as parks, playgrounds, playing fields (e.g. ovals), secondary schools and footpaths. Ref. NEPM 2013, Schedule B1, Table 1A(1).
2. Soil HSLs for vapour intrusion assuming coarse texture (sand) soils and a contamination source at 0m to <1m depth.
3. Ecological investigation levels:
   a. EIL – Generic EIL for aged Arsenic and Naphthalene, Calculated EILs for other metals in urban residential and public open space settings with due regard for background concentrations, soil cation exchange capacity, texture and pH, Ref. NEPM 2013, Schedule B1, Tables 1B(1) to 1B(5).
   b. ESL – Ecological Screening Level for F1, F2, F3, F4, BTEX and Benzo(a)pyrene in coarse texture soils in urban residential and public open space settings, Ref. NEPM 2013, Schedule B1, Table 1B(6).
4. Arsenic: HIL assumes 70% oral bioavailability. Site-specific bioavailability may be important and should be considered where appropriate (refer Schedule B7).
5. F1: concentration of TPH C_6-C_{10} fraction minus the sum of BTEX concentrations.
6. F2: concentration of TPH >C_{10}-C_{16} fraction minus the concentration of Naphthalene.
7. F3: concentration of TPH >C_{16}-C_{34}.
8. F4: concentration of TPH >C_{34}-C_{40}.
9. Carcinogenic PAHs: HIL is based on the 8 carcinogenic PAHs and their TEFs (potency relative to B(a)P) adopted by CCME 2008 (refer Schedule B7). The B(a)P TEQ is calculated by multiplying the concentration of each carcinogenic PAH in the sample by its B(a)P TEF, given below, and summing these products.

10. Total PAHs: HIL is based on the sum of the 16 PAHs most commonly reported for contaminated sites (WHO 1998). The application of the total PAH HIL should consider the presence of carcinogenic PAHs and naphthalene (the most volatile PAH). Carcinogenic PAHs reported in the total PAHs should meet the B(a)P TEQ HIL. Naphthalene reported in the total PAHs should meet the relevant HSL.
11. Criteria to be updated for any detected pesticides.

Table D-2 Waste Classification without Leachate Testing

Contaminant	Maximum Values of *Specific Contaminant Concentration* for Classification without TCLP	
	General Solid Waste CT1 (mg/kg)	Restricted Solid Waste CT2 (mg/kg)
Arsenic	100	400
Asbestos	**"Special Waste - Asbestos Waste"** if ANY Asbestos is present	
Benzene	10	40
Benzo(a)pyrene	0.8	3.2
Cadmium	20	80
Chromium (VI)	100	400
Cyanide (amenable)	70	280
Ethylbenzene	600	2,400
Lead	100	400
Mercury	4	16
Nickel	40	160
Petroleum hydrocarbons C_6-C_9	650	2,600
Petroleum hydrocarbons C_{10}-C_{36}	10,000	40,000
Polychlorinated biphenyls (PCB)	<50	<50
Polycyclic aromatic hydrocarbons (total PAH)	200	800
Tetrachloroethylene (PCE)	14	56
Toluene	288	1,152
Trichloroethylene (TCE)	10	40
Vinyl Chloride (VC)	4	16
Xylenes (total)	1,000	4,000

Note: N/A = not applicable (assessed using SCC1 and SCC2 values, only) see Table C-3

Table D-3 Waste Classification without Leachate Testing

Contaminant	Maximum Values of *Specific Contaminant Concentration* for Classification without TCLP	
	General Solid Waste CT1 (mg/kg)	Restricted Solid Waste CT2 (mg/kg)
Arsenic	100	400
Asbestos	**"Special Waste - Asbestos Waste"** if ANY Asbestos is present	
Benzene	10	40
Benzo(a)pyrene	0.8	3.2
Cadmium	20	80
Chromium (VI)	100	400
Cyanide (amenable)	70	280
Ethylbenzene	600	2,400
Lead	100	400
Mercury	4	16
Nickel	40	160
Petroleum hydrocarbons C_6-C_9	650	2,600
Petroleum hydrocarbons C_{10}-C_{36}	10,000	40,000
Polychlorinated biphenyls (PCB)	<50	<50
Polycyclic aromatic hydrocarbons (total PAH)	200	800
Tetrachloroethylene (PCE)	14	56
Toluene	288	1,152
Trichloroethylene (TCE)	10	40
Vinyl Chloride (VC)	4	16
Xylenes (total)	1,000	4,000

