Douglas Partners

Geotechnics / Environment / Groundwater

Report on Geotechnical Investigation

Proposed LEES1 Carslaw Extension Eastern Avenue, The University of Sydney

Prepared for
The University of Sydney

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Integrated Practical Solutions

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Proposed LEES1 Carslaw Extension
Eastern Avenue, The University of Sydney

1. Introduction

This report presents the results of a geotechnical investigation undertaken for the proposed LEES1 Carslaw extension at The University of Sydney. The work was commissioned by The University of Sydney.

The project involves the construction of a seven storey building extension with one basement level on the southern side of the existing Carslaw Building.

Geotechnical investigation was undertaken to provide information on the subsurface conditions on the site and included the drilling of boreholes, laboratory testing and engineering analysis. Details of the field work and comments relevant to design and construction are given in this report.

In addition, some samples were taken from the bores to provide a preliminary contamination assessment and waste classification for disposal purposes.

The fieldwork for the LEES1 Carslaw extension was carried out in conjunction with the fieldwork for the F23 Administration Building, which is reported separately.

2. Site Description and Geology

The site of the proposed extension is approximately triangular and is located on the southern side of the Carslaw Building on Eastern Avenue, The University of Sydney. The site is currently occupied by an access laneway excavated into a slope adjacent to Carslaw Building, a landscaped area containing gardens, lawn and a footpath and a pedestrian bridge. The laneway is relatively level and the garden rises gently to the west with a difference in levels of nearly 3 m over about 70 m. A retaining wall separated the laneway from the landscaped area above.

Reference to the *Sydney 1:100 000 Geological Series Sheet* indicates that the site is underlain by Ashfield Shale of the Wianamatta Group which typically comprises black to dark grey shale and laminate.

The investigation confirmed the presence of Ashfield Shale.

3. Field Work Methods

The field work for the geotechnical investigation included the drilling of five boreholes (Bores 5 to 9) at the locations are shown on Drawing No. 1A in Appendix B. The bores were located in the landscaped area at positions nominated in project brief.

The bores were drilled to depths of approximately 8 m using a bobcat mounted drilling rig (a relatively low height rig) due to the site access having restricted height under the pedestrian bridge.

The boreholes were commenced using solid flight augers then rotary wash-boring equipment inside top casing to about 4 m depth. Standard penetration tests (SPT) were undertaken within the overburden at regular depth intervals. Disturbed samples were taken in the overburden soils for identification and laboratory testing. The bores were advanced to approximately 8 m depth using NMLC-sized diamond core drilling equipment to obtain 50 mm diameter continuous samples of the rock for identification and strength testing purposes.

The ground surface levels were obtained by survey levelling using spot levels on the plan (The University of Sydney – City Road, Underground Utility Location, Drawing No VG1036-2D, dated 11/2/15) provided by the University.

4. Field Work Results

The subsurface conditions encountered in the boreholes are presented on the borehole logs in Appendix C. Notes defining descriptive terms and classification methods are included in Appendix C.

The subsurface conditions encountered in the boreholes can be summarised as:

- FILLING – silty clay with some gravel to depths of between 0.4 and 1.3 m. Bores 7 and 9 also had a foothpath over the top of the filling;
- SILTY CLAY / SHALY CLAY – generally stiff silty to very stiff clay to depths of between 2.0 m and 4.0 m;
- ROCK – initially extremely low and very low strength laminate or shale. The rock strength increased with depth with medium or high strength rock encountered at depths of between 4.1 m and 7.0 m.

Free groundwater was not observed in any of the bores while augering. The use of drilling fluid prevented groundwater observations during rotary wash-boring and coring.

5. Laboratory Testing

Twenty samples selected from the better quality rock core were tested for axial point load strength index (Is_{50}). The results ranged from 0.2 MPa to 3.3 MPa which correspond to low to very high strength. These Is_{50} results suggest an unconfined compressive strength (UCS) up to about 60 MPa for the rock encountered during the investigation.

6. Proposed Development

The project involves the construction of an extension on the southern side of the Carslaw Building. Concept design indicate a seven storey building with one basement level at RL 30.71, which is some 1.5 m below Carslaw Building level 1.

The geotechnical issues considered relevant to the proposed development include excavation, excavation support and foundations. Excavation for the basement will be up to about 4.5 m depth.

7. Comments

7.1 Excavation

Excavation for the one basement level is expected to be in filling, clay and rock. Excavation in filling, silty clay and extremely low to very low strength rock, which is expected to comprise most of the excavated material, should be readily achievable using conventional earthmoving equipment such as an excavator with bucket attachments.

The level of the existing laneway is at about 0.5 m above bulk excavation level and therefore excavation will involve removal of the pavement as well as the retaining wall.

Excavation in low strength and stronger rock will probably require the use of ripping equipment or rock hammers. Based on the bores, the stronger rock may be encountered in the western end of the excavation below about RL 31 m. The use of rock hammers will cause vibration which, if not controlled, could possibly result in damage to nearby structures or utilities and may cause disturbance to occupants. It is suggested that vibrations be provisionally limited to a peak particle velocity (PPV) of 8 mm/s at the foundation level of the Carslaw Building to protect the architectural features of the building and to reduce discomfort for the occupants. The owners of any in-ground utilities on and around the property should also be consulted in regards to vibration levels. A site specific vibration monitoring trial may be required to determine vibration attenuation once excavation plant and methods have been finalised.

Rock hammers may also be required for the removal of the laneway and retaining wall for which vibration limits would also apply.

7.2 Excavation Support

7.2.1 General

Before excavating, the founding levels of any adjacent structures within the zone of influence of the proposed basement, such as the Carslaw Building footings and possibly the pedestrian bridge, should be established and appropriate measures taken. If the Carslaw Building, whose lowest floor level is 1.5 m higher than the proposed basement level, is founded on shallow footings, some underpinning or suitable lateral support may be required.

Vertical excavations in filling, soil and weathered rock cannot be guaranteed to remain vertical. Temporary batters of 1(H):1(V) could be used to support the sides of the excavation where there is adequate space such as on the southern and eastern sides.

Where the excavation is deep or there is inadequate space for batters, soldier piles with reinforced shotcrete infill panels are commonly used to support excavations in clay and weathered rock. The soldier piles would generally be spaced at about 2 m to 2.5 m centres and should be founded at least two pile diameters below the lowest excavation level (both bulk and detailed) adjacent to the shoring wall piles. Shotcreting will be needed over the full excavation depth and should be undertaken in maximum 1.5 m or 2.0 m 'drops' as excavation proceeds in order to reduce the risk of local slippages and collapse between soldier piles. Temporary ground anchors will probably be required to prevent excessive lateral deformation of shoring/retaining walls. For the permanent situation, the basement structure usually provides the required lateral support to the perimeter excavation once the temporary anchors are de-stressed.

Particular care will be required in the design of excavation support adjacent to the Carslaw Building, to cater for any surcharge loads from the building acting on any new shoring walls.

7.2.2 Design

Excavation faces retained either temporarily or permanently will be subjected to earth pressures from the ground surface down to the top of medium strength rock, which for the current site is likely to represent the full depth of excavation. Table 1 outlines material and strength parameters that may be used for the design of excavation support structures.

Table 1: Typical Material and Strength Parameters for Excavation Support Structures

Material	Bulk Density (kN/m^3)	Coefficient of Active Earth Pressure (K_a)	Coefficient of Earth Pressure at Rest (K_o)	Ultimate Passive Earth Pressure (kPa)
Filling	18	0.4	0.6	-
Silty clay	20	0.3	0.45	-
Extremely low to low strength rock	22	0.2	0.3	400

It is likely that shoring of a one basement level excavation will only require one row of 'tie-back' ground anchors.

Lateral pressures due to surcharge loads from the existing structures such as the adjacent pedestrian bridge and construction machinery should be included where relevant. Hydrostatic pressure acting on the shoring walls should also be included in the design where adequate drainage is not provided behind the full height of the wall.

The ultimate passive pressures given in Table 1 should incorporate a suitable factor of safety to limit wall (and ground) deflections.

Rock sockets below the bulk excavation level for the purpose of passive restraint should have a minimum length of two pile diameters below the lowest level of any nearby excavation (including any detailed excavations).

Regular inspections will be required during excavation to determine whether any adverse conditions are present and will require additional support for the permanent condition.

7.2.3 Ground Anchors

Where necessary, the use of declined ‘tie-back’ (ground) anchors is suggested for the temporary lateral restraint of the perimeter pile walls. Such ground anchors should be declined below the horizontal to allow anchorage into the stronger bedrock materials at depth. The design of temporary ground anchors for the support of pile wall systems may be carried out using the typical ultimate bond stresses with an appropriate factor of safety at the grout-rock interface given in Table 2.

Table 2: Typical Ultimate Bond Stresses for Anchor Design

Material Description	Ultimate Bond Stress (kPa)
Extremely Low to Low Strength Rock	100
Medium Strength Rock	500

Ground anchors should be designed to have a free length equal to their height above the base of the excavation and have a minimum 3 m bond length. After installation they should be proof loaded to 125% of the Design Working Load and locked-off at no higher than 80% of the Working load. Periodic checks should be carried out during the construction phase to ensure that the Lock-Off Load is maintained and not lost due to creep effects or other causes.

The parameters given in Table 2 assume that the anchor holes are clean and adequately flushed, with grouting and other installation procedures carried out carefully and in accordance with good anchoring practice. Careful installation and close supervision by a geotechnical specialist may allow increased bond stresses to be adopted during construction, subject to testing.

In normal circumstances the building will restrain the basement excavation over the long term and therefore ground anchors are expected to be temporary only. The use of permanent anchors would require careful attention to corrosion protection. Further advice on design and specification should be sought if permanent anchors are to be employed at this site.

Care should be taken to avoid damaging buried services, pipes and subsurface structures during anchor installation.

7.3 Groundwater

Groundwater was not observed in any of the bores whilst augering. Based on this, groundwater level, water is not expected to be a significant issue for a single basement level construction.

Nevertheless, it is anticipated that the groundwater ingress into the excavation will occur as seepage through and along strata boundaries on the site especially after wet weather. Based on experience, it is anticipated that any seepage through the clayey soils and rock can probably be controlled using a sub-floor drainage and collection system in the lower basement level. Seepage through shales sometimes results in iron precipitates which have the potential to block drainage material and additional maintenance precautions (e.g. wash-out points and 'rodding points', etc.) should be taken to avoid blocking of the drains over the medium to longer term.

7.4 Foundations

The proposed bulk excavation works are expected to expose mainly extremely or very low strength rock with hard shaly clay at bulk level over the eastern end of the building footprint. For the anticipated column loads of 7 500 kN, shallow spread footings (i.e. pad or strip footings) founded extremely or very low strength rock with bearing pressures of between 700 kPa and 1000 kPa would result in very large sizes and may be impractical.

Therefore, piles are considered suitable as foundations for the likely column loads indicated. Bored piers would be expected to be a suitable pile type, however, some allowance should be made for the possibility of water seepage and some collapse into the pier holes during construction if water is encountered. Bored piles should be taken to rock and could be proportioned on the basis of the typical design parameters provided in Table 3.

Table 3: Typical Design Parameters for Bored Piles

Material Description	Ultimate Pressures (kPa)		Serviceability Pressures (kPa)	
	End-Bearing	Shaft(1)	End-Bearing	Shaft(1)
Medium Strength Rock	30 000	600	3 500	300
High Strength Rock	80 000	1 000	6 000	500

Note: (1) Provided adequate socket roughness is achieved

An appropriate geotechnical strength reduction factor should be applied to the Ultimate strengths (i.e. capacities) values for limit state design. The selection of the geotechnical reduction factor (Φ_g) is based on a series of individual risk ratings (IRR) which are weighted and lead to an average risk rating (ARR). The individual ratings and final value of Φ_g depend on the following factors:

- Site: the type, quantity and quality of testing
- Design: design methods and parameter selections;
- Installation: construction control and monitoring;
- Pile Testing Regime: testing benefit factor based on percentage of piles tested and the type of tests; and
- Redundancy: whether other piles can take up the load if a given pile settles or fails.

The actual value of Φ_g will have to be determined by the designer of the piles, however, it is expected to possibly be in the range of 0.4 to 0.55.

If the serviceability design pressures (i.e. basic 'working stress' design method) are adopted for design purposes, settlements would be limited to less than 1% of the pile diameter.

The levels of the different rock strength layers encountered in the bores are provided in Table 3.

Table 4: Levels of Depth of Typical Design Parameters for Bored Piles

Rock Strength	Level of Varying Rock Strengths (RL m)				
	Bore 5	Bore 6	Bore 7	Bore 8	Bore 9
Medium Strength Rock	27.5	27.5	28.3	27.4	28.3
High Strength Rock	27.5	26.0	26.3	25.3	28.3

All bored piles should be inspected by an experienced geotechnical professional during construction to check the adequacy of the foundation material and to check the socket cleanliness and roughness.

7.5 Seismic Design

In accordance with the Earthquake Loading Standard, AS1170.4 - 2007 the site is assessed to have a hazard factor (z) of 0.08 and a subsoil class of "Be".

8. Preliminary Contamination Assessment

The preliminary site (contamination) investigation (PSI) was conducted and reported with reference to the National Environment Protection Council (NEPC) National Environment Protection (Assessment of Site Contamination) Measure 1999 (amended 2013) [NEPC, 2013] and included a review of available site history (from previous reports), a site walkover, and soil analysis from samples collected during the geotechnical investigation.

For the purpose of the PSI the site is defined as the extents of the proposed building extension.

A preliminary waste classification was also conducted and reported as part of the assessment.

8.1 Site History

DP has previously prepared a PSI for the Sydney University Site that included the current investigation area, report *Preliminary Site Investigation, Proposed Campus Improvement Program, Camperdown and Darlington Campus, University of Sydney,* Prepared for University of Sydney – Campus Infrastructure and Services, Project 73716.00 dated November 2013 (DP 2013).

Overall, based on the historical review, it was apparent that the Camperdown Campus has been used as a university since prior to the 1930s (land titles indicate since 1912), whilst the Darlington Campus comprised a large number of residential and commercial (retail) properties at least until the 1970s, from which gradual acquisition by the University appears to have taken place, culminating in the consolidation of individual lots in 1991. Site history also indicates that a large part of the Camperdown campus was previously used for farming.

Based on the site history and an inspection of then current operations, the areas of environmental concern identified were as follows:

- The University of Sydney holds chemical licenses for the storage and use of a variety of chemical, for experimental purposes. The Workcover records did not indicate that any of these chemical stores are present in the current investigation area and therefore there is a low potential for chemicals that the Site is impacted by these chemicals;
- The extent of fill across the site used for formation processes and levelling appears to be extensive. Previous investigation has identified the presence of fill across much of the site, to depths of up to 9m bgl. The fill has been found to be variable in depth and composition (including some areas containing asbestos, slag and ash);
- There is a potential for asbestos to be present in near surface soils as a result of the demolition of former structures;
- The hazardous materials registers have identified hazardous building materials (including asbestos and lead based paint) in many of the older buildings within the university grounds;
- A significant portion of the campus was previously used for farming. It is therefore possible that residual contamination from the use of pesticides and fertilisers could remain on the site; and
- The site was acquired by the University of Sydney in 1912 and has been operated as a university grounds since that time.

Based on the outcomes of this PSI, the identified contamination risks were not considered to pose a restriction on the future developments proposed by the University, subject to implementing the following recommendations:

- The storage and disposal practices for all dangerous goods within the site should be reviewed for compliance with current Dangerous Goods codes and standards. If found non-compliant, measures should be implemented to work towards compliance;
- All recommendations provided in the hazardous building materials registers existing for the University should be implemented as current management measures and/or during demolition, as appropriate. The removal of any hazardous building materials from the site must be conducted in accordance with the appropriate WorkCover codes and standards;
- A detailed site inspection (DSI) should be carried out prior to any future redevelopment works to investigate the areas of environmental concern identified in the report; and
- Any soil to be removed off site must be assessed against the NSW DECCW *Waste Classification Guidelines* (2008, now 2014) prior to disposal in order to inform disposal options.

8.2 Site Assessment Criteria

The proposed development will include the extension on the southern side of the Carslaw Building including a seven storey building with one basement level which will be used for teaching services.

Analytical results were assessed (as a Tier 1 assessment) against the site assessment criteria (SAC) comprising the investigation and screening levels of Schedule B1, National Environment Protection Council, *National Environment Protection Measure* 1999, as amended 2013 (NEPC, 2013). The NEPM guidelines are endorsed by the NSW EPA under the CLM Act 1997.

The investigation and screening levels applied in the current investigation comprise levels adopted for a commercial/industrial land use scenario which provides the most appropriate exposure risk for a university environment where the greatest exposure risk will be staff at the university.

Petroleum based Health Screening Levels (HSLs) for direct contact at commercial and industrial site have been adopted from the Cooperative Research Centre for Contamination Assessment and Remediation of the Environment (CRC CARE) *Technical Report no.10 Health screening levels for petroleum hydrocarbons in soil and groundwater* (2011) as referenced in NEPC (2013) in the absence of equivalent guidelines in NEPC (2013). HSLs for maintenance workers have not been considered as the HSLs for commercial and industrial landuse are considered to be protective of maintenance workers.

Management Limits to avoid or minimise the potential hazardous effects of petroleum hydrocarbons have been adopted in NEPC (2013) as interim Tier 1 guidance. The adopted Management Limits will apply to any depth in the soil profile. The management limits for commercial and industrial sites and coarse soil texture have been adopted.

A detailed asbestos assessment as outlined in NEPC (2013) was not undertaken. As such, asbestos was screened from jar samples taken for general analysis of contaminants. Therefore the presence or absence of asbestos at a limit of reporting of 0.1 g/kg has been adopted for this assessment as an initial screen.

Based on the preliminary nature of the investigation and the proposed basement excavation within the "site" as assessment of the analytical data against ecological investigation and screening levels is not considered relevant and has not been considered further in this investigation.

The adopted SAC are listed on Table 6, Appendix D.

8.3 Waste Classification

The waste classification was generally conducted in accordance with NSW EPA *Waste Classification Guidelines* 2014*.* Waste classification of the material was conducted with reference to the six step process as set out in the NSW EPA guideline and summarised in **Table 5** below.

Table 5: Six Step Classification

Step	Classification	Rationale
1. Is it special waste?	No	Asbestos was not observed during field investigations
2. Is it liquid waste?	No	Waste composed of soil matrix (i.e. no liquids)

Step	Classification	Rationale
3. Is the waste "pre-classified"?	No	not pre-classified
4. Does the waste have hazardous waste characteristics?	No	Waste not observed to/ or considered at risk to contain explosives, gases, flammable solids, oxidising agents, organic peroxides, toxic substances or corrosive substances.
5. Chemical Assessment	Undertaken	
6. Is the was putrescible?	No	All observed components of material composed of materials pre-classified as non-putrescible (i.e. soils). Organic content is assessed to be minor.

8.4 Laboratory Results

Selected soil samples were analysed for the for a range of potential contaminants including heavy metals (HM), polycyclic aromatic hydrocarbons (PAH), total recoverable hydrocarbons (TRH), monocyclic aromatic hydrocarbons (BTEXN – benzene, toluene, naphthalene, ethyl benzene, and xylenes), organochlorine pesticides (OCP), organophosphate pesticides (OPP), polychlorinated biphynels (PCB) total phenolics and asbestos (refer to the chain of custody information, Appendix D).

Based on the initial results additional analysis was conducted for toxicity characteristic leaching procedure (TCLP) on lead and PAH. The results of the laboratory analysis are presented in Table 5, Appendix D, and discussed in the following section.

8.5 Discussion of Contamination Results

The analyte concentrations in the soil samples analysed were generally within the adopted SAC with the following exceptions:

- Carcinogenic PAH - Benzo(a)pyrene TeQ in sample BH6/0.5: 400 mg/kg which exceeded the HIL of 40 mg/kg; and
- TRH C16-C34 in sample BH6/0.5: 13,000 mg/kg which exceeded the management limit of 3500 mg/kg.

No asbestos was detected in the soil samples and no significant building rubble was observed in the test bores. It is noted however that there are limitations to the test bore method with regards to detecting asbestos and therefore it is possible that asbestos may be present in the fill material.

The above concentrations of carcinogenic PAH and TRH were at hotspot concentrations relative to the investigation and management levels (i.e. 2.5 times the level).

It is likely that the elevated PAH and TRH concentrations detected in BH6 are associated with the pavement material composition, and/or the presence of asphalt. It is recommended that additional investigation be conducted in the vicinity of the test bore to define the extent and possible source of contamination and to determine if a remediation action plan (RAP) is warranted. If significant contamination is identified then groundwater assessment may also be warranted.

It is considered that the site can be made suitable for the proposed development subject to the remediation (excavation and disposal) of the TRH and PAH hotspot detected at BH6. It is noted that the proposed development includes a basement excavation that would be expected to extend below the impacted fill detected in BH6. In this regard it is likely that the impacted soil will be removed as a result of the site redevelopment works, thereby rendering the site suitable.

8.6 Waste Classification

The concentrations of the contaminants analysed were generally within the General Solid Waste Guideline without TCLP (NSW EPA 2014) with the exception of the following:

- Benzo(a)pyrene in samples BH6/0.5 (290 mg/kg), BH8/0.5 (9 mg/kg) and BH9/1.0 (3.1 mg/kg);
- TRH (C10-C36) in sample BH6/0.5 (146110 mg/kg); and
- Lead in samples BH6/0.5 (110 mg/kg), BH8/0.5 (150 mg/kg) and BH9/1.0 (270 mg/kg).

Therefore TCLP analysis was conducted for PAH and lead on the above listed samples. Based on leachable concentrations and specific contaminant concentrations, the fill is preliminarily classified as General Solid Waste (non-putrescible) with the exception of BH6/ 0.5. Fill at BH6/ 0.5 is preliminarily classified as Hazardous Waste based on total PAH and benzo(a)pyrene concentrations which exceeded Restricted Solid Waste thresholds. It is possible that the recorded PAH concentrations are a result of asphalt debris within the filling, however, this was not recorded on field logs. The additional investigation recommended for this location in Section 8.5 should also aim to confirm the waste classification on the basis of a larger data set.

8.7 Recommendations

Based on the results of the PSI, the following recommendations are made:

- Additional investigation is recommended in the vicinity of BH6 to confirm the waste classification, delineate the extent of the PAH and TRH hotspot and determine if an RAP is warranted. It is recommended that test pits, rather than test bores be adopted for the additional investigation;
- Following the delineation of the TRH and PAH hotspot at BH6 the impacted soils should be excavated, disposed and validated following removal;
- Given the limited number of samples analysed, further *in situ* or *ex situ* testing should be carried out to confirm the preliminary waste classification assigned herein;
- Once the waste classification is confirmed, the fill should be excavated and appropriately disposed off site under the assigned waste classification;
- An unexpected finds protocol should be prepared for bulk excavation and construction works to manage unexpected contamination finds; and

- Following the excavation of fill soils for the basement levels the underlying natural soil should be inspected and validated to determine if the underlying natural soil can be classified as virgin excavated natural material (VENM).

9. Limitations

Douglas Partners Pty Ltd (DP) has prepared this report for the LEES1 Carslaw Extension at The University of Sydney in accordance with DP's proposal dated 18 May 2015. The report is provided for the use of The University of Sydney for these projects only and for the purpose(s) described in the report. It should not be used for other projects or by a third party.

The results provided in the report are indicative of the sub-surface conditions only at the specific sampling or testing locations, and then only to the depths investigated and at the time the work was carried out. Subsurface conditions can change abruptly due to variable geological processes and also as a result of anthropogenic influences. Such changes may occur after DP's field testing has been completed.

DP's advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by DP in this report may be limited by undetected variations in ground conditions between sampling locations. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

This report must be read in conjunction with all of the attached notes and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion given in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

The contents of this report do not constitute formal design components such as are required, by the Health and Safety Legislation and Regulations, to be included in a Safety Report specifying the hazards likely to be encountered during construction and the controls required to mitigate risk. This design process requires a risk assessment to be undertaken, with such assessment being dependent upon factors relating to likelihood of occurrence and consequences of damage to property and to life. This, in turn, requires project data and analysis presently beyond the knowledge and project role respectively of DP. DP may be able, however, to assist the client in carrying out a risk assessment of potential hazards contained in the Comments section of this report, as an extension to the current scope of works, if so requested, and provided that suitable additional information is made available to DP. Any such risk assessment would, however, be necessarily restricted to the geotechnical components set out in this report and to their application by the project designers to project design, construction, maintenance and demolition.

Douglas Partners Pty Ltd

Appendix A

About this Report

Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

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This report is the property of Douglas Partners Pty Ltd. The report may only be used for the purpose for which it was commissioned and in accordance with the Conditions of Engagement for the commission supplied at the time of proposal. Unauthorised use of this report in any form whatsoever is prohibited.

Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to justify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

Where groundwater levels are measured in boreholes there are several potential problems, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;
- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

About this Report

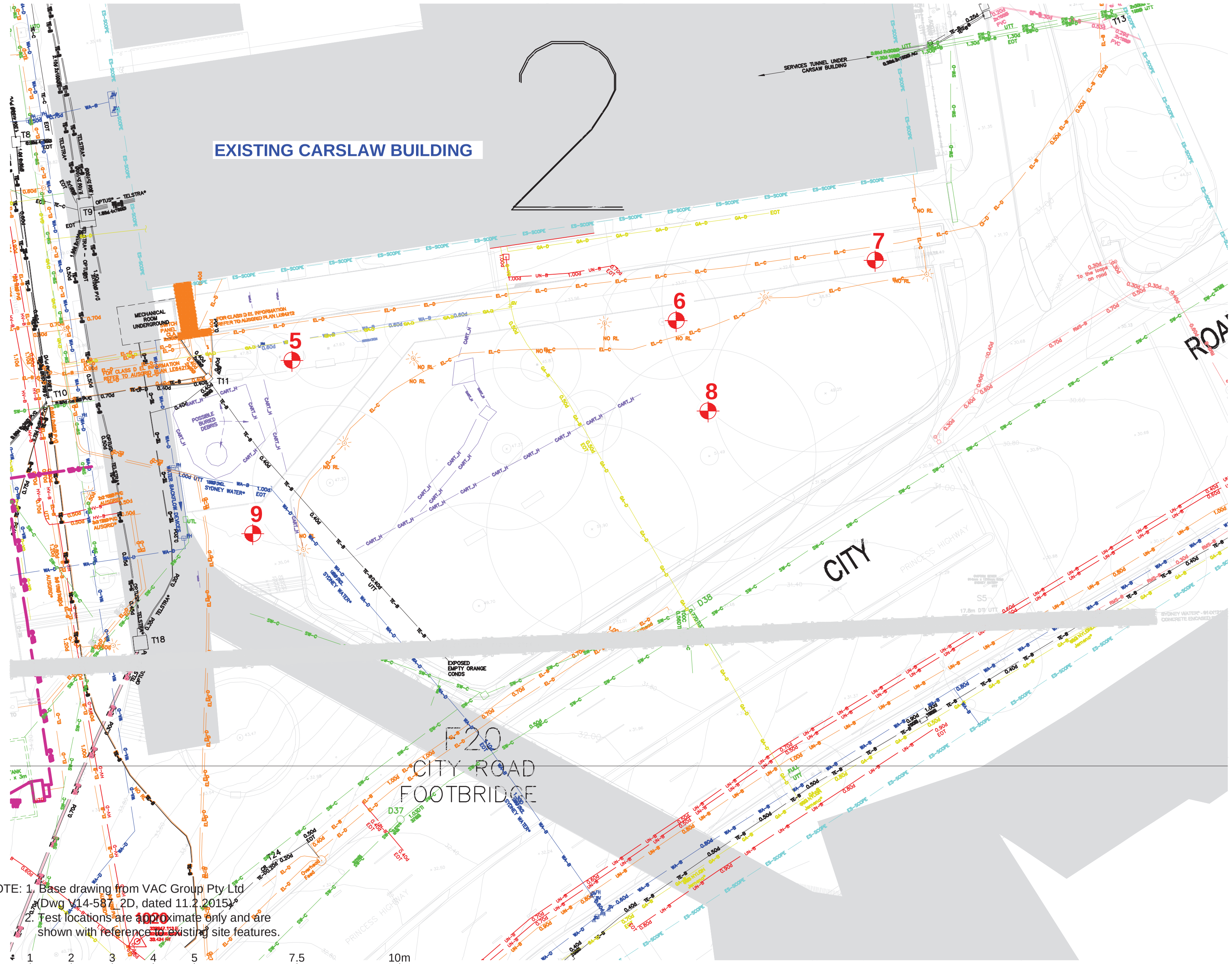
Site Anomalies
In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

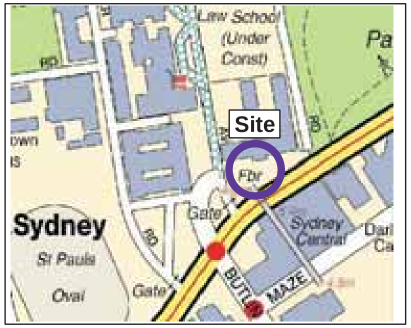
Information for Contractual Purposes
Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection
The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

Appendix B

Drawing No. 1A – Location of Tests





Locality Plan

LEGEND
Borehole location

NOTE: 1. Base drawing from VAC Group Pty Ltd (Dwg V14-587_2D, dated 11.2.2015).
2. Test locations are approximate only and are shown with reference to existing site features.

0 1 2 3 4 5 7.5 10m
1:100 @ A3

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CLIENT: The University of Sydney		TITLE: **Location of Tests**	PROJECT No: 84897
OFFICE: Sydney	DRAWN BY: PSCH	**Proposed LEES1 Carslaw Extension**	DRAWING No: 1A
SCALE: 1:100 @ A3	DATE: 8.7.2015	**Eastern Avenue, THE UNIVERSITY OF SYDNEY**	REVISION: 0

Appendix C

Results of Field Work

Sampling

Sampling is carried out during drilling or test pitting to allow engineering examination (and laboratory testing where required) of the soil or rock.

Disturbed samples taken during drilling provide information on colour, type, inclusions and, depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples are taken by pushing a thin-walled sample tube into the soil and withdrawing it to obtain a sample of the soil in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Test Pits

Test pits are usually excavated with a backhoe or an excavator, allowing close examination of the in-situ soil if it is safe to enter into the pit. The depth of excavation is limited to about 3 m for a backhoe and up to 6 m for a large excavator. A potential disadvantage of this investigation method is the larger area of disturbance to the site.

Large Diameter Augers

Boreholes can be drilled using a rotating plate or short spiral auger, generally 300 mm or larger in diameter commonly mounted on a standard piling rig. The cuttings are returned to the surface at intervals (generally not more than 0.5 m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube samples.

Continuous Spiral Flight Augers

The borehole is advanced using 90-115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in clays and sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are disturbed and may be mixed with soils from the sides of the hole. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively low reliability, due to the remoulding, possible mixing or softening of samples by groundwater.

Non-core Rotary Drilling

The borehole is advanced using a rotary bit, with water or drilling mud being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from the rate of penetration. Where drilling mud is used this can mask the cuttings and reliable identification is only possible from separate sampling such as SPTs.

Continuous Core Drilling

A continuous core sample can be obtained using a diamond tipped core barrel, usually with a 50 mm internal diameter. Provided full core recovery is achieved (which is not always possible in weak rocks and granular soils), this technique provides a very reliable method of investigation.

Standard Penetration Tests

Standard penetration tests (SPT) are used as a means of estimating the density or strength of soils and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, Methods of Testing Soils for Engineering Purposes - Test 6.3.1.

The test is carried out in a borehole by driving a 50 mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm increments and the 'N' value is taken as the number of blows for the last 300 mm. In dense sands, very hard clays or weak rock, the full 450 mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form.

- In the case where full penetration is obtained with successive blow counts for each 150 mm of, say, 4, 6 and 7 as:

  4,6,7
  N=13

- In the case where the test is discontinued before the full penetration depth, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm as:

  15, 30/40 mm

The results of the SPT tests can be related empirically to the engineering properties of the soils.

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

Dynamic penetrometer tests (DCP or PSP) are carried out by driving a steel rod into the ground using a standard weight of hammer falling a specified distance. As the rod penetrates the soil the number of blows required to penetrate each successive 150 mm depth are recorded. Normally there is a depth limitation of 1.2 m, but this may be extended in certain conditions by the use of extension rods. Two types of penetrometer are commonly used.

- Perth sand penetrometer - a 16 mm diameter flat ended rod is driven using a 9 kg hammer dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands and is mainly used in granular soils and filling.
- Cone penetrometer - a 16 mm diameter rod with a 20 mm diameter cone end is driven using a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). This test was developed initially for pavement subgrade investigations, and correlations of the test results with California Bearing Ratio have been published by various road authorities.

Soil Descriptions

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Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are based on Australian Standard AS 1726, Geotechnical Site Investigations Code. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

Soil Types

Soil types are described according to the predominant particle size, qualified by the grading of other particles present:

Type	Particle size (mm)
Boulder	>200
Cobble	63 - 200
Gravel	2.36 - 63
Sand	0.075 - 2.36
Silt	0.002 - 0.075
Clay	<0.002

The sand and gravel sizes can be further subdivided as follows:

Type	Particle size (mm)
Coarse gravel	20 - 63
Medium gravel	6 - 20
Fine gravel	2.36 - 6
Coarse sand	0.6 - 2.36
Medium sand	0.2 - 0.6
Fine sand	0.075 - 0.2

The proportions of secondary constituents of soils are described as:

Term	Proportion	Example
And	Specify	Clay (60%) and Sand (40%)
Adjective	20 - 35%	Sandy Clay
Slightly	12 - 20%	Slightly Sandy Clay
With some	5 - 12%	Clay with some sand
With a trace of	0 - 5%	Clay with a trace of sand

Definitions of grading terms used are:

- Well graded - a good representation of all particle sizes
- Poorly graded - an excess or deficiency of particular sizes within the specified range
- Uniformly graded - an excess of a particular particle size
- Gap graded - a deficiency of a particular particle size with the range

Cohesive Soils

Cohesive soils, such as clays, are classified on the basis of undrained shear strength. The strength may be measured by laboratory testing, or estimated by field tests or engineering examination. The strength terms are defined as follows:

Description	Abbreviation	Undrained shear strength (kPa)
Very soft	vs	<12
Soft	s	12 - 25
Firm	f	25 - 50
Stiff	st	50 - 100
Very stiff	vst	100 - 200
Hard	h	>200

Cohesionless Soils

Cohesionless soils, such as clean sands, are classified on the basis of relative density, generally from the results of standard penetration tests (SPT), cone penetration tests (CPT) or dynamic penetrometers (PSP). The relative density terms are given below:

Relative Density	Abbreviation	SPT N value	CPT qc value (MPa)
Very loose	vl	<4	<2
Loose	l	4 - 10	2 -5
Medium dense	md	10 - 30	5 - 15
Dense	d	30 - 50	15 - 25
Very dense	vd	>50	>25

Soil Descriptions

Soil Origin

It is often difficult to accurately determine the origin of a soil. Soils can generally be classified as:

- Residual soil - derived from in-situ weathering of the underlying rock;
- Transported soils - formed somewhere else and transported by nature to the site; or
- Filling - moved by man.

Transported soils may be further subdivided into:

- Alluvium - river deposits
- Lacustrine - lake deposits
- Aeolian - wind deposits
- Littoral - beach deposits
- Estuarine - tidal river deposits
- Talus - scree or coarse colluvium
- Slopewash or Colluvium - transported downslope by gravity assisted by water. Often includes angular rock fragments and boulders.

Rock Strength

Rock strength is defined by the Point Load Strength Index ($Is_{(50)}$) and refers to the strength of the rock substance and not the strength of the overall rock mass, which may be considerably weaker due to defects. The test procedure is described by Australian Standard 4133.4.1 - 1993. The terms used to describe rock strength are as follows:

Term	Abbreviation	Point Load Index $Is_{(50)}$ MPa	Approx Unconfined Compressive Strength MPa*
Extremely low	EL	<0.03	<0.6
Very low	VL	0.03 - 0.1	0.6 - 2
Low	L	0.1 - 0.3	2 - 6
Medium	M	0.3 - 1.0	6 - 20
High	H	1 - 3	20 - 60
Very high	VH	3 - 10	60 - 200
Extremely high	EH	>10	>200

* Assumes a ratio of 20:1 for UCS to $Is_{(50)}$

Degree of Weathering

The degree of weathering of rock is classified as follows:

Term	Abbreviation	Description
Extremely weathered	EW	Rock substance has soil properties, i.e. it can be remoulded and classified as a soil but the texture of the original rock is still evident.
Highly weathered	HW	Limonite staining or bleaching affects whole of rock substance and other signs of decomposition are evident. Porosity and strength may be altered as a result of iron leaching or deposition. Colour and strength of original fresh rock is not recognisable
Moderately weathered	MW	Staining and discolouration of rock substance has taken place
Slightly weathered	SW	Rock substance is slightly discoloured but shows little or no change of strength from fresh rock
Fresh stained	Fs	Rock substance unaffected by weathering but staining visible along defects
Fresh	Fr	No signs of decomposition or staining

Degree of Fracturing

The following classification applies to the spacing of natural fractures in diamond drill cores. It includes bedding plane partings, joints and other defects, but excludes drilling breaks.

Term	Description
Fragmented	Fragments of <20 mm
Highly Fractured	Core lengths of 20-40 mm with some fragments
Fractured	Core lengths of 40-200 mm with some shorter and longer sections
Slightly Fractured	Core lengths of 200-1000 mm with some shorter and loner sections
Unbroken	Core lengths mostly > 1000 mm

Rock Descriptions

Rock Quality Designation

The quality of the cored rock can be measured using the Rock Quality Designation (RQD) index, defined as:

$$\text{RQD \%} = \frac{\text{cumulative length of 'sound' core sections} \geq 100 \text{ mm long}}{\text{total drilled length of section being assessed}}$$

where 'sound' rock is assessed to be rock of low strength or better. The RQD applies only to natural fractures. If the core is broken by drilling or handling (i.e. drilling breaks) then the broken pieces are fitted back together and are not included in the calculation of RQD.

Stratification Spacing

For sedimentary rocks the following terms may be used to describe the spacing of bedding partings:

Term	Separation of Stratification Planes
Thinly laminated	< 6 mm
Laminated	6 mm to 20 mm
Very thinly bedded	20 mm to 60 mm
Thinly bedded	60 mm to 0.2 m
Medium bedded	0.2 m to 0.6 m
Thickly bedded	0.6 m to 2 m
Very thickly bedded	> 2 m

Symbols & Abbreviations

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Introduction

These notes summarise abbreviations commonly used on borehole logs and test pit reports.

Drilling or Excavation Methods

C	Core Drilling
R	Rotary drilling
SFA	Spiral flight augers
NMLC	Diamond core - 52 mm dia
NQ	Diamond core - 47 mm dia
HQ	Diamond core - 63 mm dia
PQ	Diamond core - 81 mm dia

Water

▷	Water seep
▽	Water level

Sampling and Testing

A	Auger sample
B	Bulk sample
D	Disturbed sample
E	Environmental sample
U_{50}	Undisturbed tube sample (50mm)
W	Water sample
pp	pocket penetrometer (kPa)
PID	Photo ionisation detector
PL	Point load strength Is(50) MPa
S	Standard Penetration Test
V	Shear vane (kPa)

Description of Defects in Rock

The abbreviated descriptions of the defects should be in the following order: Depth, Type, Orientation, Coating, Shape, Roughness and Other. Drilling and handling breaks are not usually included on the logs.

Defect Type

B	Bedding plane
Cs	Clay seam
Cv	Cleavage
Cz	Crushed zone
Ds	Decomposed seam
F	Fault
J	Joint
Lam	lamination
Pt	Parting
Sz	Sheared Zone
V	Vein

Orientation

The inclination of defects is always measured from the perpendicular to the core axis.

h	horizontal
v	vertical
sh	sub-horizontal
sv	sub-vertical

Coating or Infilling Term

cln	clean
co	coating
he	healed
inf	infilled
stn	stained
ti	tight
vn	veneer

Coating Descriptor

ca	calcite
cbs	carbonaceous
cly	clay
fe	iron oxide
mn	manganese
slt	silty

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

Other

fg	fragmented
bnd	band
qtz	quartz

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PROPOSED LEES1 CARSLOW EXT. – THE UNIVERSITY OF SYDNEY

BORE 5 PROJECT 84897 JUN 2015

3.9 – 8.0m

BOREHOLE LOG

CLIENT: The University of Sydney
PROJECT: LEES1 Carslaw Extension
LOCATION: Eastern Avenue, The University of Sydney

SURFACE LEVEL: 34.5 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 5
PROJECT No: 84897
DATE: 29/6/2015
SHEET 1 OF 1

Depth (m)	Description of Strata	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)	Type	Core Rec. %	RQD %	Test Results & Comments
0.0–0.4	FILLING - light grey-brown, fine sand filling with some silt/clay and a trace of concrete gravel and grass roots, humid		A			
0.4–1.1	FILLING - apparently poorly compacted, grey, silty clay filling with some fine sand, moist		A/E A/E			
1.1–2.0	CLAY - stiff, light brown clay, moist		S E			3,4,6 N = 10
2.0–3.9	SHALE/LAMINITE - extremely low to very low strength, light grey-brown, shale/laminite	Note: Unless otherwise stated, rock is fractured along rough planar bedding dipping 0°- 10°	E S			18,20/100mm refusal
3.9–6.2	SHALE/LAMINITE - extremely low and very low to low strength, extremely to highly weathered, fragmented to fractured, light grey to grey and brown, shale/laminite with medium strength ironstone bands	3.9m: CORE LOSS: 450mm 4.35-4.85m: B's 0°, fe 5.08m: J45°, un, ro, cln 5.16-5.2m: Cs 5.3-5.48m: Cs 5.8m: B10°, fe 5.9m: J60°, un, ro, cly	C	80	0	PL(A) = 0.7
6.2–8.0	LAMINITE - low to medium then high strength, slightly weathered, fractured and slightly fractured, grey-brown, laminite with approximately 25% fine sandstone laminations	6.2m: J35°, un, ro, fe 6.25m: J40°- 70°, cu, he, fe 6.5m: J30°, he, fe 6.8-7.3m: B's 0°, fe 7.4m: J45°- 50°, cu, ro, fe 7.7-7.95m: B's 0°, fe	C	100	77	PL(A) = 0.3 PL(A) = 1.3
8.0	Bore discontinued at 8.0m					

RIG: Bobcat **DRILLER:** SY **LOGGED:** SI **CASING:** HW to 2.5m
TYPE OF BORING: Solid flight auger to 2.5m; Rotary to 3.9m; NMLC-Coring to 8.0m
WATER OBSERVATIONS: No free groundwater observed whilst augering
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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PROPOSED LEES1 CARSLOW EXT. – THE UNIVERSITY OF SYDNEY

BORE 6 PROJECT 84897 JUL 2015

4.0 – 8.0m

BOREHOLE LOG

CLIENT: The University of Sydney
PROJECT: LEES1 Carslaw Extension
LOCATION: Eastern Avenue, The University of Sydney

SURFACE LEVEL: 33.5 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 6
PROJECT No: 84897
DATE: 30/6/2015
SHEET 1 OF 1