Note: N/A = not applicable (assessed using SCC1 and SCC2 values, only) see Table C-3

Table D-4 Waste Classification using TCLP and SCC Values

Contaminant	Maximum Values for *Leachable Concentration* and Specific Contaminant Concentration when used together			
	General Solid Waste		*Restricted Solid Waste*	
	Leachable Concentration	Specific Contaminant Concentration	Leachable Concentration	Specific Contaminant Concentration
	TCLP1 (mg/L)	SCC1 (mg/kg)	TCLP2 (mg/L)	SCC2 (mg/kg)
Arsenic	5.0	500	20	2,000
Asbestos	**"Special Waste - Asbestos Waste"** if ANY Asbestos is present			
Benzene	0.5	18	2	72
Benzo(a)pyrene	0.04	10	0.16	23
Cadmium	1.0	100	4	400
Chromium (VI)	5	1,900	20	7,600
Cyanide (amenable)	3.5	300	14	1,200
Ethylbenzene	30	1,080	120	4,320
Lead	5	1,500	20	6,000
Mercury	0.2	50	0.8	200
Nickel	2	1,050	8	4,200
Petroleum hydrocarbons C_6-C_9	N/A	650	N/A	2,600
Petroleum hydrocarbons C_{10}-C_{36}	N/A	10,000	N/A	40,000
Polychlorinated biphenyls (PCB)	N/A	<50	N/A	<50
Polycyclic aromatic hydrocarbons (total PAH)	N/A	200	N/A	800
Tetrachloroethylene (PCE)	0.7	25.2	2.8	100.8
Toluene	14.4	518	57.6	2,073
Trichloroethylene (TCE)	0.5	18	2	72
Vinyl Chloride (VC)	0.2	7.2	0.8	28.8
Xylenes	50	1,800	200	7,200

Note: N/A = not applicable (assessed using SCC1 and SCC2 values, only)

Table D-5 Groundwater Remediation Criteria

Analyte	Unit	PQL	Aquatic Ecosystems Marine, 95% Level of Protection [2a]	Recreational Use Primary and Secondary Contact Recreation [3]
Heavy Metals				
Arsenic	µg/L	1	13 [5]	50
Cadmium	µg/L	0.1	0.7 [6]	5
Chromium (Total)	µg/L	1	27 [7]	50
Copper	µg/L	1	1.3	1,000
Lead	µg/L	1	4.4 [6]	50
Mercury (inorganic)	µg/L	0.1	0.1 [2b]	1
Nickel	µg/L	1	7 [6]	100
Zinc	µg/L	5	15 [6]	5,000
TRHs				
F1	µg/L	50	50 [8]	NV
F2	µg/L	60	60 [8]	NV
F3	µg/L	500	500 [8]	NV
F4	µg/L	500	500 [8]	NV
PAHs				
Naphthalene	µg/L	0.1	50	NV
Benzo(α)pyrene	µg/L	0.1	0.1 [2b,9]	0.01
Total PAHs	µg/L	1	NV	NV
BTEX				
Benzene	µg/L	0.5	500	10
Toluene	µg/L	0.5	-	NV
Ethylbenzene	µg/L	0.5	-	NV
Xylenes (total)	µg/L	0.5	-	NV

Phenols			
Total Phenols	µg/L	400	-

Notes:

All concentrations are shown in units of µg/L
[1] Groundwater remediation criteria may be expanded during data gap closure assessment to include VOCs criteria and updated recreational criteria.
[2a] Marine, 95% Level of Protection – National Water Quality Management Strategy (NWQMS), Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand (ANZECC and ARMCANZ), Australian and New Zealand Guidelines for Fresh and Marine Water Quality, October 2000 (ANZECC 2000).
[2b] Marine, 99% Level of Protection to account for bioaccumulation – National Water Quality Management Strategy (NWQMS), Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand (ANZECC and ARMCANZ), Australian and New Zealand Guidelines for Fresh and Marine Water Quality, October 2000 (ANZECC 2000).
[3] Primary and Secondary Contact Recreation - NWQMS, ANZECC and ARMCANZ, ANZECC 2000
[4] Australian Standard AS 2159-2009 – Piling – Design and Installation
[5] Arsenic criteria is based on Arsenic V species value
[6] Metal criteria for cadmium, chromium, copper, lead, nickel, and zinc have not been adjusted for $CaCO_3$ and should be adjusted subject to site specific groundwater hardness.
[7] Chromium (total) criteria is based on chromium III value.
[8] In absence of criteria for the preferred laboratory (SGS Australia) PQL has been used.
[9] Low reliability trigger value is adopted.
NV – No value is available in ASC NEPM 2013, Schedule B1, Guidelines on Investigation Levels for Soil and Groundwater.
NL – Not Limiting. The soil vapour limit exceeds the soil concentration at which the pore water phase cannot dissolve any more of the individual chemical.

Appendix E – Remedial Technology

REVIEW OF REMEDIATION OPTIONS & TECHNOLOGIES

A number of soil remediation options were reviewed to examine the suitability of each method, in considering the remedial options available for the site, the surrounding lands and the geological and hydrogeological limitations, the following issues have been considered:

- Prioritisation of works in areas of most concern;
- Ability of remedial method to treat contamination with respect to natural and infrastructure limitations;
- Remedial timetable;
- Cost effectiveness;
- Defensible method to ensure the site is remediated to appropriate levels / validation criteria; and
- Regulatory compliance.

The following sections provide details on various remediation options for the material found on site.

E1 FILL, SOILS & RESIDUAL CLAYS

E1.1. BIOVENTING

Bioventing stimulates the natural in situ biodegradation of aerobically degradable compounds in soil by increasing oxygen flow to existing soil microorganisms. In contrast to soil vapour vacuum extraction, bioventing uses low air flow rates to provide only enough oxygen to sustain microbial activity. Oxygen is most commonly supplied through direct air injection into residual contamination in soil. In addition to degradation of adsorbed fuel residuals, volatile compounds are biodegraded as vapours move slowly through biologically active soil. Bioventing techniques have been successfully used to remediate soils contaminated by petroleum hydrocarbons, non-chlorinated solvents, some pesticides, wood preservatives, and other organic chemicals.

Factors that may limit the applicability and effectiveness of the process include:

- A high water table within 1-2 m of the surface, saturated soil lenses, or low permeability soils all may reduce bioventing performance.
- Vapours can build up in basements or underneath buildings within the radius of influence of air injection wells. This problem can be alleviated by extracting air near the structure of concern.
- Extremely low soil moisture content may limit biodegradation and the effectiveness of bioventing.
- Monitoring of off-gases at the soil surface may be required.
- Aerobic biodegradation of many chlorinated compounds may not be effective unless there is a co-metabolite present, or an anaerobic cycle.

E1.2 ENHANCED BIOREMEDIATION

Enhanced bioremediation is a process in which indigenous or inoculated micro-organisms (e.g., fungi, bacteria, and other microbes) degrade organic contaminants found in soil and/or ground water, converting them to harmless end products. Nutrients, oxygen, or other additives are used to enhance bioremediation and contaminant desorption from subsurface materials. In the presence of sufficient oxygen (aerobic conditions), and other nutrient elements, microorganisms will ultimately convert many organic contaminants to carbon dioxide, water, and microbial cell mass. In the absence of oxygen (anaerobic conditions), the organic contaminants will be ultimately metabolized to methane, limited amounts of carbon dioxide, and trace amounts of hydrogen gas. Under sulfate-reduction conditions, sulfate is converted to sulfide or elemental sulfur, and under nitrate-reduction conditions, nitrogen gas is ultimately produced.