Depth (m)	Description of Strata	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)	Sampling Type	Core Rec. %	RQD %	Test Results & Comments
0.0	FILLING - light grey to dark grey, silty clay filling with some gravel (roadbase) and grass at top		A, A/E			
0.7	CLAY - stiff, orange-brown to red-brown clay, slightly silty, with a trace of ironstone gravel, moist		A/E, S, E			3,3,5 N = 8
2.0	SHALE - extremely low to very low strength, light grey shale	Note: Unless otherwise stated, rock is fractured along rough planar bedding dipping 0°- 10°	E, S			14,25/100mm refusal
4.0	SHALE - extremely low to very low strength, highly weathered, fractured, light grey-brown shale	4.0-4.3m: B's 0°, cly, fe	C	100	45	
4.35	with medium strength ironstone bands					
	SHALE - low to medium strength, highly to moderately then slightly weathered, fractured and slightly fractured, grey-brown shale with some extremely low to very low strength bands	4.58m: J, sv, pl, ro, fe 4.66m: J85° & 70°, st, ro, cln 4.85m: J, sv, pl, ro, fe 5.05m: J, sv, un, ro, cln 5.23-5.3m: Cs 5.31m: J70°, pl, ro, cln 5.4m: J30°, un, ro, fe 5.6m: J30°, pl, ro, fe, cly 5.83m: J90°, un, ro, cln 5.93-6.33m: B (x3) 0°, fe				PL(A) = 0.3 PL(A) = 0.3
6.0	LAMINITE - medium then high strength, slightly weathered, slightly fractured, grey to grey-brown, laminite with approximately 20% fine sandstone laminations	6.5m: J70° & 85°, st, ro, fe 6.62-6.66m: Cs 6.72 & 6.94m: B's 5°, fe 7m: J45°, pl, sm, fe 7.2m: B0°, fe, Cz, 5mm 7.3-7.4m: Cs 7.7m: J35°, pl, ro, fe	C	100	88	PL(A) = 0.7 PL(A) = 1.2
8.0	Bore discontinued at 8.0m					

RIG: Bobcat **DRILLER:** SY **LOGGED:** SI **CASING:** HW to 2.5m
TYPE OF BORING: Solid flight auger to 2.5m; Rotary to 4.0m; NMLC-Coring to 8.0m
WATER OBSERVATIONS: No free groundwater observed whilst augering
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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PROPOSED LEES1 CARSLOW EXT. – THE UNIVERSITY OF SYDNEY

BORE 7 PROJECT 84897 JUL 2015

4.0 – 8.0m

BOREHOLE LOG

CLIENT: The University of Sydney
PROJECT: LEES1 Carslaw Extension
LOCATION: Eastern Avenue, The University of Sydney

SURFACE LEVEL: 32.4 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 7
PROJECT No: 84897
DATE: 1/7/2015
SHEET 1 OF 1

Depth (m)	Description of Strata	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)	Sampling Type	Core Rec. %	RQD %	Test Results & Comments
0.1	CONCRETE SLAB		A			
0.2	ROADBASE GRAVEL					
0.4	FILLING - light brown, silty sand filling, humid		A/E			
	CLAY - stiff, red-brown to light grey-brown clay, slightly silty, moist		A/E			
			S			3,4,9 N = 13
1.5	SHALY CLAY - hard, light grey-brown, shaly clay, damp		E			
			E			
			S			7,14,25 N = 39
3.0	LAMINITE - very low strength, light grey-brown laminite	Note: Unless otherwise stated, rock is fractured along rough planar bedding dipping 0°- 10°				
4.0	LAMINITE - medium strength, highly to moderately then slightly weathered, slightly fractured, grey-brown, laminite with approximately 20% fine sandstone laminations and some clay bands	4.0-4.7m: cly 4.26m: B5°, fe 4.3m: B0°, cly, 10mm & J55°, pl, sm, cly 4.43-4.46m: Cs 4.5m: J35°, pl, ro, fe 4.63m: B0°, fe 4.81m: B0°, cly, 20mm 5.3 & 5.4m: B0°, fe 5.62m: J35°, un, ro, cln 5.7 & 5.82m: B0°, fe 5.92m: J45°, pl, sm, fe, cly 5.95 & 6.06m: Cs	C	100	86	PL(A) = 0.6 PL(A) = 0.4
6.06	LAMINITE - high then high to very high strength, slightly weathered then fresh stained, slightly fractured, light grey to grey, laminite with approximately 30% fine sandstone laminations	6.22m: B0°, Cz, 20mm 6.46-6.50m: fg, fe 6.65 & 6.8m: B0°, fe 7.45 & 7.87m: B5°, fe	C	100	92	PL(A) = 1.3 PL(A) = 3.3
8.0	Bore discontinued at 8.0m					

RIG: Bobcat **DRILLER:** SY **LOGGED:** SI **CASING:** HW to 2.5m
TYPE OF BORING: Diatube to 0.1m; Solid flight auger to 2.5m; Rotary to 4.0m; NMLC-Coring to 8.0m
WATER OBSERVATIONS: No free groundwater observed whilst augering
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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D O U G L A S   P A R T N E R S   P T Y   L T D

PROPOSED LEES1 CARSLOW EXT. – THE UNIVERSITY OF SYDNEY

BORE 8   PROJECT 84897   JUN 2015

4.3 – 8.45m

BOREHOLE LOG

CLIENT: The University of Sydney
PROJECT: LEES1 Carslaw Extension
LOCATION: Eastern Avenue, The University of Sydney

SURFACE LEVEL: 33.3 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 8
PROJECT No: 84897
DATE: 30/6/2015
SHEET 1 OF 1

Depth (m)	Description of Strata	Discontinuities	Sampling Type	Core Rec. %	RQD %	Test Results & Comments
0.0	FILLING - apparently poorly compacted, grey, silty clay filling with some fine sand, moist		A, A/E, A/E			
1.0	CLAY - stiff, light brown clay, moist		S, E			3,4,6 N = 10
1.8	SHALY CLAY- hard, light grey mottled brown, shaly clay, moist	Note: Unless otherwise stated, rock is fractured along rough planar bedding dipping 0°- 10°	E, S			7,16,28 N = 44
4.0	SHALE/LAMINITE - very low strength, light grey shale/laminite		S			23,25/100mm refusal
4.3		4.3m: CORE LOSS: 200mm				
4.5	LAMINITE - low strength, highly to moderately weathered, fractured, grey-brown laminite with some very low strength bands	4.62m: J45°, pl, sm, cly 4.75m: J30° & 90°, st, ro, fe 5.28m: J65°, un, ro, fe 5.4m: J60°, pl, sm, fe 5.5m: J30° & 60°, cu, ro, fe 5.7-5.75m: Cs	C	87	0	PL(A) = 0.2
5.9	LAMINITE - medium then high strength, moderately then slightly weathered, fractured and slightly fractured, grey-brown, laminite with approximately 25% fine sandstone lamination	5.93m: J35°, pl, ro, fe 6.1-6.55m: B's 0°, fe 6.55m: J45°- 70°, cu, fe, he 6.8m: J45°, pl, ro, fe 7.2-7.33m: Cs	C	100	37	PL(A) = 0.7 PL(A) = 0.7
		7.4-7.7m: B's 5°- 10°, fe 8.1-8.4m: B's 5°- 10°, fe	C	100	60	PL(A) = 0.8 PL(A) = 1.3
8.45	Bore discontinued at 8.45m					

RIG: Bobcat **DRILLER:** SY **LOGGED:** SI **CASING:** HW to 2.5m
TYPE OF BORING: Solid flight auger to 2.5m; Rotary to 4.3m; NMLC-Coring to 8.45m
WATER OBSERVATIONS: No free groundwater observed whilst augering
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

DOUGLAS PARTNERS PTY LTD

PROPOSED LEES1 CARSLOW EXT. – THE UNIVERSITY OF SYDNEY

BORE 9 PROJECT 84897 JUN 2015

3.9 – 8.0m

BOREHOLE LOG

CLIENT: The University of Sydney
PROJECT: LEES1 Carslaw Extension
LOCATION: Eastern Avenue, The University of Sydney

SURFACE LEVEL: 35.0 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 9
PROJECT No: 84897
DATE: 29/6/2015
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Discontinuities	Type	Core Rec. %	RQD %	Test Results & Comments
35	0.1	PAVERS					
	0.4	FILLING - light grey, fine to medium sand filling with some concrete gravel, humid		A			
34	1	FILLING - apparently poorly compacted, light grey and grey, silty clay filling with some sand and crushed shale fragments, moist		A/E A/E			
	1.3	SILTY CLAY - stiff, brown, silty clay with ironstone gravel, moist		S E			3,5,6 N = 11
33	2.0	SHALE/LAMINITE - very low strength, light grey to grey, shale/laminite		E			
32	3		Note: Unless otherwise stated, rock is fractured along rough planar bedding dipping 0°- 10°	S			17,25/100mm refusal
31	4.1	LAMINITE - alternate bands of extremely low to very low and low strength, extremely to highly weathered, fragmented to fractured, grey-brown laminite	3.9m: CORE LOSS: 200mm 4.1-4.3m: fg 4.3-4.33m: Cs 4.33-4.53m: B's 0°, fe 4.8, 4.88 & 4.94m: Cs, 10-50mm				PL(A) = 0.2
30	5		5.27m: J60°, pl, ro, fe 5.37m: J70°, un, ro, fe 5.52-5.65m: Cs 5.65 & 5.82m: fg	C	93	13	PL(A) = 0.2
29	6		6.2 & 6.52m: B10°, fe				PL(A) = 0.2
28	6.7	LAMINITE - high strength, moderately then slightly weathered, slightly fractured, grey-brown, laminite with approximately 25% fine sandstone laminations	6.7m: J45°, pl, ro, fe 6.8m: J30°, pl, ro, fe 6.9-7.9m: B (x8) 0° - 5°, fe	C	100	100	PL(A) = 1.7
27	8.0	Bore discontinued at 8.0m					
26	9						

Degree of Weathering: EW HW MW SW FS FR
Rock Strength: Ex Low, Very Low, Low, Medium, High, Very High, Ex High
Fracture Spacing (m): 0.01, 0.05, 0.10, 0.50, 1.00
Discontinuities: B - Bedding, J - Joint, S - Shear, F - Fault

RIG: Bobcat **DRILLER:** SY **LOGGED:** SI **CASING:** HW to 2.5m
TYPE OF BORING: Solid flight auger to 2.5m; Rotary to 3.9m; NMLC-Coring to 8.0m
WATER OBSERVATIONS: No free groundwater observed whilst augering
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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Appendix D

Results of Laboratory Testing

Field_ID	LocCode	Sample_Depth_Range	Sampled_Date-Time	Moisture	Arsenic	Cadmium	Chromium (III+VI)	Copper	Lead	Lead TCLP	Mercury	Nickel	Zinc	C10-C16	C16-C34	C34-C40	F2-NAPHTHALENE	C6 - C9	C10 - C14	C15 - C28	C29-C36	+C10 - C36 (Sum of total)	C6-C10 less BTEX (F1)	C6-C10	Benzene	Ethylbenzene	Toluene	Xylene (m & p)	Xylene (o)	Xylene Total
				Inorganics	Metals									TPH											BTEX					
				%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/L	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQL				0.1	4	0.4	1	1	1		0.1	1	1	50	100	100	50	25	50	100	100		25	25	0.2	1	0.5	2	1	
NSW 2014 General Solid Waste (No Leaching)					100	20			100		4	40						650				10000			10	600	288			1000
NSW 2014 General Solid Waste (leached)					**500**	**100**			**1500**	**5**	**50**	**1050**						**650**				**10000**			**18**	**1080**	**518**			**1800**
NSW 2014 Restricted Solid Waste (No Leaching)					*400*	*80*			*400*		*16*	*160*						*2600*				*40000*			*40*	*2400*	*1152*			*4000*
NSW 2014 Restricted Solid Waste (leached)					2000	400			6000	20	200	4200						2600				40000			72	4320	2073			7200
NEPM 2013 Table 1A(1) HILs Comm/Ind D Soil					3000	900		240000	1500		730	6000	400000																	
CRC Care Direct Contact HSL-D														20000	27000	38000								26000	430	27000	99000			81000
NEPM 2013 Table 1A(3) Comm/Ind D Soil HSL for Vapour Intrusion, Sand 0-1m																	NL						260		3	NL	NL			230
NEPM 2013 Table 1B(7) Management Limits Comm / Ind, Coarse Soil														1000	3500	10000								700						
BH5	BH5	0.5	29/06/2015	12	<4	<0.4	9	11	38	-	0.2	4	53	<50	<100	<100	<50	<25	<50	<100	<100	<250	<25	<25	<0.2	<1	<0.5	<2	<1	<3
BH6	BH6	0.5		11	5	<0.4	9	130	170	0.08	1	12	200	720	13,000	2200	710	<25	210	9800	4600	**14,610**	<25	<25	<0.2	<1	<0.5	<2	<1	<3
BH7	BH7	0.5		24	7	<0.4	21	16	30	-	<0.1	3	11	<50	<100	<100	<50	<25	<50	<100	<100	<250	<25	<25	<0.2	<1	<0.5	<2	<1	<3
BH8	BH8	0.5	30/06/2015	21	8	0.5	17	81	150	0.04	0.4	8	150	<50	430	<100	<50	<25	<50	330	180	535	<25	<25	<0.2	<1	<0.5	<2	<1	<3
BH9	BH9	1	29/06/2015	22	7	0.4	18	93	270	0.2	0.4	9	120	<50	110	<100	<50	<25	<50	<100	<100	<250	<25	<25	<0.2	<1	<0.5	<2	<1	<3

				Polycyclic aromatic hydrocarbons																		
				Total Positive PAHs	Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(a) pyrene	Benzo(a)pyrene TCLP	Benzo(a)pyrene TEQ calc(PQL)	Benzo(b)&(k)fluoranthene	Benzo(g,h,i)perylene	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-c,d)pyrene	Naphthalene	Phenanthrene	Phenolics Total	Pyrene
				mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/L	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQL					0.1	0.1	0.1	0.1	0.05		0.5	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	5	0.1
NSW 2014 General Solid Waste (No Leaching)				200					0.8													
NSW 2014 General Solid Waste (leached)				**200**					**10**	**0.04**												
NSW 2014 Restricted Solid Waste (No Leaching)				*800*					*3.2*													
NSW 2014 Restricted Solid Waste (leached)				800					23	0.16												
NEPM 2013 Table 1A(1) HILs Comm/Ind D Soil				4000							40											
CRC Care Direct Contact HSL-D																			11000			
NEPM 2013 Table 1A(3) Comm/Ind D Soil HSL for Vapour Intrusion, Sand 0-1m																			NL			
NEPM 2013 Table 1B(7) Management Limits Comm / Ind, Coarse Soil																						
Field_ID	**LocCode**	**Sample_Depth_Range**	**Sampled_Date-Time**																			
BH5	BH5	0.5	29/06/2015	1.2	<0.1	<0.1	<0.1	0.1	0.1	-	<0.5	0.2	0.1	0.1	<0.1	0.2	<0.1	<0.1	<0.1	0.1	<5	0.2
BH6	BH6	0.5		***3900***	13	70	130	290	***290***	<0.001	400	440	150	260	14	720	48	150	27	610	<5	710
BH7	BH7	0.5		0.26	<0.1	<0.1	<0.1	<0.1	0.05	-	<0.5	<0.2	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<5	0.1
BH8	BH8	0.5	30/06/2015	140	0.8	3.5	5.7	10	*9*	0.003	13	14	4	8.8	1.1	25	3.1	4.3	<1 - 0.7	24	<5	23
BH9	BH9	1	29/06/2015	45	0.1	0.6	1.5	3.5	3.1	<0.001	4.6	5.1	1.5	3.1	0.4	8.4	0.6	1.6	<1 - 0.3	6.9	<5	7.9

Polychlorinated Biphenyls

Field_ID	LocCode	Sample_Depth_Range	Sampled_Date-Time	Arochlor 1016	Arochlor 1221	Arochlor 1232	Arochlor 1242	Arochlor 1248	Arochlor 1254	Arochlor 1260	Total PCB
				mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	
EQL				0.1	0.1	0.1	0.1	0.1	0.1	0.1	
NSW 2014 General Solid Waste (No Leaching)											50
NSW 2014 General Solid Waste (leached)											**50**
NSW 2014 Restricted Solid Waste (No Leaching)											*50*
NSW 2014 Restricted Solid Waste (leached)											50
NEPM 2013 Table 1A(1) HILs Comm/Ind D Soil											
CRC Care Direct Contact HSL-D											
NEPM 2013 Table 1A(3) Comm/Ind D Soil HSL for Vapour Intrusion, Sand 0-1m											
NEPM 2013 Table 1B(7) Management Limits Comm / Ind, Coarse Soil											
BH5	BH5	0.5	29/06/2015	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0
BH6	BH6	0.5		<1	<1	<1	<1	<1	<1	<1	0
BH7	BH7	0.5		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0
BH8	BH8	0.5	30/06/2015	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0
BH9	BH9	1	29/06/2015	<1	<1	<1	<1	<1	<1	<1	0

Organochlorine Pesticides

Field_ID	4,4-DDE	a-BHC	Aldrin	Aldrin + Dieldrin	b-BHC	Chlordane (cis)	Chlordane (trans)	d-BHC	DDD	DDT	DDT+DDE+DDD	Dieldrin	Endosulfan I	Endosulfan II	Endosulfan sulphate	Endrin	Endrin aldehyde	g-BHC (Lindane)	Heptachlor	Heptachlor epoxide	Methoxychlor
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQL	0.1	0.1	0.1		0.1	0.1	0.1	0.1	0.1	0.1		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
NSW 2014 General Solid Waste (No Leaching)																					
NSW 2014 General Solid Waste (leached)																					
NSW 2014 Restricted Solid Waste (No Leaching)																					
NSW 2014 Restricted Solid Waste (leached)																					
NEPM 2013 Table 1A(1) HILs Comm/Ind D Soil				45							3600					100			50		2500
CRC Care Direct Contact HSL-D																					
NEPM 2013 Table 1A(3) Comm/Ind D Soil HSL for Vapour Intrusion, Sand 0-1m																					
NEPM 2013 Table 1B(7) Management Limits Comm / Ind, Coarse Soil																					
BH5	<0.1	<0.1	<0.1	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.3	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
BH6	<1	<1	<1	<2	<1	<1	<1	<1	<1	<1	<3	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
BH7	<0.1	<0.1	<0.1	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.3	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
BH8	<0.1	<0.1	<0.1	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.3	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
BH9	<0.1	<0.1	<0.1	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.3	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Field_ID	LocCode	Sample_Depth_Range	Sampled_Date-Time	Organophosphorous Pesticides											Pesticides		Asbestos	
				Azinophos methyl	Bromophos-ethyl	Chlorpyrifos	Chlorpyrifos-methyl	Diazinon	Dichlorvos	Dimethoate	Ethion	Fenitrothion	Malathion	Ronnel	Pesticides (total, NSW Waste 2009)	Scheduled chemicals (NSW Waste 2014)	Asbestos ID in Soil	Asbestos fibres
				mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg		g/kg	-
EQL				0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.6	1.3	0.1	fibres
NSW 2014 General Solid Waste (No Leaching)						4									250	<50		
NSW 2014 General Solid Waste (leached)						**7.5**									**250**	**<50**		
NSW 2014 Restricted Solid Waste (No Leaching)						*16*									*1000*	*<50*		
NSW 2014 Restricted Solid Waste (leached)						30									1000	<50		
NEPM 2013 Table 1A(1) HILs Comm/Ind D Soil						2000												
CRC Care Direct Contact HSL-D																		
NEPM 2013 Table 1A(3) Comm/Ind D Soil HSL for Vapour Intrusion, Sand 0-1m																		
NEPM 2013 Table 1B(7) Management Limits Comm / Ind, Coarse Soil																		
BH5	BH5	0.5	29/06/2015	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.6	<1.3	Not detected	No asbestos detected
BH6	BH6	0.5		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<6	<13	Not detected	No asbestos detected
BH7	BH7	0.5		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.6	<1.3	Not detected	No asbestos detected
BH8	BH8	0.5	30/06/2015	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.6	<1.3	Not detected	No asbestos detected
BH9	BH9	1	29/06/2015	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.6	<1.3	Not detected	No asbestos detected

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CERTIFICATE OF ANALYSIS **130575**

Client:
Douglas Partners Pty Ltd
96 Hermitage Rd
West Ryde
NSW 2114

Attention: Kelly McPhee, Geoff Young

Sample log in details:

Your Reference:	**84897, Sydney University**		
No. of samples:	9 soils		
Date samples received / completed instructions received	03/07/15	/	03/07/15

Analysis Details:
Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for solids and on an as received basis for other matrices.
Please refer to the last page of this report for any comments relating to the results.