Factors that may limit the applicability and effectiveness bio remediation of the process include:

- Interaction between the soil matrix and microorganisms influence the results;
- Contaminants may be subject to leaching requiring treatment of the underlying ground water;
- Preferential flow paths may severely decrease contact between injected fluids and contaminants throughout the contaminated zones. The system should not be used for clay, highly layered, or heterogeneous subsurface environments because of oxygen (or other electron acceptor) transfer limitations.
- High concentrations of heavy metals, highly chlorinated organics, long chain hydrocarbons, or inorganic salts may be toxic to microorganisms;
- A surface treatment system, such as air stripping or carbon adsorption, may be required to treat extracted groundwater prior to re-injection or disposal; and
- The length of time required for treatment can range from 6 months to 5 years and is dependent on many site-specific factors.

E1.3 CAPPING AND CONTAINMENT

The “cap and contain” method employs a risk minimisation approach similar to “ongoing management”, where impacted soils are managed on site so as not to pose an ongoing risk to the environment or human health. Impacted soils are contained by the placement of an impervious barrier or clean fill materials on top of the impacted material to prevent exposure to site occupiers, workers or the environment. The base of this “clean zone” would be clearly marked by a demarcation barrier to indicate that below this depth workers could potentially be exposed to contamination, which would then trigger additional health, safety and environmental controls.

Capping and containment may be an appropriate remedial option for soil containing both organic and inorganic contaminants that contain residual contamination, particularly if the mix of contaminants is not easily treated. The conditions for this remedial action alternative are:

- The contaminant is relatively non-mobile, including low volatility, insoluble and has low migration potential in a soil matrix;
- The primary exposure route to the contaminant and risk to human health is through direct dermal contact, dust inhalation or soil ingestion;
- The primary exposure route for the environment is mitigated through low leaching potential or migration to groundwater; and
- The contained area can be monitored and incorporated into any final land-use plans.

In the use of capping and containment, the focus of the response is to prevent contact with, or exposure to the contaminated soils by human receptors and/or eliminate transport by water to off-site receptors.

E1.4 CHEMICAL OXIDATION/INJECTION

Chemical oxidation remedial strategies involve the addition of an oxidising agent to the soil or groundwater. The rate and extent of degradation of a target chemical of concern is dependent on its susceptibility to oxidative degradation as well as the site conditions, such as pH, temperature, the concentration of oxidant, and the concentration of secondary oxidant-consuming substances such as natural organic matter.

Factors which may limit the applicability and effectiveness of chemical oxidation include:

- Requirement for handling large quantities of hazardous oxidizing chemicals due to the oxidant demand of the target organic chemicals and the unproductive oxidant consumption of the formation;
- Some chemicals of concern are resistant to oxidation; and
- There is a potential for process-induced detrimental effects.

E1.5 EXCAVATION AND OFF-SITE DISPOSAL

Excavation and disposal of contaminated wastes is a frequently used option, typically used when a rapid site remediation program is required or where significant subsurface contamination exists that is potentially impacting on sensitive off-site receptors. Wastes must be classified in accordance with the NSW EPA Guidelines.

Based on the required disposal of the landfill material, this option would adequately address the remediation goals through the removal of the contaminants from the site. Furthermore, with the removal of any identified contaminated fill soils, the long-term liability associated with soil contamination shall be minimised, along with substantial improvement of subsurface site conditions with regard to contamination of soil and groundwater.

E1.6 LAND FARMING

Ex situ land-farming is a proven treatment for petroleum hydrocarbon impacted soils. In general the higher the molecular weight or number of rings in a compound, the slower the degradation rate.

Factors that may limit the applicability and effectiveness of the land farming include:

- The large amount of space required;
- Conditions affecting biological degradation of contaminants (e.g., temperature, rain fall) are largely uncontrolled, which increases the length of time to complete remediation.
- Only suitable for organic contaminants.
- Volatile contaminants, such as solvents, must be pre-treated because they would volatilise into the atmosphere, causing air pollution.
- Dust control is an important consideration, especially during tilling and other material handling operations.
- Runoff collection facilities must be constructed and monitored.