Report Details:

Date results requested by: / Issue Date:	8/07/15	/	7/07/15
Date of Preliminary Report:	Not Issued		

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Accredited for compliance with ISO/IEC 17025. **Tests not covered by NATA are denoted with *.**

Results Approved By:

Jacinta Hurst
Laboratory Manager

vTRH(C6-C10)/BTEXN in Soil Our Reference:	UNITS	130575-1	130575-2	130575-3	130575-4	130575-5
Your Reference	-------------	BH1	BH2	BH3	BH4	BH5
Depth	------------	1.0	0.5	1.0	0.5	0.5
Date Sampled		12/06/2015	12/06/2015	11/06/2015	-	29/06/2015
Type of sample		Soil	Soil	Soil	Soil	Soil
Date extracted	-	06/07/2015	06/07/2015	06/07/2015	06/07/2015	06/07/2015
Date analysed	-	06/07/2015	06/07/2015	06/07/2015	06/07/2015	06/07/2015
TRH C_6 - C_9	mg/kg	<25	<25	<25	<25	<25
TRH C_6 - C_{10}	mg/kg	<25	<25	<25	<25	<25
vTPH C_6 - C_{10} less BTEX (F1)	mg/kg	<25	<25	<25	<25	<25
Benzene	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Toluene	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Ethylbenzene	mg/kg	<1	<1	<1	<1	<1
m+p-xylene	mg/kg	<2	<2	<2	<2	<2
o-Xylene	mg/kg	<1	<1	<1	<1	<1
naphthalene	mg/kg	<1	<1	<1	<1	<1
Surrogate aaa-Trifluorotoluene	%	94	100	100	86	88

vTRH(C6-C10)/BTEXN in Soil Our Reference:	UNITS	130575-6	130575-7	130575-8	130575-9
Your Reference	-------------	BH6	BH7	BH8	BH9
Depth	------------	0.5	0.5	0.5	1.0
Date Sampled		-	-	30/06/2015	29/06/2015
Type of sample		Soil	Soil	Soil	Soil
Date extracted	-	06/07/2015	06/07/2015	06/07/2015	06/07/2015
Date analysed	-	06/07/2015	06/07/2015	06/07/2015	06/07/2015
TRH C_6 - C_9	mg/kg	<25	<25	<25	<25
TRH C_6 - C_{10}	mg/kg	<25	<25	<25	<25
vTPH C_6 - C_{10} less BTEX (F1)	mg/kg	<25	<25	<25	<25
Benzene	mg/kg	<0.2	<0.2	<0.2	<0.2
Toluene	mg/kg	<0.5	<0.5	<0.5	<0.5
Ethylbenzene	mg/kg	<1	<1	<1	<1
m+p-xylene	mg/kg	<2	<2	<2	<2
o-Xylene	mg/kg	<1	<1	<1	<1
naphthalene	mg/kg	12	<1	<1	<1
Surrogate aaa-Trifluorotoluene	%	89	82	89	86

svTRH (C10-C40) in Soil Our Reference: Your Reference Depth Date Sampled Type of sample	UNITS ------------- ------------	130575-1 BH1 1.0 12/06/2015 Soil	130575-2 BH2 0.5 12/06/2015 Soil	130575-3 BH3 1.0 11/06/2015 Soil	130575-4 BH4 0.5 - Soil	130575-5 BH5 0.5 29/06/2015 Soil
Date extracted	-	06/07/2015	06/07/2015	06/07/2015	06/07/2015	06/07/2015
Date analysed	-	06/07/2015	07/07/2015	06/07/2015	06/07/2015	06/07/2015
TRHC $_{10}$ - C $_{14}$	mg/kg	<50	<50	<50	<50	<50
TRHC $_{15}$ - C $_{28}$	mg/kg	<100	210	<100	<100	<100
TRHC $_{29}$ - C $_{36}$	mg/kg	<100	540	<100	<100	<100
TRH>C $_{10}$-C $_{16}$	mg/kg	<50	<50	<50	<50	<50
TRH>C $_{10}$ - C $_{16}$ less Naphthalene (F2)	mg/kg	<50	<50	<50	<50	<50
TRH>C $_{16}$-C $_{34}$	mg/kg	<100	580	<100	<100	<100
TRH>C $_{34}$-C $_{40}$	mg/kg	<100	550	<100	<100	<100
Surrogate o-Terphenyl	%	87	86	83	83	83

svTRH (C10-C40) in Soil Our Reference: Your Reference Depth Date Sampled Type of sample	UNITS ------------- ------------	130575-6 BH6 0.5 - Soil	130575-7 BH7 0.5 - Soil	130575-8 BH8 0.5 30/06/2015 Soil	130575-9 BH9 1.0 29/06/2015 Soil
Date extracted	-	06/07/2015	06/07/2015	06/07/2015	06/07/2015
Date analysed	-	07/07/2015	06/07/2015	06/07/2015	06/07/2015
TRHC $_{10}$ - C $_{14}$	mg/kg	210	<50	<50	<50
TRHC $_{15}$ - C $_{28}$	mg/kg	9,800	<100	330	<100
TRHC $_{29}$ - C $_{36}$	mg/kg	4,600	<100	180	<100
TRH>C $_{10}$-C $_{16}$	mg/kg	720	<50	<50	<50
TRH>C $_{10}$ - C $_{16}$ less Naphthalene (F2)	mg/kg	710	<50	<50	<50
TRH>C $_{16}$-C $_{34}$	mg/kg	13,000	<100	430	110
TRH>C $_{34}$-C $_{40}$	mg/kg	2,200	<100	<100	<100
Surrogate o-Terphenyl	%	#	85	93	89

PAHs in Soil						
Our Reference:	UNITS	130575-1	130575-2	130575-3	130575-4	130575-5
Your Reference	-------------	BH1	BH2	BH3	BH4	BH5
Depth	------------	1.0	0.5	1.0	0.5	0.5
Date Sampled		12/06/2015	12/06/2015	11/06/2015	-	29/06/2015
Type of sample		Soil	Soil	Soil	Soil	Soil
Date extracted	-	06/07/2015	06/07/2015	06/07/2015	06/07/2015	06/07/2015
Date analysed	-	06/07/2015	06/07/2015	06/07/2015	06/07/2015	06/07/2015
Naphthalene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Acenaphthylene	mg/kg	<0.1	0.1	<0.1	<0.1	<0.1
Acenaphthene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Fluorene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Phenanthrene	mg/kg	0.1	1.3	0.2	<0.1	0.1
Anthracene	mg/kg	<0.1	0.4	<0.1	<0.1	<0.1
Fluoranthene	mg/kg	0.4	3.9	0.4	<0.1	0.2
Pyrene	mg/kg	0.5	3.9	0.4	<0.1	0.2
Benzo(a)anthracene	mg/kg	0.2	2.2	0.2	<0.1	0.1
Chrysene	mg/kg	0.2	2.1	0.2	<0.1	0.1
Benzo(b,j+k)fluoranthene	mg/kg	0.5	3.9	0.4	<0.2	0.2
Benzo(a)pyrene	mg/kg	0.3	2.2	0.2	<0.05	0.1
Indeno(1,2,3-c,d)pyrene	mg/kg	0.2	1.0	0.1	<0.1	<0.1
Dibenzo(a,h)anthracene	mg/kg	<0.1	0.2	<0.1	<0.1	<0.1
Benzo(g,h,i)perylene	mg/kg	0.2	0.9	0.1	<0.1	0.1
Benzo(a)pyrene TEQ calc (zero)	mg/kg	<0.5	3.2	<0.5	<0.5	<0.5
Benzo(a)pyrene TEQ calc(half)	mg/kg	<0.5	3.2	<0.5	<0.5	<0.5
Benzo(a)pyrene TEQ calc(PQL)	mg/kg	<0.5	3.2	<0.5	<0.5	<0.5
Total Positive PAHs	mg/kg	2.7	22	2.2	NIL (+)VE	1.2
Surrogate p-Terphenyl-d14	%	104	94	103	101	101

PAHs in Soil					
Our Reference:	UNITS	130575-6	130575-7	130575-8	130575-9
Your Reference	-------------	BH6	BH7	BH8	BH9
Depth	------------	0.5	0.5	0.5	1.0
Date Sampled		-	-	30/06/2015	29/06/2015
Type of sample		Soil	Soil	Soil	Soil
Date extracted	-	06/07/2015	06/07/2015	06/07/2015	06/07/2015
Date analysed	-	06/07/2015	06/07/2015	06/07/2015	06/07/2015
Naphthalene	mg/kg	27	<0.1	0.7	0.3
Acenaphthylene	mg/kg	70	<0.1	3.5	0.6
Acenaphthene	mg/kg	13	<0.1	0.8	0.1
Fluorene	mg/kg	48	<0.1	3.1	0.6
Phenanthrene	mg/kg	610	<0.1	24	6.9
Anthracene	mg/kg	130	<0.1	5.7	1.5
Fluoranthene	mg/kg	720	0.1	25	8.4
Pyrene	mg/kg	710	0.1	23	7.9
Benzo(a)anthracene	mg/kg	290	<0.1	10	3.5
Chrysene	mg/kg	260	<0.1	8.8	3.1
Benzo(b,j+k)fluoranthene	mg/kg	440	<0.2	14	5.1
Benzo(a)pyrene	mg/kg	290	0.05	9.0	3.1
Indeno(1,2,3-c,d)pyrene	mg/kg	150	<0.1	4.3	1.6
Dibenzo(a,h)anthracene	mg/kg	14	<0.1	1.1	0.4
Benzo(g,h,i)perylene	mg/kg	150	<0.1	4.0	1.5
Benzo(a)pyrene TEQ calc (zero)	mg/kg	400	<0.5	13	4.6
Benzo(a)pyrene TEQ calc(half)	mg/kg	400	<0.5	13	4.6
Benzo(a)pyrene TEQ calc(PQL)	mg/kg	400	<0.5	13	4.6
Total Positive PAHs	mg/kg	3,900	0.26	140	45
Surrogate p-Terphenyl-d14	%	107	100	99	100

Organochlorine Pesticides in soil						
Our Reference:	UNITS	130575-1	130575-2	130575-3	130575-4	130575-5
Your Reference	-------------	BH1	BH2	BH3	BH4	BH5
Depth	------------	1.0	0.5	1.0	0.5	0.5
Date Sampled		12/06/2015	12/06/2015	11/06/2015	-	29/06/2015
Type of sample		Soil	Soil	Soil	Soil	Soil
Date extracted	-	06/07/2015	06/07/2015	06/07/2015	06/07/2015	06/07/2015
Date analysed	-	06/07/2015	06/07/2015	06/07/2015	06/07/2015	06/07/2015
HCB	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
alpha-BHC	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
gamma-BHC	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
beta-BHC	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Heptachlor	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
delta-BHC	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Aldrin	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Heptachlor Epoxide	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
gamma-Chlordane	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
alpha-chlordane	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Endosulfan I	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
pp-DDE	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Dieldrin	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Endrin	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
pp-DDD	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Endosulfan II	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
pp-DDT	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Endrin Aldehyde	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Endosulfan Sulphate	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Methoxychlor	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Surrogate TCMX	%	102	99	102	102	99

Organochlorine Pesticides in soil Our Reference: Your Reference Depth Date Sampled Type of sample	UNITS ------------ ------------	130575-6 BH6 0.5 - Soil	130575-7 BH7 0.5 - Soil	130575-8 BH8 0.5 30/06/2015 Soil	130575-9 BH9 1.0 29/06/2015 Soil
Date extracted	-	06/07/2015	06/07/2015	06/07/2015	06/07/2015
Date analysed	-	06/07/2015	06/07/2015	06/07/2015	06/07/2015
HCB	mg/kg	<1	<0.1	<0.1	<0.1
alpha-BHC	mg/kg	<1	<0.1	<0.1	<0.1
gamma-BHC	mg/kg	<1	<0.1	<0.1	<0.1
beta-BHC	mg/kg	<1	<0.1	<0.1	<0.1
Heptachlor	mg/kg	<1	<0.1	<0.1	<0.1
delta-BHC	mg/kg	<1	<0.1	<0.1	<0.1
Aldrin	mg/kg	<1	<0.1	<0.1	<0.1
Heptachlor Epoxide	mg/kg	<1	<0.1	<0.1	<0.1
gamma-Chlordane	mg/kg	<1	<0.1	<0.1	<0.1
alpha-chlordane	mg/kg	<1	<0.1	<0.1	<0.1
Endosulfan I	mg/kg	<1	<0.1	<0.1	<0.1
pp-DDE	mg/kg	<1	<0.1	<0.1	<0.1
Dieldrin	mg/kg	<1	<0.1	<0.1	<0.1
Endrin	mg/kg	<1	<0.1	<0.1	<0.1
pp-DDD	mg/kg	<1	<0.1	<0.1	<0.1
Endosulfan II	mg/kg	<1	<0.1	<0.1	<0.1
pp-DDT	mg/kg	<1	<0.1	<0.1	<0.1
Endrin Aldehyde	mg/kg	<1	<0.1	<0.1	<0.1
Endosulfan Sulphate	mg/kg	<1	<0.1	<0.1	<0.1
Methoxychlor	mg/kg	<1	<0.1	<0.1	<0.1
Surrogate TCMX	%	106	100	95	108

Organophosphorus Pesticides						
Our Reference:	UNITS	130575-1	130575-2	130575-3	130575-4	130575-5
Your Reference	-------------	BH1	BH2	BH3	BH4	BH5
Depth	------------	1.0	0.5	1.0	0.5	0.5
Date Sampled		12/06/2015	12/06/2015	11/06/2015	-	29/06/2015
Type of sample		Soil	Soil	Soil	Soil	Soil
Date extracted	-	06/07/2015	06/07/2015	06/07/2015	06/07/2015	06/07/2015
Date analysed	-	06/07/2015	06/07/2015	06/07/2015	06/07/2015	06/07/2015
Azinphos-methyl (Guthion)	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Bromophos-ethyl	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Chlorpyriphos	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Chlorpyriphos-methyl	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Diazinon	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Dichlorvos	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Dimethoate	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Ethion	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Fenitrothion	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Malathion	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Parathion	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Ronnel	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Surrogate TCMX	%	102	99	102	102	99

Organophosphorus Pesticides					
Our Reference:	UNITS	130575-6	130575-7	130575-8	130575-9
Your Reference	-------------	BH6	BH7	BH8	BH9
Depth	------------	0.5	0.5	0.5	1.0
Date Sampled		-	-	30/06/2015	29/06/2015
Type of sample		Soil	Soil	Soil	Soil
Date extracted	-	06/07/2015	06/07/2015	06/07/2015	06/07/2015
Date analysed	-	06/07/2015	06/07/2015	06/07/2015	06/07/2015
Azinphos-methyl (Guthion)	mg/kg	<1	<0.1	<0.1	<0.1
Bromophos-ethyl	mg/kg	<1	<0.1	<0.1	<0.1
Chlorpyriphos	mg/kg	<1	<0.1	<0.1	<0.1
Chlorpyriphos-methyl	mg/kg	<1	<0.1	<0.1	<0.1
Diazinon	mg/kg	<1	<0.1	<0.1	<0.1
Dichlorvos	mg/kg	<1	<0.1	<0.1	<0.1
Dimethoate	mg/kg	<1	<0.1	<0.1	<0.1
Ethion	mg/kg	<1	<0.1	<0.1	<0.1
Fenitrothion	mg/kg	<1	<0.1	<0.1	<0.1
Malathion	mg/kg	<1	<0.1	<0.1	<0.1
Parathion	mg/kg	<1	<0.1	<0.1	<0.1
Ronnel	mg/kg	<1	<0.1	<0.1	<0.1
Surrogate TCMX	%	100	100	95	108

PCBs in Soil Our Reference: Your Reference Depth Date Sampled Type of sample	UNITS ------------ ------------	130575-1 BH1 1.0 12/06/2015 Soil	130575-2 BH2 0.5 12/06/2015 Soil	130575-3 BH3 1.0 11/06/2015 Soil	130575-4 BH4 0.5 - Soil	130575-5 BH5 0.5 29/06/2015 Soil
Date extracted	-	06/07/2015	06/07/2015	06/07/2015	06/07/2015	06/07/2015
Date analysed	-	06/07/2015	06/07/2015	06/07/2015	06/07/2015	06/07/2015
Aroclor 1016	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Aroclor 1221	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Aroclor 1232	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Aroclor 1242	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Aroclor 1248	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Aroclor 1254	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Aroclor 1260	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Surrogate TCLMX	%	102	99	102	102	99

PCBs in Soil Our Reference: Your Reference Depth Date Sampled Type of sample	UNITS ------------ ------------	130575-6 BH6 0.5 - Soil	130575-7 BH7 0.5 - Soil	130575-8 BH8 0.5 30/06/2015 Soil	130575-9 BH9 1.0 29/06/2015 Soil
Date extracted	-	06/07/2015	06/07/2015	06/07/2015	06/07/2015
Date analysed	-	06/07/2015	06/07/2015	06/07/2015	06/07/2015
Aroclor 1016	mg/kg	<1	<0.1	<0.1	<1
Aroclor 1221	mg/kg	<1	<0.1	<0.1	<1
Aroclor 1232	mg/kg	<1	<0.1	<0.1	<1
Aroclor 1242	mg/kg	<1	<0.1	<0.1	<1
Aroclor 1248	mg/kg	<1	<0.1	<0.1	<1
Aroclor 1254	mg/kg	<1	<0.1	<0.1	<1
Aroclor 1260	mg/kg	<1	<0.1	<0.1	<1
Surrogate TCLMX	%	100	100	95	108

Acid Extractable metals in soil						
Our Reference:	UNITS	130575-1	130575-2	130575-3	130575-4	130575-5
Your Reference	-------------	BH1	BH2	BH3	BH4	BH5
Depth	------------	1.0	0.5	1.0	0.5	0.5
Date Sampled		12/06/2015	12/06/2015	11/06/2015	-	29/06/2015
Type of sample		Soil	Soil	Soil	Soil	Soil
Date digested	-	06/07/2015	06/07/2015	06/07/2015	06/07/2015	06/07/2015
Date analysed	-	06/07/2015	06/07/2015	06/07/2015	06/07/2015	06/07/2015
Arsenic	mg/kg	<4	4	4	5	<4
Cadmium	mg/kg	<0.4	<0.4	<0.4	<0.4	<0.4
Chromium	mg/kg	14	11	19	12	9
Copper	mg/kg	32	84	23	19	11
Lead	mg/kg	18	130	32	24	38
Mercury	mg/kg	<0.1	0.2	<0.1	<0.1	0.2
Nickel	mg/kg	10	14	5	10	4
Zinc	mg/kg	41	140	20	11	53

Acid Extractable metals in soil					
Our Reference:	UNITS	130575-6	130575-7	130575-8	130575-9
Your Reference	-------------	BH6	BH7	BH8	BH9
Depth	------------	0.5	0.5	0.5	1.0
Date Sampled		-	-	30/06/2015	29/06/2015
Type of sample		Soil	Soil	Soil	Soil
Date digested	-	06/07/2015	06/07/2015	06/07/2015	06/07/2015
Date analysed	-	06/07/2015	06/07/2015	06/07/2015	06/07/2015
Arsenic	mg/kg	5	7	8	7
Cadmium	mg/kg	<0.4	<0.4	0.5	0.4
Chromium	mg/kg	9	21	17	18
Copper	mg/kg	130	16	81	93
Lead	mg/kg	170	30	150	270
Mercury	mg/kg	1	<0.1	0.4	0.4
Nickel	mg/kg	12	3	8	9
Zinc	mg/kg	200	11	150	120

Misc Soil - Inorg						
Our Reference:	UNITS	130575-1	130575-2	130575-3	130575-4	130575-5
Your Reference	-------------	BH1	BH2	BH3	BH4	BH5
Depth	------------	1.0	0.5	1.0	0.5	0.5
Date Sampled		12/06/2015	12/06/2015	11/06/2015	-	29/06/2015
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	06/07/2015	06/07/2015	06/07/2015	06/07/2015	06/07/2015
Date analysed	-	06/07/2015	06/07/2015	06/07/2015	06/07/2015	06/07/2015
Total Phenolics (as Phenol)	mg/kg	<5	<5	<5	<5	<5

Misc Soil - Inorg					
Our Reference:	UNITS	130575-6	130575-7	130575-8	130575-9
Your Reference	-------------	BH6	BH7	BH8	BH9
Depth	------------	0.5	0.5	0.5	1.0
Date Sampled		-	-	30/06/2015	29/06/2015
Type of sample		Soil	Soil	Soil	Soil
Date prepared	-	06/07/2015	06/07/2015	06/07/2015	06/07/2015
Date analysed	-	06/07/2015	06/07/2015	06/07/2015	06/07/2015
Total Phenolics (as Phenol)	mg/kg	<5	<5	<5	<5

Moisture Our Reference: Your Reference Depth Date Sampled Type of sample	UNITS ------------- ------------	130575-1 BH1 1.0 12/06/2015 Soil	130575-2 BH2 0.5 12/06/2015 Soil	130575-3 BH3 1.0 11/06/2015 Soil	130575-4 BH4 0.5 - Soil	130575-5 BH5 0.5 29/06/2015 Soil
Date prepared	-	6/07/2015	6/07/2015	6/07/2015	6/07/2015	6/07/2015
Date analysed	-	7/07/2015	7/07/2015	7/07/2015	7/07/2015	7/07/2015
Moisture	%	6.3	8.4	16	23	12

Moisture Our Reference: Your Reference Depth Date Sampled Type of sample	UNITS ------------- ------------	130575-6 BH6 0.5 - Soil	130575-7 BH7 0.5 - Soil	130575-8 BH8 0.5 30/06/2015 Soil	130575-9 BH9 1.0 29/06/2015 Soil
Date prepared	-	6/07/2015	6/07/2015	6/07/2015	6/07/2015
Date analysed	-	7/07/2015	7/07/2015	7/07/2015	7/07/2015
Moisture	%	11	24	21	22

Asbestos ID - soils						
Our Reference:	UNITS	130575-1	130575-2	130575-3	130575-4	130575-5
Your Reference	-------------	BH1	BH2	BH3	BH4	BH5
Depth	------------	1.0	0.5	1.0	0.5	0.5
Date Sampled		12/06/2015	12/06/2015	11/06/2015	-	29/06/2015
Type of sample		Soil	Soil	Soil	Soil	Soil
Date analysed	-	7/07/2015	7/07/2015	7/07/2015	7/07/2015	7/07/2015
Sample mass tested	g	Approx. 40g	Approx. 40g	Approx. 35g	Approx. 30g	Approx. 35g
Sample Description	-	Brown coarse grain soil & rocks	Brown coarse grain soil & rocks	Brown coarse grain soil & rocks	Brown coarse grain soil & rocks	Brown coarse grain soil & rocks
Asbestos ID in soil	-	No asbestos detected at reporting limit of 0.1g/kg Organic fibres detected	No asbestos detected at reporting limit of 0.1g/kg Organic fibres detected	No asbestos detected at reporting limit of 0.1g/kg Organic fibres detected	No asbestos detected at reporting limit of 0.1g/kg Organic fibres detected	No asbestos detected at reporting limit of 0.1g/kg Organic fibres detected
Trace Analysis	-	No asbestos detected	No asbestos detected	No asbestos detected	No asbestos detected	No asbestos detected

Asbestos ID - soils					
Our Reference:	UNITS	130575-6	130575-7	130575-8	130575-9
Your Reference	-------------	BH6	BH7	BH8	BH9
Depth	------------	0.5	0.5	0.5	1.0
Date Sampled		-	-	30/06/2015	29/06/2015
Type of sample		Soil	Soil	Soil	Soil
Date analysed	-	7/07/2015	7/07/2015	7/07/2015	7/07/2015
Sample mass tested	g	Approx. 35g	Approx. 30g	Approx. 35g	Approx. 35g
Sample Description	-	Brown coarse grain soil & rocks	Brown coarse grain soil & rocks	Brown coarse grain soil & rocks	Brown coarse grain soil & rocks
Asbestos ID in soil	-	No asbestos detected at reporting limit of 0.1g/kg Organic fibres detected	No asbestos detected at reporting limit of 0.1g/kg Organic fibres detected	No asbestos detected at reporting limit of 0.1g/kg Organic fibres detected	No asbestos detected at reporting limit of 0.1g/kg Organic fibres detected
Trace Analysis	-	No asbestos detected	No asbestos detected	No asbestos detected	No asbestos detected

Method ID	Methodology Summary
Org-016	Soil samples are extracted with methanol and spiked into water prior to analysing by purge and trap GC-MS. Water samples are analysed directly by purge and trap GC-MS. F1 = (C6-C10)-BTEX as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater.
Org-014	Soil samples are extracted with methanol and spiked into water prior to analysing by purge and trap GC-MS.
Org-003	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-FID. F2 = (>C10-C16)-Naphthalene as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater (HSLs Tables 1A (3, 4)). Note Naphthalene is determined from the VOC analysis.
Org-012 subset	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-MS. Benzo(a)pyrene TEQ as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater - 2013. For soil results:- 1. 'TEQ PQL' values are assuming all contributing PAHs reported as <PQL are actually at the PQL. This is the most conservative approach and can give false positive TEQs given that PAHs that contribute to the TEQ calculation may not be present. 2. 'TEQ zero' values are assuming all contributing PAHs reported as <PQL are zero. This is the least conservative approach and is more susceptible to false negative TEQs when PAHs that contribute to the TEQ calculation are present but below PQL. 3. 'TEQ half PQL' values are assuming all contributing PAHs reported as <PQL are half the stipulated PQL. Hence a mid-point between the most and least conservative approaches above. Note, the Total +ve PAHs PQL is reflective of the lowest individual PQL and is therefore" Total +ve PAHs" is simply a sum of the positive individual PAHs.
Org-005	Soil samples are extracted with dichloromethane/acetone and waters with dichloromethane and analysed by GC with dual ECD's.
Org-008	Soil samples are extracted with dichloromethane/acetone and waters with dichloromethane and analysed by GC with dual ECD's.
Org-006	Soil samples are extracted with dichloromethane/acetone and waters with dichloromethane and analysed by GC-ECD.
Metals-020 ICP-AES	Determination of various metals by ICP-AES.
Metals-021 CV-AAS	Determination of Mercury by Cold Vapour AAS.
Inorg-031	Total Phenolics by segmented flow analyser (in line distillation with colourimetric finish). Solids are extracted in a caustic media prior to analysis.
Inorg-008	Moisture content determined by heating at 105+/-5 deg C for a minimum of 12 hours.
ASB-001	Asbestos ID - Qualitative identification of asbestos in bulk samples using Polarised Light Microscopy and Dispersion Staining Techniques including Synthetic Mineral Fibre and Organic Fibre as per Australian Standard 4964-2004.

QUALITY CONTROL vTRH(C6-C10)/BTEXN in Soil	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Date extracted	-			06/07/2015	130575-1	06/07/2015 || 06/07/2015	LCS-1	06/07/2015
Date analysed	-			06/07/2015	130575-1	06/07/2015 || 06/07/2015	LCS-1	06/07/2015
TRH C_6 - C_9	mg/kg	25	Org-016	<25	130575-1	<25 || <25	LCS-1	101%
TRH C_6 - C_{10}	mg/kg	25	Org-016	<25	130575-1	<25 || <25	LCS-1	101%
Benzene	mg/kg	0.2	Org-016	<0.2	130575-1	<0.2 || <0.2	LCS-1	99%
Toluene	mg/kg	0.5	Org-016	<0.5	130575-1	<0.5 || <0.5	LCS-1	100%
Ethylbenzene	mg/kg	1	Org-016	<1	130575-1	<1 || <1	LCS-1	101%
m+p-xylene	mg/kg	2	Org-016	<2	130575-1	<2 || <2	LCS-1	103%
o-Xylene	mg/kg	1	Org-016	<1	130575-1	<1 || <1	LCS-1	99%
naphthalene	mg/kg	1	Org-014	<1	130575-1	<1 || <1	[NR]	[NR]
Surrogate aaa-Trifluorotoluene	%		Org-016	99	130575-1	94 || 95 || RPD: 1	LCS-1	99%

QUALITY CONTROL svTRH (C10-C40) in Soil	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Date extracted	-			06/07/2015	130575-1	06/07/2015 || 06/07/2015	LCS-1	06/07/2015
Date analysed	-			06/07/2015	130575-1	06/07/2015 || 06/07/2015	LCS-1	06/07/2015
TRH C_{10} - C_{14}	mg/kg	50	Org-003	<50	130575-1	<50 || <50	LCS-1	98%
TRH C_{15} - C_{28}	mg/kg	100	Org-003	<100	130575-1	<100 || <100	LCS-1	101%
TRH C_{29} - C_{36}	mg/kg	100	Org-003	<100	130575-1	<100 || <100	LCS-1	96%
TRH >C_{10}-C_{16}	mg/kg	50	Org-003	<50	130575-1	<50 || <50	LCS-1	98%
TRH >C_{16}-C_{34}	mg/kg	100	Org-003	<100	130575-1	<100 || <100	LCS-1	101%
TRH >C_{34}-C_{40}	mg/kg	100	Org-003	<100	130575-1	<100 || <100	LCS-1	96%
Surrogate o-Terphenyl	%		Org-003	85	130575-1	87 || 83 || RPD: 5	LCS-1	111%

QUALITY CONTROL PAHs in Soil	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Date extracted	-			06/07/2015	130575-1	06/07/2015 || 06/07/2015	LCS-1	06/07/2015
Date analysed	-			06/07/2015	130575-1	06/07/2015 || 06/07/2015	LCS-1	06/07/2015
Naphthalene	mg/kg	0.1	Org-012 subset	<0.1	130575-1	<0.1 || <0.1	LCS-1	110%
Acenaphthylene	mg/kg	0.1	Org-012 subset	<0.1	130575-1	<0.1 || <0.1	[NR]	[NR]
Acenaphthene	mg/kg	0.1	Org-012 subset	<0.1	130575-1	<0.1 || <0.1	[NR]	[NR]
Fluorene	mg/kg	0.1	Org-012 subset	<0.1	130575-1	<0.1 || <0.1	LCS-1	98%
Phenanthrene	mg/kg	0.1	Org-012 subset	<0.1	130575-1	0.1 || 0.1 || RPD: 0	LCS-1	99%
Anthracene	mg/kg	0.1	Org-012 subset	<0.1	130575-1	<0.1 || <0.1	[NR]	[NR]
Fluoranthene	mg/kg	0.1	Org-012 subset	<0.1	130575-1	0.4 || 0.6 || RPD: 40	LCS-1	99%

QUALITY CONTROL PAHs in Soil	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Pyrene	mg/kg	0.1	Org-012 subset	<0.1	130575-1	0.5 || 0.6 || RPD: 18	LCS-1	103%
Benzo(a)anthracene	mg/kg	0.1	Org-012 subset	<0.1	130575-1	0.2 || 0.3 || RPD: 40	[NR]	[NR]
Chrysene	mg/kg	0.1	Org-012 subset	<0.1	130575-1	0.2 || 0.3 || RPD: 40	LCS-1	99%
Benzo(b,j+k) fluoranthene	mg/kg	0.2	Org-012 subset	<0.2	130575-1	0.5 || 0.6 || RPD: 18	[NR]	[NR]
Benzo(a)pyrene	mg/kg	0.05	Org-012 subset	<0.05	130575-1	0.3 || 0.3 || RPD: 0	LCS-1	98%
Indeno(1,2,3-c,d)pyrene	mg/kg	0.1	Org-012 subset	<0.1	130575-1	0.2 || 0.2 || RPD: 0	[NR]	[NR]
Dibenzo(a,h)anthracene	mg/kg	0.1	Org-012 subset	<0.1	130575-1	<0.1 || <0.1	[NR]	[NR]
Benzo(g,h,i)perylene	mg/kg	0.1	Org-012 subset	<0.1	130575-1	0.2 || 0.2 || RPD: 0	[NR]	[NR]
Surrogate p-Terphenyl-d14	%		Org-012 subset	90	130575-1	104 || 106 || RPD: 2	LCS-1	99%

QUALITY CONTROL Organochlorine Pesticides in soil	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Date extracted	-			06/07/2015	130575-1	06/07/2015 || 06/07/2015	LCS-1	06/07/2015
Date analysed	-			06/07/2015	130575-1	06/07/2015 || 06/07/2015	LCS-1	06/07/2015
HCB	mg/kg	0.1	Org-005	<0.1	130575-1	<0.1 || <0.1	[NR]	[NR]
alpha-BHC	mg/kg	0.1	Org-005	<0.1	130575-1	<0.1 || <0.1	LCS-1	105%
gamma-BHC	mg/kg	0.1	Org-005	<0.1	130575-1	<0.1 || <0.1	[NR]	[NR]
beta-BHC	mg/kg	0.1	Org-005	<0.1	130575-1	<0.1 || <0.1	LCS-1	102%
Heptachlor	mg/kg	0.1	Org-005	<0.1	130575-1	<0.1 || <0.1	LCS-1	107%
delta-BHC	mg/kg	0.1	Org-005	<0.1	130575-1	<0.1 || <0.1	[NR]	[NR]
Aldrin	mg/kg	0.1	Org-005	<0.1	130575-1	<0.1 || <0.1	LCS-1	109%
Heptachlor Epoxide	mg/kg	0.1	Org-005	<0.1	130575-1	<0.1 || <0.1	LCS-1	103%
gamma-Chlordane	mg/kg	0.1	Org-005	<0.1	130575-1	<0.1 || <0.1	[NR]	[NR]
alpha-chlordane	mg/kg	0.1	Org-005	<0.1	130575-1	<0.1 || <0.1	[NR]	[NR]
Endosulfan I	mg/kg	0.1	Org-005	<0.1	130575-1	<0.1 || <0.1	[NR]	[NR]
pp-DDE	mg/kg	0.1	Org-005	<0.1	130575-1	<0.1 || <0.1	LCS-1	105%
Dieldrin	mg/kg	0.1	Org-005	<0.1	130575-1	<0.1 || <0.1	LCS-1	109%
Endrin	mg/kg	0.1	Org-005	<0.1	130575-1	<0.1 || <0.1	LCS-1	108%
pp-DDD	mg/kg	0.1	Org-005	<0.1	130575-1	<0.1 || <0.1	LCS-1	114%
Endosulfan II	mg/kg	0.1	Org-005	<0.1	130575-1	<0.1 || <0.1	[NR]	[NR]
pp-DDT	mg/kg	0.1	Org-005	<0.1	130575-1	<0.1 || <0.1	[NR]	[NR]
Endrin Aldehyde	mg/kg	0.1	Org-005	<0.1	130575-1	<0.1 || <0.1	[NR]	[NR]
Endosulfan Sulphate	mg/kg	0.1	Org-005	<0.1	130575-1	<0.1 || <0.1	LCS-1	105%
Methoxychlor	mg/kg	0.1	Org-005	<0.1	130575-1	<0.1 || <0.1	[NR]	[NR]
Surrogate TCMX	%		Org-005	99	130575-1	102 || 100 || RPD: 2	LCS-1	99%

QUALITY CONTROL Organophosphorus Pesticides	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date extracted	-			06/07/2015	130575-1	06/07/2015 || 06/07/2015	LCS-1	06/07/2015
Date analysed	-			06/07/2015	130575-1	06/07/2015 || 06/07/2015	LCS-1	06/07/2015
Azinphos-methyl (Guthion)	mg/kg	0.1	Org-008	<0.1	130575-1	<0.1 || <0.1	LCS-1	102%
Bromophos-ethyl	mg/kg	0.1	Org-008	<0.1	130575-1	<0.1 || <0.1	[NR]	[NR]
Chlorpyriphos	mg/kg	0.1	Org-008	<0.1	130575-1	<0.1 || <0.1	LCS-1	123%
Chlorpyriphos-methyl	mg/kg	0.1	Org-008	<0.1	130575-1	<0.1 || <0.1	[NR]	[NR]
Diazinon	mg/kg	0.1	Org-008	<0.1	130575-1	<0.1 || <0.1	[NR]	[NR]
Dichlorvos	mg/kg	0.1	Org-008	<0.1	130575-1	<0.1 || <0.1	LCS-1	88%
Dimethoate	mg/kg	0.1	Org-008	<0.1	130575-1	<0.1 || <0.1	[NR]	[NR]
Ethion	mg/kg	0.1	Org-008	<0.1	130575-1	<0.1 || <0.1	LCS-1	126%
Fenitrothion	mg/kg	0.1	Org-008	<0.1	130575-1	<0.1 || <0.1	LCS-1	109%
Malathion	mg/kg	0.1	Org-008	<0.1	130575-1	<0.1 || <0.1	LCS-1	80%
Parathion	mg/kg	0.1	Org-008	<0.1	130575-1	<0.1 || <0.1	LCS-1	106%
Ronnel	mg/kg	0.1	Org-008	<0.1	130575-1	<0.1 || <0.1	[NR]	[NR]
Surrogate TCMX	%		Org-008	99	130575-1	102 || 100 || RPD: 2	LCS-1	102%

QUALITY CONTROL PCBs in Soil	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date extracted	-			06/07/2015	130575-1	06/07/2015 || 06/07/2015	LCS-1	06/07/2015
Date analysed	-			06/07/2015	130575-1	06/07/2015 || 06/07/2015	LCS-1	06/07/2015
Aroclor 1016	mg/kg	0.1	Org-006	<0.1	130575-1	<0.1 || <0.1	[NR]	[NR]
Aroclor 1221	mg/kg	0.1	Org-006	<0.1	130575-1	<0.1 || <0.1	[NR]	[NR]
Aroclor 1232	mg/kg	0.1	Org-006	<0.1	130575-1	<0.1 || <0.1	[NR]	[NR]
Aroclor 1242	mg/kg	0.1	Org-006	<0.1	130575-1	<0.1 || <0.1	[NR]	[NR]
Aroclor 1248	mg/kg	0.1	Org-006	<0.1	130575-1	<0.1 || <0.1	[NR]	[NR]
Aroclor 1254	mg/kg	0.1	Org-006	<0.1	130575-1	<0.1 || <0.1	LCS-1	128%
Aroclor 1260	mg/kg	0.1	Org-006	<0.1	130575-1	<0.1 || <0.1	[NR]	[NR]
Surrogate TCLMX	%		Org-006	99	130575-1	102 || 100 || RPD: 2	LCS-1	91%

QUALITY CONTROL Acid Extractable metals in soil	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date digested	-			06/07/2015	130575-1	06/07/2015 || 06/07/2015	LCS-1	06/07/2015
Date analysed	-			06/07/2015	130575-1	06/07/2015 || 06/07/2015	LCS-1	06/07/2015
Arsenic	mg/kg	4	Metals-020 ICP-AES	<4	130575-1	<4 || <4	LCS-1	102%
Cadmium	mg/kg	0.4	Metals-020 ICP-AES	<0.4	130575-1	<0.4 || <0.4	LCS-1	96%
Chromium	mg/kg	1	Metals-020 ICP-AES	<1	130575-1	14 || 12 || RPD: 15	LCS-1	98%
Copper	mg/kg	1	Metals-020 ICP-AES	<1	130575-1	32 || 23 || RPD: 33	LCS-1	96%
Lead	mg/kg	1	Metals-020 ICP-AES	<1	130575-1	18 || 15 || RPD: 18	LCS-1	92%
Mercury	mg/kg	0.1	Metals-021 CV-AAS	<0.1	130575-1	<0.1 || <0.1	LCS-1	76%
Nickel	mg/kg	1	Metals-020 ICP-AES	<1	130575-1	10 || 9 || RPD: 11	LCS-1	93%
Zinc	mg/kg	1	Metals-020 ICP-AES	<1	130575-1	41 || 34 || RPD: 19	LCS-1	96%

QUALITY CONTROL Misc Soil - Inorg	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			06/07/2015	130575-1	06/07/2015 || 06/07/2015	LCS-1	06/07/2015
Date analysed	-			06/07/2015	130575-1	06/07/2015 || 06/07/2015	LCS-1	06/07/2015
Total Phenolics (as Phenol)	mg/kg	5	Inorg-031	<5	130575-1	<5 || <5	LCS-1	101%

QUALITY CONTROL vTRH(C6-C10)/BTEXN in Soil	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Spike % Recovery
Date extracted	-	[NT]	[NT]	130575-2	06/07/2015
Date analysed	-	[NT]	[NT]	130575-2	06/07/2015
TRHC_6 - C_9	mg/kg	[NT]	[NT]	130575-2	101%
TRHC_6 - C_{10}	mg/kg	[NT]	[NT]	130575-2	101%
Benzene	mg/kg	[NT]	[NT]	130575-2	99%
Toluene	mg/kg	[NT]	[NT]	130575-2	100%
Ethylbenzene	mg/kg	[NT]	[NT]	130575-2	100%
m+p-xylene	mg/kg	[NT]	[NT]	130575-2	102%
o-Xylene	mg/kg	[NT]	[NT]	130575-2	99%
naphthalene	mg/kg	[NT]	[NT]	[NR]	[NR]
Surrogate aaa-Trifluorotoluene	%	[NT]	[NT]	130575-2	93%

QUALITY CONTROL svTRH (C10-C40) in Soil	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Spike % Recovery
Date extracted	-	[NT]	[NT]	130575-2	07/07/2015
Date analysed	-	[NT]	[NT]	130575-2	07/07/2015
TRHC $_{10}$ - C $_{14}$	mg/kg	[NT]	[NT]	130575-2	89%
TRHC $_{15}$ - C $_{28}$	mg/kg	[NT]	[NT]	130575-2	#
TRHC $_{29}$ - C $_{36}$	mg/kg	[NT]	[NT]	130575-2	#
TRH>C $_{10}$-C $_{16}$	mg/kg	[NT]	[NT]	130575-2	89%
TRH>C $_{16}$-C $_{34}$	mg/kg	[NT]	[NT]	130575-2	#
TRH>C $_{34}$-C $_{40}$	mg/kg	[NT]	[NT]	130575-2	#
Surrogate o-Terphenyl	%	[NT]	[NT]	130575-2	104%

QUALITY CONTROL PAHs in Soil	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Spike % Recovery
Date extracted	-	[NT]	[NT]	130575-2	07/07/2015
Date analysed	-	[NT]	[NT]	130575-2	07/07/2015
Naphthalene	mg/kg	[NT]	[NT]	130575-2	105%
Acenaphthylene	mg/kg	[NT]	[NT]	[NR]	[NR]
Acenaphthene	mg/kg	[NT]	[NT]	[NR]	[NR]
Fluorene	mg/kg	[NT]	[NT]	130575-2	94%
Phenanthrene	mg/kg	[NT]	[NT]	130575-2	108%
Anthracene	mg/kg	[NT]	[NT]	[NR]	[NR]
Fluoranthene	mg/kg	[NT]	[NT]	130575-2	#
Pyrene	mg/kg	[NT]	[NT]	130575-2	#
Benzo(a)anthracene	mg/kg	[NT]	[NT]	[NR]	[NR]
Chrysene	mg/kg	[NT]	[NT]	130575-2	133%
Benzo(b,j+k)fluoranthene	mg/kg	[NT]	[NT]	[NR]	[NR]
Benzo(a)pyrene	mg/kg	[NT]	[NT]	130575-2	#
Indeno(1,2,3-c,d)pyrene	mg/kg	[NT]	[NT]	[NR]	[NR]
Dibenzo(a,h)anthracene	mg/kg	[NT]	[NT]	[NR]	[NR]
Benzo(g,h,i)perylene	mg/kg	[NT]	[NT]	[NR]	[NR]
Surrogate p-Terphenyl-d14	%	[NT]	[NT]	130575-2	91%

QUALITY CONTROL Organochlorine Pesticides in soil	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Spike % Recovery
Date extracted	-	[NT]	[NT]	130575-2	06/07/2015
Date analysed	-	[NT]	[NT]	130575-2	06/07/2015
HCB	mg/kg	[NT]	[NT]	[NR]	[NR]
alpha-BHC	mg/kg	[NT]	[NT]	130575-2	103%
gamma-BHC	mg/kg	[NT]	[NT]	[NR]	[NR]
beta-BHC	mg/kg	[NT]	[NT]	130575-2	97%
Heptachlor	mg/kg	[NT]	[NT]	130575-2	101%
delta-BHC	mg/kg	[NT]	[NT]	[NR]	[NR]
Aldrin	mg/kg	[NT]	[NT]	130575-2	107%
Heptachlor Epoxide	mg/kg	[NT]	[NT]	130575-2	102%
gamma-Chlordane	mg/kg	[NT]	[NT]	[NR]	[NR]
alpha-chlordane	mg/kg	[NT]	[NT]	[NR]	[NR]
Endosulfan I	mg/kg	[NT]	[NT]	[NR]	[NR]
pp-DDE	mg/kg	[NT]	[NT]	130575-2	100%
Dieldrin	mg/kg	[NT]	[NT]	130575-2	104%
Endrin	mg/kg	[NT]	[NT]	130575-2	103%
pp-DDD	mg/kg	[NT]	[NT]	130575-2	107%
Endosulfan II	mg/kg	[NT]	[NT]	[NR]	[NR]
pp-DDT	mg/kg	[NT]	[NT]	[NR]	[NR]
Endrin Aldehyde	mg/kg	[NT]	[NT]	[NR]	[NR]
Endosulfan Sulphate	mg/kg	[NT]	[NT]	130575-2	100%
Methoxychlor	mg/kg	[NT]	[NT]	[NR]	[NR]
Surrogate TCMX	%	[NT]	[NT]	130575-2	95%

QUALITY CONTROL Organophosphorus Pesticides	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Spike % Recovery
Date extracted	-	[NT]	[NT]	130575-2	06/07/2015
Date analysed	-	[NT]	[NT]	130575-2	06/07/2015
Azinphos-methyl (Guthion)	mg/kg	[NT]	[NT]	130575-2	95%
Bromophos-ethyl	mg/kg	[NT]	[NT]	[NR]	[NR]
Chlorpyriphos	mg/kg	[NT]	[NT]	130575-2	114%
Chlorpyriphos-methyl	mg/kg	[NT]	[NT]	[NR]	[NR]
Diazinon	mg/kg	[NT]	[NT]	[NR]	[NR]
Dichlorvos	mg/kg	[NT]	[NT]	130575-2	90%
Dimethoate	mg/kg	[NT]	[NT]	[NR]	[NR]
Ethion	mg/kg	[NT]	[NT]	130575-2	106%
Fenitrothion	mg/kg	[NT]	[NT]	130575-2	104%
Malathion	mg/kg	[NT]	[NT]	130575-2	77%
Parathion	mg/kg	[NT]	[NT]	130575-2	98%
Ronnel	mg/kg	[NT]	[NT]	[NR]	[NR]
Surrogate TCMX	%	[NT]	[NT]	130575-2	99%

QUALITY CONTROL PCBs in Soil	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Spike % Recovery
Date extracted	-	[NT]	[NT]	130575-2	06/07/2015
Date analysed	-	[NT]	[NT]	130575-2	06/07/2015
Aroclor 1016	mg/kg	[NT]	[NT]	[NR]	[NR]
Aroclor 1221	mg/kg	[NT]	[NT]	[NR]	[NR]
Aroclor 1232	mg/kg	[NT]	[NT]	[NR]	[NR]
Aroclor 1242	mg/kg	[NT]	[NT]	[NR]	[NR]
Aroclor 1248	mg/kg	[NT]	[NT]	[NR]	[NR]
Aroclor 1254	mg/kg	[NT]	[NT]	130575-2	123%
Aroclor 1260	mg/kg	[NT]	[NT]	[NR]	[NR]
Surrogate TCLMX	%	[NT]	[NT]	130575-2	93%

QUALITY CONTROL Acid Extractable metals in soil	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Spike % Recovery
Date digested	-	[NT]	[NT]	130575-2	06/07/2015
Date analysed	-	[NT]	[NT]	130575-2	06/07/2015
Arsenic	mg/kg	[NT]	[NT]	130575-2	97%
Cadmium	mg/kg	[NT]	[NT]	130575-2	97%
Chromium	mg/kg	[NT]	[NT]	130575-2	97%
Copper	mg/kg	[NT]	[NT]	130575-2	125%
Lead	mg/kg	[NT]	[NT]	130575-2	96%
Mercury	mg/kg	[NT]	[NT]	130575-2	85%
Nickel	mg/kg	[NT]	[NT]	130575-2	106%
Zinc	mg/kg	[NT]	[NT]	130575-2	105%

Report Comments:

Total Recoverable Hydrocarbons in soil: # Percent recovery is not possible to report as the high concentration of analytes in the sample/s have caused interference.