E2 GROUNDWATER

E2.1 ENHANCED BIOREMEDIATION

Bioremediation is a process in which indigenous micro-organisms (i.e., fungi, bacteria, and other microbes) degrade organic contaminants found in soil and/or ground water.

Enhanced bioremediation attempts to accelerate the natural biodegradation process by providing nutrients, electron acceptors, and competent degrading microorganisms that may otherwise be limiting the rapid conversion of contamination organics to innocuous end products.

Oxygen enhancement can be achieved by either sparging air below the water table or circulating hydrogen peroxide (H_2O_2) throughout the contaminated ground water zone. Under anaerobic conditions, nitrate is circulated throughout the ground water contamination zone to enhance bioremediation. Additionally, solid-phase peroxide products (e.g., oxygen releasing compound (ORC)) can also be used for oxygen enhancement and to increase the rate of biodegradation.

Air sparging below the water table increases ground water oxygen concentration and enhances the rate of biological degradation of organic contaminants by naturally occurring microbes. Air sparging also increases mixing in the saturated zone, which increases the contact between ground water and soil. Oxygen enhancement with air sparging is typically used in conjunction with SVE or bioventing to enhance removal of the volatile component under consideration.

During hydrogen peroxide enhancement, a dilute solution of hydrogen peroxide is circulated through the contaminated ground water zone to increase the oxygen content of ground water and enhance the rate of aerobic biodegradation of organic contaminants by naturally occurring microbes.

Solubilized nitrate is circulated throughout ground water contamination zones to provide an alternative electron acceptor for biological activity and enhance the rate of degradation of organic contaminants. Development of nitrate enhancement is still at the pilot scale. This technology enhances the anaerobic biodegradation through the addition of nitrate.

Bio-enhanced remediation strategies are slow and may take several years for plume clean-up.

E2.2 AIR SPARGING

In air sparging, air is injected into a contaminated aquifer where it traverses horizontally and vertically in channels through the soil column, creating an underground stripper that removes contaminants by volatilization. This injected air helps to flush (bubble) the contaminants up into the unsaturated zone where a vapour extraction system is used to remove the vapour phase contamination.

In principal the more volatile a contaminant the more appropriate air sparging as a remediation strategy is. Methane can be added to the system to enhance co-metabolism of chlorinated organics.

Factors that may limit the applicability and effectiveness of the process include:

- Preferential air flow pathways reducing the contact between sparged air and the contaminants;
- Air injection wells must be designed for site-specific conditions; and
- Soil heterogeneity may cause some zones to be relatively unaffected.

E2.3 CHEMICAL OXIDATION

In a chemical oxidation system oxidants are added to the system in order to oxidise the chemical of concern to less toxic species. The Chemical oxidants most commonly employed include peroxide, ozone, and permanganate. These oxidants cause the rapid and complete chemical destruction of

many toxic organic chemicals while some chemicals are subject to partially degradation and subsequently reduced by bioremediation.

In general oxidants are capable of achieving high treatment efficiencies (e.g., > 90 percent) for unsaturated aliphatic (e.g., trichloroethylene [TCE]) and aromatic compounds (e.g., benzene), with very fast reaction rates (90 percent destruction in minutes). Field applications have clearly affirmed that matching the oxidant and in situ delivery system to the contaminants of concern (COCs) and the site conditions is the key to successful implementation and achieving performance goals.

Oxidation using liquid hydrogen peroxide (H_2O_2) in the presence of native or supplemental ferrous iron (Fe^{+2}) produces Fenton's Reagent which yields free hydroxyl radicals (OH-). These strong, nonspecific oxidants can rapidly degrade a variety of organic compounds. Fenton's Reagent oxidation is most effective under very acidic pH (e.g., pH 2 to 4) and becomes ineffective under moderate to strongly alkaline conditions. The reactions are extremely rapid and follow second-order kinetics.