PAH_S: # Percent recovery is not possible to report as the high concentration of analytes in the sample/s have caused interference.

Asbestos: A portion of the supplied samples were sub-sampled for asbestos analysis according to Envirolab procedures. We cannot guarantee that these sub-samples are indicative of the entire sample. Envirolab recommends supplying 40-50g of sample in its own container.

OC/OP/PCB's in soil:PQL has been raised due to interference from analytes(other than those being tested) in the sample/s.

Asbestos ID was analysed by Approved Identifier:	Paul Ching
Asbestos ID was authorised by Approved Signatory:	Paul Ching

INS: Insufficient sample for this test	PQL: Practical Quantitation Limit	NT: Not tested
NA: Test not required	RPD: Relative Percent Difference	NA: Test not required
<: Less than	>: Greater than	LCS: Laboratory Control Sample

Quality Control Definitions

Blank: This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.

Duplicate: This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.

Matrix Spike : A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.

LCS (Laboratory Control Sample) : This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.

Surrogate Spike: Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.
Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.
Spikes for Physical and Aggregate Tests are not applicable.
For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.
Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

CHAIN OF CUSTODY

Douglas Partners
Geotechnics / Environment / Groundwater

Client:	Douglas Partners	Project Number	84897	To:	Envirolab Services
Contact Person:	Kelly McPhee	Project Name:	Sydney University	Contact Person:	Aileen Hie
Project Mgr:	Geoff Young	PO No.:	122353	Address:	12 Ashley Street
Sampler:	Kelly McPhee	lab Quote No. :			Chatswood NSW 2068
Address:	96 Hermitage Road West Ryde NSW 2114	Date results required:	3 day	Phone:	02 9910 6200
		Or choose: standard / same day / 1 day / 2 day / 3 day *Note: Inform lab in advance if urgent turnaround is required - surcharges apply*		Fax:	02 9910 6201
				Email:	ahie@envirolab.com.au
Phone:	9809 0666 Mob: 0419 781 366	Report format: esdat / PDF / Excel		Laboratory Report No:	
Email:	kelly.mcphee @douglaspartners.com.au geoff.young @douglaspartners.com.au	Comments:		Lab Comments:	
Prior Storage (Fridge, Esky, Shelf)					

	Field Sample ID	Depth	Date sampled	Container Type	Type of sample	Combo 8a	Comments
1	BH1	1.0	12/06/2015	jar	soil	X	
2	BH2	0.5	12/06/2015	jar	soil	X	
3	BH3	1.0	11/06/2015	jar	soil	X	
4	BH4	0.5		jar	soil	X	
5	BH5	0.5	29/06/2015	jar	soil	X	
6	BH6	0.5		jar	soil	X	
7	BH7	0.5		jar	soil	X	
8	BH8	0.5	30/06/2015	jar	soil	X	
9	BH9	1.0	29/06/2015	jar	soil	X	

ENVIROLAB
Envirolab Services
12 Ashley St
Chatswood NSW 2067
Ph: (02) 9910 6200
Job No: 130575
Date Received: 3/7/15
Time Received: 17:40
Received by: PT
Temp: Cool/Ambient 3.6
Cooling: Ice/Icepack
Security: Intact/Broken/None

Relinquished by: Douglas Partners	Sample Receipt	*Lab use only:*
Hand delivered / Courier (by whom)	Received by (Company): ELS	Samples Received: Cool or Ambient (circle one)
Condition of Sample at dispatch Cool or Ambient (circle)	Print Name: Phd	Temperature Received at: (if applicable) 3.6°C
Temperature (if Applicable)	Date & Time: 3/7/15 17:40	Transported by: Hand delivered / courier
Print Name: Kelly McPhee	Signature: PT	
Date & Time: 3/7 2.30pm		
Signature:		Page____ of ____

13 March 2015

REPORT

THE UNIVERSITY OF SYDNEY

Geotechnical Desktop Study for Proposed New Building and Extension (F07 and F23 Projects)

Submitted to:
Katie Pritchard
The University of Sydney
Campus Infrastructure and Services
Level 1, Service Building G12
Darlington Campus

Report Number. 1520860_001_R_Rev0

Distribution:

The University of Sydney - 1 Copy
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1.0 INTRODUCTION

Golder Associates (Golder) has been engaged by the University of Sydney - Campus Infrastructure and Services team (CIS) to undertake a geotechnical desktop study for a proposed new administrative building (F23 building) and an extension of the existing Carslaw building (F07 extension).

This desktop study was carried out in general accordance with Golder proposal Ref. P1520860_001_P_Rev 0 dated 15 January 2015.

Both projects are located within the Darlington Campus of the University of Sydney. The F23 building is being constructed to co-locate and consolidate administrative functions. It is going to be constructed on an area currently used for car parking (Figure 1) and is likely to include two basement levels.

Figure 1: The site of proposed building F23

Figure 2: The site of the F07 extension

The F07 extension will be used to co-locate the schools of Molecular Bio-Science and Biological Sciences (Figure 2). The extension to the existing Carslaw building is likely to include one basement level.

1.1 Scope of Work

The purpose of this geotechnical desktop study is to provide a review of available information relating to the existing site conditions to assist further planning and design development. The following scope of work has been completed:

- A review of available geological and topographical information for the site, including previous geotechnical reports, provided by CIS, and hydrogeological information.
- A site visit by a senior geotechnical engineer (Jamie McIlquham).
- A review of documented location of major utility services in the project area obtained from a Dial Before You Dig enquiry.
- A preliminary assessment of the potential for Acid Sulfate Soil (ASS) using ASS risk maps (ASRIS, 2015).
- A review of available groundwater bore information in the study area.
- A search of dangerous goods records through WorkCover.
- A review of the contamination land records and environmental protection licence information.
- An assessment of anticipated subsurface materials and their likely geotechnical properties.

2.0 DESK STUDY INFORMATION

2.1 Site Location and Physical Description

The F23 building and F07 extension sites are located in Camperdown, Sydney within the Darlington Campus of the University of Sydney at the intersection of City Road and Eastern Avenue (Figure 3).

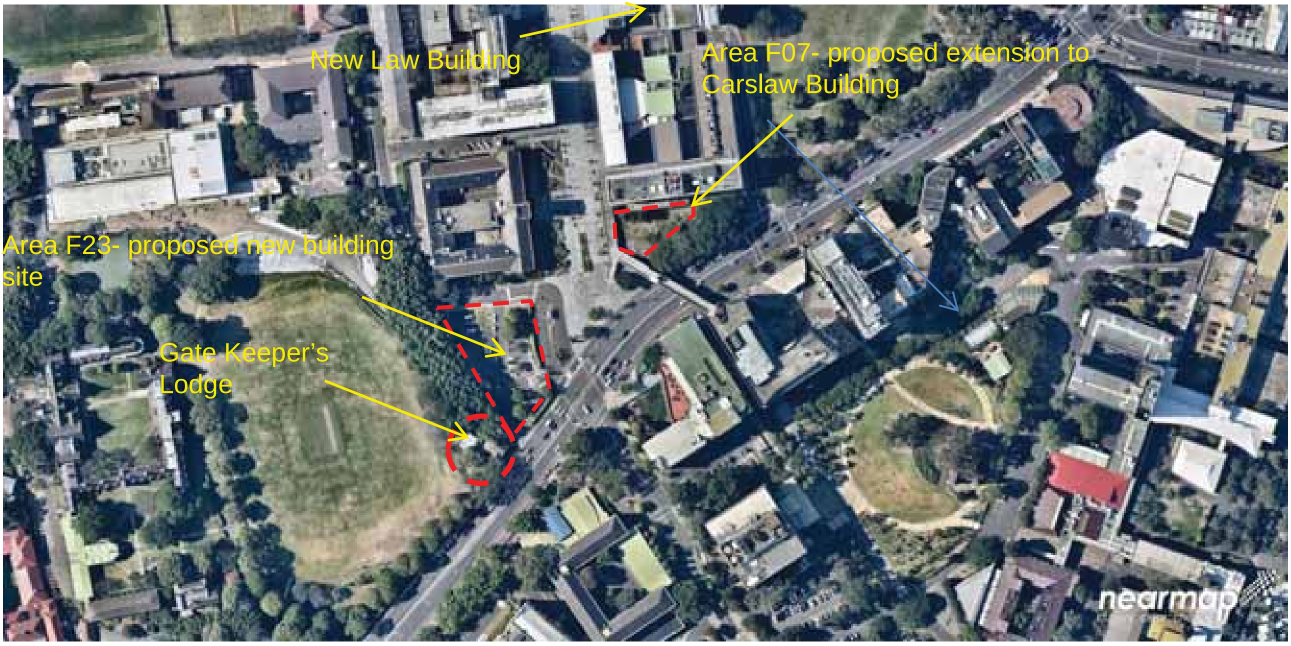

Figure 3: Locality of the study area: F07 and F23 Project sites.

The study area for the F07 extension is currently a planted area with large trees, which is bounded by the Carslaw Building to the north, City Road to the south, Barff Road to the east and Eastern Avenue to the west. The Keith Murray footbridge over City Road is located at the southwest corner of this area. The site for the F07 extension is generally flat with the ground surface generally sloping from north-west down to the south-east from approximately RL 35.5 m AHD to RL 33 m AHD over a length of about 40 m (USYD, 2013 & 2014).

The study area for the proposed F23 building is bounded by a road and the Madsen Building to the north, a vehicle access road to the east, City Road to the south, and Fisher Road and St. Paul's Oval to the west. The site for proposed building F23 is generally flat with the natural topography sloping from south-east down to the north-west from approximately RL 35 m AHD to RL 33 m AHD over a length of about 70 m (Site Survey Plan). The area is also scattered with eight medium to large trees along the walkways.

From a broader scale the study areas appear to be located on a ridge line with approximately north-south alignment.

2.2 Geology, Subsurface profile and Hydrogeology

2.2.1 Geology

The Geological Survey of NSW 1:100,000 map (Geological Series Sheet 9130, Edition 1, 1983) indicates that the site is underlain by Ashfield Shale, consisting of black to dark-grey shale and laminite with frequent sideritic clay ironstone bands. Weathering of the shale tends to produce a reddish/brown clay soil, often with poor drainage. These clay soils are usually reactive with an appreciable shrink-swell capacity when subjected to moisture variation (Howard, 1969).

Geological features in Sydney Basin typically include north-east to south-west trending faults and joint swarms that vary between about 50-80 m in width and Tertiary Age west to east oriented igneous dykes

(Och et al., 2004). The joint swarms consist of rock mass zones of relatively closer jointing than the generally widely spaced jointing of the surrounding rockmass.

The fault zones are known to comprise of much closer-jointing, shearing and measurable displacement of few metres at specific intervals resulting in fragmented, broken and clayey very poor quality rockmass.

The dykes are generally basaltic in composition and range from a few centimetres to up to 6 metres wide. Where dykes are encountered at shallow depth they are characterised by extremely weathered, low strength rock and clay together with more fractured surrounding rockmass caused by the intrusion.

No major geological structures, such as dykes, faults or folds are shown at the site. The nearest dykes recorded on the map are located over 1 km to the north east of the site trending from north-west to south-east.

The previous geotechnical investigation by JK Group (JK, 2012) and our site observations (refer Section 3) also indicate that Ashfield Shale is present at locations close to the proposed project sites.

2.2.2 Subsurface Profile

We anticipate that the site will have a relatively thin surficial fill layer associated with ground surface levelling, backfilling structures and construction of road and pavement areas. As the University has operated over a significant length of times and buildings in the area are of different ages, there may be different fills over the study area.

The fill materials may be underlain by residual soils associated with the shale. Typically fill is anticipated to comprise silty clay soils, and possibly road base materials below paved areas (JK, 2012). The shale bedrock is expected to be encountered at less than 4 m depth below ground surface, as suggested by design drawings for the footbridge over City Road (GHD, 2006). The shale encountered in previous investigations, at St Paul's College approximately 50-70 m north-west of the Area F23, showed a significant depth of weathering. Approximately the upper 5 to 10 m of the shale bedrock was recorded as extremely to distinctly weathered. The weathered shale was reported as mostly extremely low to very low strength, increasing to medium to high strength at depths of approximately 15 m below existing ground level (JK, 2012).

Based on published data, shale bedrock is anticipated to comprise near horizontal bedding planes, sub-vertical joints with at up to 90° to the horizontal, and joints with 30-60° to the horizontal with South-West or North-East dip direction (Bertuzzi & Pells, 2002). The JK Group investigation (JK, 2012) found that the structure of the shale bedrock comprised near horizontal bedding planes, joints at up to 90° to the horizontal and clay and extremely weathered seams.

The published geology and JK Group (JK, 2012) information is consistent with the records of a registered Groundwater Well (GW110247), located 250 m south-west of the site, which recorded shale bedrock at a depth of 4.5 m. Shale bedrock (Class V) was also inferred at 2 to 3 m depth at the location of the USYD footbridge (GHD, 2006).

2.2.3 Hydrogeology

The JK Group (JK, 2012) report indicates that the groundwater level around the study areas is likely to be around RL 24 m AHD (i.e. approximately 8 to 10 m below the existing ground level).

The nearest groundwater bore licensed by NSW Office of Water (GW110247) is located 250 m south-west of the site. In this bore, the upper water bearing zone was located at 22 m depth below the ground level at the well location.

2.3 Services

To assess the potential presence of services close to the site, we have completed a Dial Before You Dig enquiry. The information obtained identified the following utilities which may be affected by the proposed basement excavations:

F23 Building:

- A main Telstra cable runs across the F23 project site from Fisher Road near the Gate Keepers Lodge (see Figure 3) to the Madsen Building.
- An Ausgrid conduit has been installed along the walkway to the south of Area F23.

F07 Extension:

- Telstra and Optus fibres run along the northern boundary of Area F07 and the pedestrian walkway to the west of the area.
- Ausgrid conduits have been installed along the north-west corner of this area and the walkway to the west.

A brick sewer line is located to the south-west of Area F07, which crosses City Road and Eastern Avenue. There are also underground cables for traffic signals at the intersection of Eastern Avenue and City Road.

2.4 Acid Sulfate Soils

The Australian Soil Resource Information System (ASRIS), maintained by CSIRO, shows the ASS risk in the study areas is Class C4 'Extremely Low Probability/Low Confidence' with 'No Known Occurrence' (ASRIS 2015). This is consistent with the location of the site and the published geology of the area. ASS is usually formed within waterlogged conditions in low lying areas (typically below RL 5 m AHD).

2.5 Regulatory Agency Records Searches

2.5.1 NSW Environment Protection Authority

A search of online records held by the NSW Environment Protection Authority (EPA) was undertaken. The search findings are presented below.

2.5.2 CLM Act Notices

An on-line search on 18 February 2015 of the EPA's "Record of Notices" issued under the *Contaminated Land Management Act 1997* (the CLM Act) did not identify the project sites as being subject to current or prior notices. One premise within Camperdown was identified as having a former notice issued under the provisions of the CLM Act. The premise, located approximately 1.5 km to the west, is considered to have a low potential to impact on the project sites.

2.5.3 Notifications under Section 60 of the CLM Act

The NSW EPA maintains a "List of NSW contaminated sites notified to the EPA" under Section 60 of the *CLM Act*. Sites on this list indicate that the notifiers consider that the sites are contaminated and warrant reporting to EPA. The contamination at the site may or may not be significant enough to warrant regulation by the EPA and the EPA reviews relevant site information before making a determination as to whether or not the site warrants regulation. An online search for NSW sites near to the proposed project sites was performed on 18 February 2015.

Two premises in Camperdown and four premises in Newtown were identified as having current or former notices issued under the provisions of the CLM Act. These premises, located approximately 0.8 to 1.5 km from the project sites, are considered to have a low potential to impact on the project sites.

2.5.4 EPLs under the POEO Act

The NSW EPA maintains a public register of premises subject to an Environment Protection Licence (EPL) under the *Protection of the Environment Operations Act 1997*. An online search for premises in the Camperdown and Darlington was performed on 18 February 2015. The result of the search, limited to premises within 1 km of the site, is presented in the table below.

Table 1: EPL Search Results

Premises	Distance and direction from site (approx.)	Licence status
Sydney South West Area Health Service, Missenden Road, Camperdown	750 m NW	No longer in force
Intec Ltd, Building J01, Maze Crescent, the University of Sydney, Darlington	150 m SW	No longer in force
John Holland Pty Ltd, Corner Codrington and Abercrombie Street, Darlington	350 m S	Surrendered

It is considered that the premises identified in the search would not impact on the site.

2.6 Notified Dangerous Goods

A search of the WorkCover NSW files for records relating to historical storage of Dangerous Goods at the site was requested by Golder on 16 February 2015. WorkCover NSW advised that a search of their Stored Chemical Information Database (SCID) and microfiche records did not locate any records relating to the site.

3.0 SITE WALKOVER

We visited the site on 26th February 2015. During the site visit, we inspected the general area of each proposed structure, as well as the basement of the Carslaw building and the car park basements below the New Law Building. Observations from the site walkover are summarised in Table 2, below.

Table 2: Site Walkover Observations

Location	Observations
Madsen Building	In general, the Madsen Building appears in good condition compared to other buildings of similar inferred age within the University, with no obvious signs of structural cracking identified during the site walkover. The building has a one level basement that in some areas has signs of groundwater having entered the building. Additional drainage has been provided in some of these areas (e.g. sump pump). The building contains vibration sensitive equipment, such as electron microscopes. During the site walkover, a University representative indicated that even low levels of vibration (i.e. doors slamming) can cause issues in the operation of this equipment.
New Law Building Car Park	The site walkover included inspections of the three level basement car park of the building. The retention system used was observed to be concrete soldier piles with shotcrete infill panels. In one part of the western wall of the 2nd basement level, shotcrete had been removed, exposing weathered shale rock, inferred to be Class IV shale (Figure 4). Groundwater inflow was observed to be occurring in some locations, this tended to be associated with joints in shotcrete infill and between shotcrete and piles (Figure 4).  *Figure 4: Observations in lower basement car park of New Law Building*
Carslaw Building	We did not enter the Carslaw Building during the walkover survey, although observations were made of an existing retaining wall at its southern end. This wall has moved slightly (up to about 10 mm at movement joints) and is approximately 4 m high. In general the Carslaw Building appeared to be in reasonable condition, with no obvious signs of structural cracking noted during the walkover survey.

4.0 DISCUSSION

Based on the available information, we present the following key geotechnical and geological issues for consideration in planning and further design development:

Excavation:

- Construction of the proposed basements may involve an excavation up to 6 to 7 m below existing ground levels. The excavation materials are likely to comprise fill, residual soil and variably weathered shale bedrock.
- Subgrade conditions may be poor, with fill materials and high plasticity clays likely to be present on the site. There may be a need for a suitable working platform to be constructed to allow construction plant to traffic the area during development.
- There is vibration sensitive equipment in the Madsen Building. The selection of excavation equipment may need to consider low vibration options. Alternatively, construction could be completed when the equipment is being maintained or is not in use.
- Excess spoil for offsite disposal will need to be classified in accordance with the *Waste Classification Guidelines Part 1: Classifying Waste* (EPA November 2014).

Groundwater Management

- Perched groundwater could potentially flow through the fill, residual or extremely weathered shale profile. This will need to be considered in design of excavations and retention systems. Dewatering may be required for both temporary and permanent excavations.
- The volume of groundwater flow depends on recent weather conditions, the nature of defects within the bedrock, topography and elevation. Groundwater level may also vary due to prevailing weather condition and rainfall, and also future development around the site.

Retention and Foundation Systems

- Temporary and permanent retention systems for excavations should be designed and constructed so that acceptable ground movements result. The retention design would need to assess impact of ground movements on nearby structures, services and roads.
- Mature trees located close to the proposed structures are to be retained. The potential impact of these trees on shallow foundations and retaining walls will need to be assessed. The potential impact of smaller trees that are removed over the footprint of the structures will also need to be assessed.
- For the F027 extension, the design of the connection between old and new structures will need to consider the potential for differential movement occurring between the structures.

Additional Geotechnical Investigation

In order to inform and optimise design development and manage geotechnical risk associated with the proposal developments construction, we recommend the following:

- The borehole information for the footbridge over City Road is found. This may well include information that will be useful in the design of the F07 extension and may reduce the cost of further geotechnical investigations.
- That additional geotechnical and environmental investigations are completed at the locations of the proposed structures. These should be used to confirm the site subsurface conditions and to enable recovery of soil and groundwater samples. Golder is available to scope and carry out a detail design intrusive geotechnical investigation, as required.

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Your attention is drawn to the following limitations, which must be read in conjunction with this report.

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Geotechnics | Environment | Groundwater

Report on
Phase 2 Contamination Investigation

Proposed Carslaw Building Extension
Eastern Avenue, The University of Sydney

Prepared for
The University of Sydney

Project 84897.04
May 2016

Integrated Practical Solutions

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The undersigned, on behalf of Douglas Partners Pty Ltd, confirm that this document and all attached drawings, logs and test results have been checked and reviewed for errors, omissions and inaccuracies.

	Signature	Date
Author	D. Walker	12 May 2016
Reviewer		12 May 2016

bsi. ISO 9001 Quality Management

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Douglas Partners
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Appendices

Report on Phase 2 Contamination Investigation
Proposed Carslaw Building Extension
Eastern Avenue, The University of Sydney

1. Introduction

This report presents the results of a Phase 2 contamination investigation undertaken at the site of the proposed Carslaw Building Extension at Eastern Avenue, University of Sydney (the site). The investigation was commissioned by Sam Gibson of The University of Sydney on 27 April 2016 to provide information for a State Significant Development application (SSD 7054). In addition, preliminary waste classification of filling is provided for offsite disposal purposes.

The proposed development is for an eight level building extension to the existing Carslaw Building, which is to be used for teaching services. Some peripheral works are also proposed (in public domain areas) such as a loading dock, pedestrian access and minor landscaping to tie in with existing surrounding structures and landscaping. Excavation will be required for Level 01 of the proposed building.

2. Scope of Works

The scope of works for the investigation was:

- Review existing information for the site and the proposed development plans;
- Scan for buried services and set out suitable soil sampling locations;
- Conduct soil sampling at seven locations using a hand auger;
- Analyse selected soil samples at a NATA accredited laboratory for the following:
  - Metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc);
  - Polycyclic aromatic hydrocarbons (PAH);
  - Total recoverable hydrocarbons (TRH);
  - TRH with silica gel cleanup [total petroleum hydrocarbons (TPH)];
  - Benzene, toluene, ethylbenzene and xylene (BTEX);
  - Organochlorine pesticides (OCP);
  - Organophosphorus pesticides (OPP);
  - Polychlorinated biphenyls (PCB);
  - Total phenols;
  - Toxicity characteristic leaching procedure (TCLP) for lead and PAH; and
  - Asbestos;

- Provision of this report which presents the findings of the investigation and recommendations for further work.

3. Site Description

The site of the proposed extension is located on the southern side of the Carslaw Building on Eastern Avenue, The University of Sydney. The approximate extent of the proposed building is shown on Drawing 1, Appendix A. The approximate extent of surrounding public domain works for a loading dock and pedestrian access is also shown on Drawing 1. The site covers an area of approximately 0.15 ha.

The site is currently occupied by an access laneway excavated into a slope adjacent to the Carslaw Building and a landscaped area containing gardens, lawn and a footpath. A pedestrian bridge (which is to remain for the proposed development) is located at the eastern site boundary. The laneway is relatively level and the garden rises gently to the west with a difference in levels of nearly 3 m over approximately 70 m. A retaining wall separated the laneway from the landscaped area above.

4. Previous Investigations

Previous geotechnical and contamination investigations have been conducted at the site and findings were reported in:

- Douglas Partners Pty Ltd (DP), *Preliminary Site Investigation, Proposed Campus Improvement Program, Camperdown and Darlington Campus, University of Sydney,* November 2013 (Project 73716.00) (DP, 2013); and
- DP, *Report on Geotechnical Investigation, Proposed LEES1 Carslaw Extension, Eastern Avenue, The University of Sydney*, July 2015 (Project 84897.00) (DP, 2015).

Findings relevant to the contamination elements of the investigations are summarised in the subsections below.

4.1 DP (2013)

DP (2013) comprised a preliminary investigation for the university campus which included the current investigation area.

According to DP (2013), the site was acquired by the University of Sydney in 1912 and has been operated as university grounds since that time. A significant portion of the campus was previously used for farming. The University of Sydney holds licences for the storage of a variety of chemicals for experimental purposes; however, records did not indicate that any of these chemical stores were present in the current investigation area. The use of fill for the formation of the campus appears to be extensive, with filling at some areas found to contain asbestos, slag and ash. There is also potential for asbestos to be present in near surface soils as a result of the demolition of former structures.

Hazardous materials registers have identified hazardous building materials (including asbestos and lead based paint) in many of the older buildings within the university grounds.

4.2 DP (2015)

Field work for DP (2015) included the drilling of five boreholes (Bores 5 to 9) at the locations shown on Drawing 1, Appendix A. The subsurface conditions encountered are presented on the borehole logs, Appendix B. Notes defining descriptive terms and classification methods are also provided in Appendix B.

The subsurface conditions encountered in the boreholes is summarised as:

- FILLING – grey-brown and grey sand, grey silty clay and brown silty sand with some gravel to depths of between 0.4 m and 1.3 m. Bores 7 and 9 also had a footpath over the top of the filling;
- CLAY / SILTY CLAY / SHALY CLAY – brown, orange-brown, red-brown and grey-brown clays to depths of between 2.0 m and 4.0 m; and
- ROCK – grey, brown and grey-brown laminate or shale.

Free groundwater was not observed in any of the bores whilst augering. The use of drilling fluid prevented groundwater observations during rotary wash-boring and coring.

Selected soil samples were analysed for the range of potential contaminants including heavy metals; polycyclic aromatic hydrocarbons (PAH); total recoverable hydrocarbons (TRH); benzene, toluene, ethylbenzene, and xylenes (BTEX), organochlorine pesticides (OCP); organophosphate pesticides (OPP); polychlorinated biphenyls (PCB); total phenols and asbestos. Toxicity characteristic leaching procedure analysis (TCLP) for lead and PAH was conducted on selected samples for waste classification purposes. Results are included in Tables 5 and 6 in Section 7.2.

Analytical results were compared to assessment criteria sourced from Schedule B1, National Environment Protection Council, *National Environment Protection (Assessment of Site Contamination) Measure* 1999, as amended 2013 (NEPC, 2013) for a generic commercial land use scenario. These criteria are included in Table 5 in Section 7.2. The site assessment criteria are further discussed in Section 6.

The analyte concentrations in the soil samples analysed were generally within the adopted assessment criteria with the following exceptions:

- Benzo(a)pyrene TEQ in sample BH6/0.5: 400 mg/kg which exceeded the health investigation level of 40 mg/kg; and
- TRH $>C_{16}$-C_{34} in sample BH6/0.5: 13,000 mg/kg which exceeded the management limit of 3500 mg/kg.

No asbestos was detected in the soil samples and no significant building rubble was observed in the boreholes. It was noted, however, that there were limitations to the borehole method with regards to detecting asbestos and therefore it is possible that asbestos may be present in the fill material.

It was considered likely that the elevated PAH and TRH concentrations detected in the filling at Bore 6 were associated with the pavement material composition (as gravel roadbase was observed in the filling), and/or the presence of asphalt. It was recommended that additional investigation be conducted in the vicinity of Bore 6 to define the extent and possible source of contamination and to determine if a remediation action plan (RAP) is warranted. Following the delineation of the elevated PAH and TRH concentrations at Bore 6, the impacted soils should be excavated, disposed and validated following removal.

It was considered that the site can be made suitable for the proposed development subject to the remediation (excavation and disposal) of the elevated PAH and TRH concentrations at Bore 6. It was noted that the proposed development includes a basement (Level 01) excavation that would be expected to extend below the impacted fill at Bore 6. In this regard, it was considered likely that the impacted soil will be removed as a result of the development works, thereby rendering the site suitable. An unexpected finds protocol was recommended to be prepared for bulk excavation and construction works to manage unexpected contamination finds.

The fill was preliminarily classified as General Solid Waste (non-putrescible) with the exception of filling at Bore 6. Fill at Bore 6 was preliminarily classified at Hazardous Waste based on total PAH and benzo(a)pyrene concentrations which exceeded Restricted Solid Waste thresholds. Given the limited number of samples analysed, further *in situ* or *ex situ* testing was recommended to be carried out to confirm the preliminary waste classification. Following the excavation of fill soils for the basement (Level 01) it was recommended that the underlying natural soil should be inspected and validated to determine if the underlying natural soil can be classified as virgin excavated natural material (VENM).

5. Field Work, Analysis and QA/QC

5.1 Sample Location and Rationale

To attempt to define the extent and possible source of the elevated PAH and TRH concentrations in filling at Bore 6 (as recommend in DP (2015)), four boreholes (Bores 6A to 6D) were positioned in the garden as “step-out” sampling locations in the vicinity of Bore 6. The locations of the boreholes, shown on Drawing 1, Appendix A, were limited by the presence of buried services and vegetation.

Given that the minimum recommended sampling density for site characterisation, according to the NSW EPA *Sample Design Guidelines*, 1995, is six to seven sample points given the site’s area (approximately 0.15 ha), two bores (Bores 101 and 103) were positioned to provide site coverage (to meet the recommended sampling density by complementing previous test locations) where filling was likely to be present based on findings presented in DP (2015). Bore 102 was positioned as a step out sampling location from Bore 101 (at the request of the client). The locations of the boreholes were limited by the presence of buried services, drilling obstructions in the surface soil and vegetation.

5.2 Soil Sampling Procedures

The environmental sampling was performed by an Environmental Scientist from DP, with reference to standard operating procedures outlined in the DP *Field Procedures Manual*. All sampling data was recorded on DP chain-of-custody sheets, and the general sampling procedure comprised:

- Collection of representative soil samples from hand auger returns using disposable gloves for each sampling event;
- Transfer of samples into laboratory-prepared glass jars, capping immediately, minimising the headspace within the sample jar;
- Labelling of sample containers with individual and unique identification, including project number, sample location and sample depth;
- Placing the glass jars into a cooled, insulated and sealed container for transport to the laboratory;
- Collection of replicate soil samples in zip-lock plastic bags; and
- Use of chain of custody documentation so that sample tracking and custody could be cross-checked at any point in the transfer of samples from the field to the laboratory.

5.3 Analytical Rationale

Selected filling samples from Bores 6A to 6D were analysed for PAH and TRH $>C_{10}$-C_{40} as these were the contaminants of concern identified in filling at Bore 6.

Selected filling samples from Bores 101 to 103 were analysed for combinations of a larger range of potential contaminants comprising metals, PAH, TRH, ,BTEX, OCP, OPP, PCB, total phenols and asbestos.

The filling sample with the highest recorded concentration of benzo(a)pyrene from Bores 6A to 6D was analysed for PAH in TCLP. Similarly, the filling sample with the highest recorded benzo(a)pyrene concentration from Bores 101 and 102 (adjacent bores) was analysed for PAH in TCLP. The filling sample from Bore 103, depth 0.4-0.5m, was analysed for PAH in TCLP. The filling sample from Bore 102, was analysed for lead in TCLP given that this sample had the highest recorded lead concentration.

As the sample from Test Bore 101, depth 0.4-0.5 m, had elevated concentrations of TRH, this sample was subject to analysis for TRH $>C_{10}$-C_{40} with silica gel clean-up.

5.4 Quality Assurance and Quality Control

The field QC procedures for sampling were undertaken as prescribed in Douglas Partners' *Field Procedures Manual*. The results of field QA/QC procedures as well as a discussion of Data Quality Objectives (DQO) and Data Quality Indicators (DQI) for the assessment are provided in Appendix C.

The analytical laboratory, accredited by NATA, is required to conduct in-house QA/QC procedures. These are normally incorporated into every analytical run and include reagent blanks, spike recovery, surrogate recovery and duplicate samples. These results are included in the laboratory certificates in Appendix D and discussed in Appendix C.

6. Site Assessment Criteria

Analytical results from laboratory testing of soils are assessed against Site Assessment Criteria (SAC) primarily comprising (Tier 1) investigation levels, screening levels and management limits sourced from Schedule B1 of NEPC, 2013. This guideline has been endorsed by the NSW EPA under the Contaminated Land Management (CLM) Act 1997. Schedule B of NEPC (2013) provides investigation and screening levels for commonly encountered contaminants which are applicable to generic land uses and include consideration of, where relevant, the soil type and the depth of contamination. The investigation and screening levels are not intended to be used as clean up levels. They establish concentrations above which further appropriate investigation (e.g. Tier 2 or Tier 3) should be undertaken.

In addition to SAC sourced from NEPC (2013), screening levels (for direct contact) have been adopted from the Cooperative Research Centre for Contamination Assessment and Remediation of the Environment (CRC CARE) *Technical Report no.10 Health screening levels for petroleum hydrocarbons in soil and groundwater* (2011). The following sub-sections outline the adopted SAC for soil as documented in NEPC (2013) and CRC CARE, 2011.

6.1 Health Investigation Levels

Table 1 shows the health investigation levels (HIL) that have been adopted as SAC for assessing the human health risk from a contaminant via all relevant pathways of exposure. As the site is proposed to be developed into a university building for teaching, HIL have been adopted from Column D (for commercial/industrial sites). The table does not contain the complete list of HIL provided in NEPC (2013).

Table 1: Health Investigation Levels

Contaminant	HIL – D (mg/kg)
Metals	
Arsenic	3000
Cadmium	900
Chromium (VI)	3600
Copper	240 000
Lead	1500
Mercury (inorganic)	730
Nickel	6000
Zinc	400 000
PAH	
Carcinogenic PAH (as Benzo(a)pyrene TEQ)	40
Total PAH	4000
OCP	
DDT+DDE+DDD	3600
Aldrin + Dieldrin	45
Chlordane	530

Contaminant	HIL – D (mg/kg)
Endosulfan	2000
Endrin	100
Heptachlor	50
HCB	80
Methoxychlor	2500
OPP	
Chlorpyrifos	2000
PCB	7
Phenols	
Phenol	240 000
Pentachlorophenol	660
Cresols	25 000

6.2 Health Screening Levels for Vapour Intrusion

Table 2 shows the health screening levels (HSL) for petroleum hydrocarbon compounds adopted for the assessment and are based on the exposure to petroleum hydrocarbons through the dominant vapour inhalation exposure pathway only (i.e. not direct contact to soils). The HSL have been adopted from Column HSL D (for commercial/industrial sites). The HSL derivation has assumed a slab-on-ground construction for building structures, and, therefore is only considered relevant to parts of the site with building structures (yet to be constructed). As clay, sand and silt have been identified at the site, the most conservative HSL for the three soil types have been listed in Table 2.

Table 2: Soil Health Screening Levels for Vapour Intrusion

Contaminant	HSL – D (mg/kg)
	Depth 0 m to <1 m
Naphthalene	NL
TPH C_6-C_{10} less BTEX	250
TPH >C_{10}-C_{16} less Naphthalene	NL
Benzene	3
Toluene	NL
Ethylbenzene	NL
Xylenes	230

TPH C_6-C_{10} less BTEXTPH >C_{10}-C_{16} less NaphthaleneNLNotes: NL is 'not limiting' (where the derived soil HSL exceeds the soil saturation concentration)

6.3 Health Screening Level for Direct Contact

Table 3 shows the HSL for direct contact for commercial and industrial sites, sourced from CRC CARE (2011), which are mentioned but not presented in NEPC (2013).

Table 3: Soil Health Screening Levels for Vapour Intrusion

Contaminant	HSL – D (mg/kg)
Naphthalene	11 000
TPH C_6-C_{10}	26 000
TPH >C_{10}-C_{16}	20 000
TPH >C_{16}-C_{34}	27 000
TPH >C_{34}-C_{40}	38 000
Benzene	430
Toluene	99 000
Ethylbenzene	27 000
Xylenes	81 000

6.4 Ecological Investigation Levels and Ecological Screening Levels

Given that the proposed development will essentially result in the site being covered by the building and surrounding pavements with very minor peripheral landscaping it is considered that the site will have very limited ecological value and, thus, ecological investigation levels (EIL) and ecological screening levels (ESL) for terrestrial ecology have not been adopted as SAC.

6.5 Management Limits

In addition to appropriate consideration and application of the HSL there are additional considerations which reflect the nature and properties of petroleum hydrocarbons, including:

- Formation of observable light non-aqueous phase liquids (LNAPL);
- Fire and explosion hazards;
- Effects on buried infrastructure e.g. penetration of, or damage to, in-ground services.

Management limits to avoid or minimise these potential effects have been adopted in NEPC (2013) as interim Tier 1 guidance. The adopted management limits, from Table 1B(7), Schedule B1 of NEPC (2013) are shown in Table 4. The more conservative management limits are shown for both ‘fine’ and ‘coarse’ soil textures given that various soil types were encountered.

Table 4: Management Limits

Contaminant	Management Limit – Commercial and industrial (mg/kg)
TPH $C_6 – C_{10}$	700
TPH $>C_{10}$-C_{16}	1000
TPH $>C_{16}$-C_{34}	3500
TPH $>C_{34}$-C_{40}	10 000

6.6 Asbestos is Soil

A detailed asbestos assessment as outlined in NEPC (2013) was not undertaken. As such, asbestos was screened from jar samples taken for general analysis of contaminants. Therefore the presence or absence of asbestos at a limit of reporting of 0.1 g/kg has been adopted for this assessment as an initial screen.

6.7 Potential Impacts on Groundwater

Any impacted soils will be assessed with respect to the potential contamination risks to groundwater. The assessment may include a review of the potential for impacts based on the total concentrations present, the likelihood of migration of water through the soils and/or leachability testing.

7. Field Observations and Analytical Results

7.1 Field Observations

Soil sampling was conducted by an environmental scientist using a hand auger on 4 May 2016.

Bores 6A to 6D were drilled through a surface layer (0.1 m thick) of dark brown silty sand and clayey sand filling with trace gravel and rootlets. At Bores 6A, 6B and 6D, this surficial filling was underlain by brown silty clay filling with trace gravel and rootlets to depths of 0.5 m, 0.7 m and 0.55 m, respectively. At Bore 6C, surficial filling was underlain by brown sandy clay filling with trace gravel and rootlets to a depth of 0.55 m. Natural orange brown clay was penetrated at Bores 6B and 6D to depths of 0.75 m and 1 m, respectively. Drilling refusal was encountered on stiff clay (possible filling) at a depth of 0.5m at Bore 6A and on a possible boulder in filling at a depth of 0.55 m at Bore 6C.

Bores 101 and 102 were drilled through a surface layer (0.1 m thick) of brown clayey sand filling with trace gravel, rootlets and grass. Various filling types were encountered beneath the surficial filling including dark brown sandy clay filling with trace gravel, grey gravelly sand filling and brown clay filling with trace gravel. At Bore 101, ash, slag and glass were observed at a depth of 0.1 m to 0.3 m and ash, slag and clinker was observed at a depth of 0.3 m to 0.5 m. At Bore 102, slag and ceramic tile were observed at a depth of 0.1 m to 0.4 m and clinker and slag were observed at a depth of 0.4 m to

0.5 m. Natural orange brown clay was encountered at Bore 101 at a depth of 0.8 m and at Bore 102 at a depth of 1.1 m. Bores were discontinued at depths of 1 m at Bore 101 and 1.3 m at Bore 102.

Bore 103 was drilled through a surface layer (0.1 m thick) of brown clayey sand filling with trace gravel, rootlets and grass. Surficial filling was underlain by brown sandy clay filling with some gravel and trace slag to a depth of 0.5 m, at which depth the bore was discontinued due to drilling refusal on gravel in filling.

Free groundwater was not observed whilst drilling. No odours were noted whilst sampling.

7.2 Laboratory Results

The laboratory certificates of analysis with chain of custody documentation are provided in Appendix D. A summary of results compared to the SAC is shown in Table 5.

For preliminary waste classification purposes, Table 6 shows summarised laboratory results compared to criteria sourced from NSW EPA, *Waste Classification Guidelines,* 2014 (NSW EPA, 2014).