Ozone gas can oxidize contaminants directly or through the formation of hydroxyl radicals. Like peroxide, ozone reactions are most effective in systems with acidic pH. Due to ozone's high reactivity and instability, O_3 is usually produced onsite, and requires closely spaced delivery points (e.g., air sparging wells). In situ decomposition of the ozone can lead to beneficial oxygenation and bio-stimulation.

The following factors may limit the applicability and effectiveness of chemical oxidation include:

- Requirement for handling large quantities of hazardous oxidizing chemicals due to the oxidant demand of the target organic chemicals and the unproductive oxidant consumption of the formation.
- Some COCs are resistant to oxidation.
- There is a potential for process-induced detrimental effects. Further research and development is ongoing to advance the science and engineering of in situ chemical oxidation and to increase its overall cost effectiveness.

E2.4 REACTIVE BARRIER WALL

Construction of a permeable reactive barrier (PRB) involves the subsurface emplacement of reactive materials through which a dissolved contaminant plume enters on one side of the PRB and treated water exits the other side. This in situ method for remediating dissolved-phase contaminants in groundwater combines a passive chemical or biological treatment zone with subsurface fluid flow management.

PRBs can be installed as permanent or semi-permanent units. The most commonly used PRB configuration is that of a continuous trench in which the treatment material is backfilled. The trench is perpendicular to and intersects the groundwater plume.

Alternately low-permeability walls can be used to direct a groundwater plume toward a permeable treatment zone.

E2.5 PUMP AND TREAT

As its name implies a pump and treat remedial involves the pumping of contaminated of ground water pumping include removal of dissolved contaminants from the subsurface, and containment and treatment the water. The treated groundwater is then either re-introduced into the aquifer or disposed off-site.

The criteria for well design, pumping system, and treatment are dependent on the physical site characteristics and contaminant type. While treatment options may include a train of processes such as gravity segregation, air strippers, and activated carbon filters designed to remove specific contaminants.

The first step in determining whether ground water pumping is an appropriate remedial technology is to conduct a site characterization investigation. Site characteristics, such as hydraulic conductivity, will determine the range of remedial options possible. Chemical properties of the site and plume need to be determined to characterize transport of the contaminant and evaluate the feasibility of ground water pumping. To determine if ground water pumping is appropriate for a site, one needs to know the history of the contamination event, the properties of the subsurface, and the biological and chemical contaminant characteristics. Identifying the chemical and physical site characteristics, locating the ground water contaminant plume in three dimensions, and determining aquifer and soil properties are necessary in designing an effective ground water pumping strategy.

The following factors may limit the applicability and effectiveness of ground water pump and treat options as a remedial option:

- The time frame required to achieve the remediation goal;
- The pumping system fail to contain the contaminant plume as predicted;
- Residual saturation of the contaminant in the soil pores cannot be removed by ground water pumping.
- A pump and treat option is not suitable for contaminants with:
  - high residual saturation;
  - high sorption capabilities; and
  - homogeneous aquifers with hydraulic conductivity less than 10^{-5} cm/sec.
- Potential high operating costs;
- Biofouling of the extraction wells and associated treatment stream may severely affect system performance;
- Subsurface heterogeneities, may severely affect system performance;
- Potential toxic effects of residual surfactants in the subsurface;
- Drawdown pumping generally produces large volumes of water requiring storage and or treatment

E2.6 EXCAVATION

Excavation and disposal of contaminated wastes is a frequently used option, typically used when a rapid site remediation program is required or where significant subsurface contamination exists that is potentially impacting on sensitive off-site receptors. Excavation can also be used to remove primary sources of any groundwater contamination (such as buried tanks or drums and waste disposal areas) and remove the secondary sources of impact (contaminated fill, residual soils and impacted bedrock and bedrock fractures such as joints and bedding planes).

E3 REMEDIATION OPTIONS

The various remediation options were reviewed in a technology matrix to assess their suitability against the various subsurface materials at the site and whether the option meets the primary objectives of the remediation works program, as discussed in **Section 7.3**.