Table 5: Summary of Results of Soil Analysis (All results in mg/kg unless otherwise stated)

Sample Location (Test Bore)	Sample Depth (m)	Sample Type	Metals: Arsenic	Cadmium	Chromium (III + VI)	Copper	Lead	Mercury	Nickel	Zinc	Polycyclic Aromatic Hydrocabons (PAH): Benzo(a)pyrene TEQ	Naphthalene	Total PAHs	Petroleum Hydrocarbons: TRH C6-C10 less BTEX	TRH >C10-C16 less Naphthalene	TRH C6-C10	TRH >C10-C16	TRH >C10-C16 with Silica Gel Cleanup	TRH >C16-C34	TRH >C16-C34 with Silica Gel Cleanup	TRH >C34-C40	TRH >C34-C40 with Silica Gel Cleanup	Benzene	Toluene	Ethylbenzene	Total Xylene	Organochlorine Pesticides (OCP): DDT+DDE+DDD	Aldrin + Dieldrin	Chlordane	Endosulfan (total)	Endrin	Heptachlor	HCB	Methoxychlor	Organophophorus Pesticides (OPP): Chlorpyriphos	PCBs (total)	Phenols (total)	Asbestos (detected fibres)
Current Investigation Results (Sampling on 4 May 2016)																																						
6A	0.4-0.5	Filling	-	-	-	-	-	-	-	-	9.5	0.2	75	-	<50	-	<50	-	410	-	110	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6B	0.4-0.5	Filling	-	-	-	-	-	-	-	-	7.2	0.1	56	-	<50	-	<50	-	310	-	140	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6C	0.4-0.5	Filling	-	-	-	-	-	-	-	-	2.1	<0.1	15	-	<50	-	<50	-	130	-	<100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6D	0.4-0.5	Filling	-	-	-	-	-	-	-	-	18	0.2	130	-	<50	-	<50	-	730	-	230	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
101	0.4-0.5	Filling	6	<0.4	9	55	78	0.3	4	64	**370**	51	**4900**	<25	1249	<25	**1300**	210	**16000**	1400	2000	<100	<0.2	<0.5	<1	<3	<3	<2	<2	<3	<1	<1	<1	<1	<1	<PQL	<5	NAD
102	0.2-0.3	Filling	5	0.6	15	83	620	1.6	8	180	4.8	0.3	40	<25	<50	<25	<50	-	170	-	<100	-	<0.2	<0.5	<1	<3	-	-	-	-	-	-	-	-	-	-	-	NAD
BD2/040516	0.2-0.3	Filling	7	0.4	16	95	290	1.5	8	160	-	<1	-	<25	<50	<25	<50	-	330	-	<100	-	<0.2	<0.5	<1	<3	-	-	-	-	-	-	-	-	-	-	-	-
103	0.4-0.5	Filling	10	0.4	14	68	100	0.2	7	83	2.2	<0.1	18	<25	<50	<25	<50	-	<100	-	<100	-	<0.2	<0.5	<1	<3	<0.3	<0.2	<0.2	<0.3	<0.1	<0.1	<0.1	<0.1	<0.1	<PQL	<5	NAD
Previous Results (DP, 2015)																																						
BH5	0.5	Filling	<4	<0.4	9	11	38	0.2	4	53	<0.5	<0.1	1.2	<25	<50	<25	<50	-	<100	-	<100	-	<0.2	<1	<0.5	<3	<0.3	<0.2	<0.2	<0.3	<0.1	<0.1	<0.1	<0.1	<0.1	<PQL	<5	NAD
BH6	0.5	Filling	5	<0.4	9	130	170	1	12	200	**400**	27	3900	<25	710	<25	720	-	**13000**	-	2200	-	<0.2	<1	<0.5	<3	<3	<2	<2	<3	<1	<1	<1	<1	<1	<PQL	<5	NAD
BH7	0.5	Natural	7	<0.4	21	16	30	<0.1	3	11	<0.5	<0.1	0.26	<25	<50	<25	<50	-	<100	-	<100	-	<0.2	<1	<0.5	<3	<0.3	<0.2	<0.2	<0.3	<0.1	<0.1	<0.1	<0.1	<0.1	<PQL	<5	NAD
BH8	0.5	Filling	8	0.5	17	81	150	0.4	8	150	13	0.7	140	<25	<50	<25	<50	-	430	-	<100	-	<0.2	<1	<0.5	<3	<0.3	<0.2	<0.2	<0.3	<0.1	<0.1	<0.1	<0.1	<0.1	<PQL	<5	NAD
BH9	1	Filling	7	0.4	18	93	270	0.4	9	120	4.6	0.3	45	<25	<50	<25	<50	-	110	-	<100	-	<0.2	<1	<0.5	<3	<0.3	<0.2	<0.2	<0.3	<0.1	<0.1	<0.1	<0.1	<0.1	<PQL	<5	NAD
Site Assessment Criteria																																						
HIL (D)			3000	900	3600 for Cr(VI)	240000	1500	730	6000	400000	40	-	4000	-	-	-	-		-		-		-	-	-	-	3600	45	530	2000	100	50	80	2500	2000	7	660*	-
HSL (D) for vapour intrusion			-	-	-	-	-	-	-	-	-	NL	-	250	NL	-	-	-	-	-	-	-	3	NL	NL	230	-	-	-	-	-	-	-	-	-	-	-	-
Management Limit (Commercial land use)			-	-	-	-	-	-	-	-	-	-	-	-	-	700	1000	1000	3500	3500	10000	10000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Direct Contact HSL			-	-	-	-	-	-	-	-	-	11000	-	-	-	26000	20000	20000	27000	27000	38000	38000	430	99000	27000	81000	-	-	-	-	-	-	-	-	-	-	-	-
Adopted Screening Level			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	AD

Notes:

NAD	No asbestos detected at limit of reporting (0.1g/kg)
AD	Asbestos detected
PQL	Practical Quantitation Limit
*	Value for pentachlorophenol
BD2/040516	Blind replicate of sample from Test Bore 102, depth 0.2-0.3 m.
-	Not tested / Not applicable
TEQ	Toxicity Equivalent Quotient
NL	`Not Limiting
BOLD	Exceeds HIL
BOLD	Exceeds Management Limit

Table 6: Summary of Laboratory Results for Waste Classification

Sample Location (Test Bore)	Sample Depth (m)	Sample Type	Metals: Arsenic	Metals: Cadmium	Metals: Chromium (III + VI)	Metals: Copper	Metals: Lead	Metals: Lead in TCLP	Metals: Mercury	Metals: Nickel	Metals: Zinc	Polycyclic Aromatic Hydrocarbons: Benzo(a)pyrene	Polycyclic Aromatic Hydrocarbons: Benzo(a)pyrene in TCLP	Polycyclic Aromatic Hydrocarbons: Total PAH	Total Recoverable Hydrocarbons (TRH): C6-C9	Total Recoverable Hydrocarbons (TRH): C10-C36	Total Recoverable Hydrocarbons (TRH): C10-C36 with Silica Gel Cleanup	BTEX: Benzene	BTEX: Toluene	BTEX: Ethylbenzene	BTEX: Total Xylene	Total Polychlorinated Biphenyls (PCB)	Organochlorine Pesticides (OCP): Endosulfan	Organochlorine Pesticides (OCP): All other OCP	Organophosphorus Pesticides (OPP)	Total Phenols	Asbestos
			(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/L)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/L)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(detectable asbestos)
Current Invetigation Results (Sampling on 4 May 2016)																											
6A	0.4-0.5	Filling	-	-	-	-	-	-	-	-	-	6.5	-	75	-	470	-	-	-	-	-	-	-	-	-	-	-
6B	0.4-0.5	Filling	-	-	-	-	-	-	-	-	-	4.9	-	56	-	390	-	-	-	-	-	-	-	-	-	-	-
6C	0.4-0.5	Filling	-	-	-	-	-	-	-	-	-	1.5	-	15	-	110	-	-	-	-	-	-	-	-	-	-	-
6D	0.4-0.5	Filling	-	-	-	-	-	-	-	-	-	**12**	<0.001	130	-	810	-	-	-	-	-	-	-	-	-	-	-
101	0.4-0.5	Filling	6	<0.4	9	55	78	-	0.3	4	64	**240**	<0.001	**4900**	<25	**16990**	1615	<0.2	<1	<0.5	<3	<PQL	<3	<PQL	<PQL	<5	NAD
102	0.2-0.3	Filling	5	0.6	15	83	620	0.1	1.6	8	180	3.3	-	40	<25	100	-	<0.2	<1	<0.5	<3	-	-	-	-	-	NAD
BD2/040516	0.2-0.3	Filling	7	0.4	16	95	290	-	1.5	8	160	-	-	-	<25	<PQL	-	<0.2	<1	<0.5	<3	-	-	-	-	-	-
103	0.4-0.5	Filling	10	0.4	14	68	100	-	0.2	7	83	1.6	<0.001	18	<25	370	-	<0.2	<1	<0.5	<3	<PQL	<0.3	<PQL	<PQL	<5	NAD
Previous Results (DP, 2015)																											
BH5	0.5	Filling	<4	<0.4	9	11	38	-	0.2	4	53	0.1	-	1.2	<25	<250	-	<0.2	<1	<0.5	<3	<PQL	<0.3	<PQL	<PQL	<5	NAD
BH6	0.5	Filling	5	<0.4	9	130	170	0.08	1	12	200	**290**	<0.001	**3900**	<25	**14610**	-	<0.2	<1	<0.5	<3	<PQL	<3	<PQL	<PQL	<5	NAD
BH7	0.5	Natural	7	<0.4	21	16	30	-	<0.1	3	11	0.05	-	0.26	<25	<250	-	<0.2	<1	<0.5	<3	<PQL	<0.3	<PQL	<PQL	<5	NAD
BH8	0.5	Filling	8	0.5	17	81	150	0.04	0.4	8	150	9	0.003	140	<25	535	-	<0.2	<1	<0.5	<3	<PQL	<0.3	<PQL	<PQL	<5	NAD
BH9	1	Filling	7	0.4	18	93	270	0.2	0.4	9	120	3.1	<0.001	45	<25	<250	-	<0.2	<1	<0.5	<3	<PQL	<0.3	<PQL	<PQL	<5	NAD
General Solid Waste Criteria (without TCLP)																											
CT1			100	20	100 for Cr(IV)	-	100	-	4	40	-	0.8	-	200	650	10000	10000	10	288	600	1000	<50	60	<50*	250**	-	-
General Solid Waste Criteria (with TCLP)																											
SCC1 and TCLP1			-	-	-	-	1500	5	-	-	-	10	0.04	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Restricted Solid Waste Criteria (without TCLP)																											
CT2			400	80	400 for Cr(IV)	-	400	-	16	160	-	3.2	-	800	2600	40000	40000	40	1152	2400	4000	<50	240	<50*	1000**	-	-
Restricted Solid Waste Criteria (with TCLP)																											
SCC2 and TCLP2			-	-	-	-	6000	20	-	-	-	23	0.16	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Notes:

CT	Contaminant Threshold
SCC	Specific contaminant concentration
TCLP	Toxicity Characteristic Leaching Procedure
PQL	Practical Quantification Limit
NAD	No Asbestos Detected
BD2/040516	is blind replicate of sample from Test Bore 102, depth 0.2-0.3 m
*	Value for scheduled chemicals
**	Value for moderately harmful pesticides
-	Not Applicable / Not Defined / Not analysed
BOLD	Exceeds criterion for General Solid Waste
BOLD	Exceeds criterion for Restricted Solid Waste

8. Discussion of Results

8.1 Soil Contaminants

Concentrations of metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc), were within the respective HIL. Concentrations of BTEX, OPP, OCP, PCB and total phenols were below the practical quantitation limits (PQL) and, hence, within the respective HIL. Asbestos was not detected in analysed samples and potential asbestos-containing materials (ACM) were not observed whilst sampling.

Concentrations of PAH were within HIL and HSL except for the sample from Bore 101, depth 0.4 - 0.5 m. This sample had a benzo(a)pyrene TEQ concentration of 370 mg/kg which is more than 250 % of the HIL (40 mg/kg), and a total PAH concentration of 4900 mg/kg which is above the HIL of 4000 mg/kg. Some ash and slag was observed in the filling represented by this sample and are considered to be likely contributing sources of PAH. It is noted that ash was not noted in the filling samples from other bores (even though slag was noted in analysed filling samples from Bores 102 and 103), and therefore, it is considered that ash may be the primary source of the recorded concentration of PAH in the filling sample from Bore 101 which was significantly higher than the other samples.

Concentrations of TRH C_6-C_{10} and BTEX were below the PQL, and hence, within the respective HSL. Concentrations of TRH >C_{10}-C_{40} were within the respective HSL. Concentrations of TRH were within the management limits except for concentrations of TRH >C_{10}-C_{16} and TRH >C_{16}-C_{34} in the filling sample from Bore 101, depth 0.4-0.5 m. TRH with silica gel clean-up analysis for this sample, however, had concentrations of TRH within the management mimits. It is noted that a significant proportion of the recorded TRH in this sample is considered likely to be PAH from ash (or possibly slag, as discussed above) rather than a petroleum fuel product (such as petrol or diesel) or similar, particularly as hydrocarbon odours were not identified in the filling. Organics in filling at the garden may have also contributed to the recorded TRH concentration without silica gel clean-up.

The composition of PAH (i.e. the proportions of chemicals that comprise total PAH) in the sample from Bore 101, depth 0.4-0.5 m, is noted to be similar to that from Bore 6, depth 0.5 m (DP, 2015). Therefore the primary source of the PAH (and TRH >C_{10}-C_{40}) recorded in the filling at Bore 6, depth 0.5 m, is considered likely to be ash (or possibly slag) rather than a petroleum fuel product. Ash or slag, however, was not noted in the filling samples at Bores 6A to 6D, which recorded considerably lower concentrations of PAH.

It is considered that the variability of PAH (and TRH >C_{10}-C_{40}) concentrations in filling across the garden/landscaped area is likely to be as a result of the variable nature of the filling (containing ash and slag). Therefore, the elevated concentrations of PAH in filling from Bores 6 and 101 may not be restricted to these two locations.

Although within the HIL, elevated concentrations of lead were recorded for the analysed primary and replicate samples from Test Bore 102, depth 0.2-0.3 m. This lead is considered likely to be associated with slag observed in the filling. TCLP analysis for lead indicates a very low potential for significant leaching. TCLP analysis for PAH also indicates a very low potential for significant leaching. Given this low potential for significant leaching of lead and PAH in ash and slag (which are ordinarily immobilised (see Section 8.2)), and that the recorded TRH concentrations are not considered to be from a petroleum product, a groundwater assessment of these contaminants is not considered to be warranted.

8.2 Preliminary Waste Classification of Filling

The preliminary waste classification of filling was generally conducted in accordance with NSW EPA (2014). Waste classification of the material was conducted with reference to the six step process as set out in the guideline and summarised in Table 7 below.

Table 7: Six Step Classification Process

Step	Classification	Rationale
1. Is it special waste?	No	Asbestos was not observed during field investigations
2. Is it liquid waste?	No	Waste composed of soil matrix (i.e. no liquids)
3. Is the waste "pre-classified"?	No	Waste is not pre-classified
4. Does the waste have hazardous waste characteristics?	No	Waste not observed to/ or considered at risk to contain explosives, gases, flammable solids, oxidising agents, organic peroxides, toxic substances or corrosive substances.
5. Chemical Assessment	Undertaken	See Table 6 for summary of results.
6. Is the waste putrescible?	No	All observed components of material composed of materials pre-classified as non-putrescible (i.e. soils).

Concentrations of arsenic, cadmium, chromium, mercury, nickel, TRH C_6-C_9, BTEX, OCP, OPP and PCB were within the respective CT1 criteria for General Solid Waste. Concentrations of lead were within the SCC1 and TCLP1 criteria for General Solid Waste when used together.

Although the concentration of TRH C_{10}-C_{36} in the sample from Bore 101, depth 0.4-0.5 m was above the CT1 criterion, the concentration of TRH C_{10}-C_{36} with silica gel clean-up, which is the applicable concentration according to NSW EPA (2014), was within the CT1 criterion.

The total concentrations of benzo(a)pyrene and total PAH in the sample from Bore 101, depth 0.4 - 0.5 m were above the SCC2 and CT2 criteria for Restricted Solid Waste, however, the concentration of benzo(a)pyrene in TCLP was within the TCLP1 criterion. According to NSW EPA, *General Approval of the Immobilisation of Contaminants in Waste* Number 1999/05, the total concentration limits do not apply for the assessment of ash-contaminated natural excavated materials. Similarly, according to NSW EPA, *General Approval of the Immobilisation of Contaminants in Waste* Number 2009/07, the total concentration limits do not apply for the assessment of metallurgical furnance slag contaminated natural excavated materials. Given that the filling represented by the sample from Bore 101, depth 0.4 - 0.5 m, has ash and slag (the contributing sources of PAH), the total concentrations of benzo(a)pyrene and total PAH do not apply with reference to these general approvals. Therefore, the filling represented by the sample from Bore 101, depth 0.4 - 0.5 m, has a preliminary waste classification of General Solid Waste (non-putrescible).

The concentrations of total PAH and TRH C_{10}-C_{36} for filling samples from Bores 102 and 103 were within the CT1 criteria. The concentrations of benzo(a)pyrene for the analysed samples from these bores were within the SCC1 and TCLP1 criteria. Therefore, the filling represented by the samples from Bore 102, depth 0.2 - 0.3 m, and Bore 103, depth 0.4 - 0.5 m, has a preliminary waste classification of General Solid Waste (non-putrescible).

The concentrations of total PAH and TRH C_{10}-C_{36} were within the CT1 criterion for analysed samples from Bores 6A to 6D. Concentrations of benzo(a)pyrene for filling samples from Bores 6A to 6C were within the SCC1 and TCLP1 criteria for General Solid Waste and, hence, the filling represented by these samples has a preliminary classification as General Solid Waste (non-putrescible). The concentration of benzo(a)pyrene in the sample from Bore 6D, depth 0.4 - 0.5 m was above the SCC1 criteria, however, the concentration of benzo(a)pyrene in TCLP for this sample was within the TCLP1 criterion. Although ash or slag was not identified in the filling at this location, the composition of PAH is similar to that for the sample from Bore 101, depth 0.4 - 0.5 m, and, therefore, the filling at Bore 6D is considered likely to be impacted by ash and/or slag.

As discussed in Section 8.1, concentrations of benzo(a)pyrene, PAH and TRH C_{10}-C_{36} in the filling at Bore 6 were likely to be as a result of ash (or possible slag), although this was not confirmed through visual assessment for filling at Bores 6A to 6D. It is therefore recommended that further assessment, preferably *ex situ* (in stockpiles), be undertaken in the vicinity of Bore 6 and Bore 6D to provide final waste classification to confirm (or otherwise) that filling at this part of the site has ash or slag and the general approvals for the immobilisation of wastes (discussed above) can be applied.

8.3 Conceptual Site Model

A conceptual site model (CSM) is a representation of site-related information regarding contamination sources, receptors and exposure pathways between those sources and receptors. The CSM provides the framework for identifying how the site became contaminated and how potential receptors may be exposed to contamination either in the present or the future i.e. it enables an assessment of the potential source – pathway – receptor linkages (complete pathways).

Table 8 provides the possible pathways (P1 to P4) between the known contamination source (S1) and receptors (R1 to R6).

Table 8: Summary of Potential Complete Pathways

Potential Source	Transport Pathway	Receptor
(S1) PAH contaminated filling	(P1) Ingestion and dermal contact (P2) Inhalation of dust	(R1) Site users (Students, university employees, etc.) (R2) Construction workers (for the proposed development) (R3) Maintenance workers (post-development)
	(P2) Inhalation of dust	(R4) Adjacent site users
	(P3) Surface water run-off	(R5) Surface water

Given that proposed development will essentially result in the site being covered by the building and surrounding pavements with very minor peripheral landscaping, terrestrial ecology at the site has not been listed as a potential receptor.

Given that results do not indicate a significant potential for groundwater contamination from filling at the site, groundwater has not been listed at a potential receptor.

8.4 Recommendations

Given that excavation of filling is proposed to accommodate Level 01 of the proposed building extension, filling contaminated with PAH (including at Bore 6 and Bore 101) can be excavated and disposed offsite as part of these works. Filling observed to contain ash and/or slag (likely sources of PAH) whilst excavating should be designated for offsite disposal to a licenced landfill. Further assessment by an environmental consultant would be required where filling is proposed to be reused or retained on site for the development.

Further testing or assessment (preferably *ex situ*) should be carried out to provide final waste classification, particularly in the vicinity of Bores 6 and 6D where the source of the PAH and TRH C_{10}-C_{36} has not been confirmed by visual means.

An unexpected finds protocol should be prepared for bulk excavation and construction works to manage unexpected contamination finds (if not already prepared).

Following the excavation of fill soils for Level 01, the underlying natural soil should be inspected and validated to determine if the underlying natural soil can be classified as virgin excavated natural material (VENM).

9. Conclusion

Based on the results and findings of this investigation, it is considered that the site can be made suitable for the proposed development subject to the remediation of PAH contaminated filling. Given that excavation of filling is proposed to accommodate Level 01 of the proposed building extension, the method of remediating the filling contaminated with PAH can be offsite disposal of the material to a licenced landfill as part of the construction works. Further assessment by an environmental consultant would be required where filling is proposed to be reused or retained on site.

Further testing or assessment should be carried out to provide final waste classification of soils to be disposed offsite. Following the excavation of fill soils the underlying natural soil should be inspected and validated to determine if the underlying natural soil can be classified as VENM.

An unexpected finds protocol should be prepared for bulk excavation and construction works to manage unexpected contamination finds (if not already prepared).

10. Limitations

Douglas Partners Pty Ltd (DP) has prepared this report for the Carslaw Building Extension at The University of Sydney in accordance with DP's email dated 27 April 2016 and acceptance received from Mr Sam Gibson on 27 April 2016. The report is provided for the use of The University of Sydney for these projects only and for the purpose(s) described in the report. It should not be used for other projects or by a third party.

The results provided in the report are indicative of the sub-surface conditions only at the specific sampling or testing locations, and then only to the depths investigated and at the time the work was carried out. Subsurface conditions can change abruptly due to variable geological processes and also as a result of anthropogenic influences. Such changes may occur after DP's field testing has been completed.

DP's advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by DP in this report may be limited by undetected variations in ground conditions between sampling locations. The advice may also be limited by site accessibility. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

This report must be read in conjunction with all of the attached notes and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion given in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

The contents of this report do not constitute formal design components such as are required, by the Health and Safety Legislation and Regulations, to be included in a Safety Report specifying the hazards likely to be encountered during construction and the controls required to mitigate risk.

Division 4, Section 45, of *The Protection of the Environment Operations (Waste) Regulation 2014* states that it is an offence for waste to be transported to a place that cannot lawfully be used as a facility to accept that waste. It is the duty of the owner and transporter of the waste to ensure that the waste is disposed of appropriately. DP does not accept liability for the unlawful disposal of waste materials from any site. DP accepts no responsibility for the material tracking, loading, management, transport or disposal of waste from the site. Before disposal of the material to a licensed landfill is undertaken, the waste producer will be required to obtain prior consent from the landfill.

Both the receiving site and the site disposing of the material should satisfy the requirements of the licence before disposal of the material is undertaken. Note that appropriate prior arrangement with the receiving site/relevant authorities should be obtained prior to the disposal of any material off site. The receiving site should check to ensure that the material received matches the description provided in this report and contains no cross contamination.

Douglas Partners Pty Ltd

Appendix A

Drawing