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Geotechnics / Environment / Groundwater

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Attention: Ms Joelle Sarkis

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Project 86030.00
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KS/DH

Dear Sirs

Geotechnical Investigation and Preliminary Waste Classification
DoEAMD-16-78 Group 2 - Parramatta Region
425 Hume Highway, Public School, Yagoona

1. Introduction

This letter report presents the results of a geotechnical investigation and preliminary waste classification assessment carried out at the site of a proposed new school building to be constructed within the grounds of Yagoona Public School at 425 Hume Highway Yagoona. The work was requested by Conrad Gargett Pty Ltd, architects for the project, as part of the NSW Department of Education school upgrading program DoEAMD-16-78 Group 2 – Parramatta Regions.

The construction of a two storey school building on an elevated base is proposed, and site investigation was carried out to provide information on subsurface conditions for geotechnical design and preliminary waste classification of the soil.

The investigation comprised borehole drilling, followed by laboratory testing of selected soil samples recovered from the boreholes. Details of the field and laboratory work are given in the report, together with comments relating to design and construction practice.

Douglas Partners Pty Ltd (DP) has previously carried out investigation for the site for a new covered outdoor learning area (COLA) in 2009. Details of this previous work are summarised in Section 3. (Background) of this report with relevant results incorporated.

Preliminary survey and design plans prepared by Conrad Gargett were provided for this report.

2. Site Description and Regional Geology

The site, within the Yagoona Public School grounds (known as Lot 30 in DP 1108849), is an irregular shape some 75 m by 36 m. It is bounded to the north by the existing school structures, the south by a playing field, the west by railway reserve and the east by an access road. At the time of the investigation the site was primarily a grass covered playing field with site surface level grading gently to the south from RL 45.0 m to RL 43.5 m relative to the Australian Height Datum (AHD). Several trees are located within the footprint near the western boundary and a large tree is located nearby to the north of the proposed building site.

Reference to the 1:100 000 Sydney Geological Sheet indicates that the site underlain by Triassic aged Bringelly Shale of the Wianamatta Group. It typically comprises shale, carbonaceous claystone, laminite, fine to medium-grained lithic sandstone, and rare coal.

Shale was encountered in the deeper boreholes confirming the presence of Bringelly Shale.

Reference to the 2002 Map of Salinity Potential in Western Sydney indicates the site is in an area of no known salinity but may have moderate salinity potential and is close to a boundary of an area with high salinity potential.

3. Background

The previous DP investigation (Project 71163.18 dated 14 July 2009) included to two boreholes drilled to refusal depths of 2.9 m and 1.3 m. The progression of strata typically comprised up to 1.1 m of clay and gravel filling over an old topsoil layer then natural clay to depths of 1.3 – 2.4 m then shale and sandstone bedrock.

4. Field Work

4.1 Geotechnical

4.1.1 Methods

After underground services searches and location in the field, each boreholes location was marked and surveyed in the field.

The field investigation included three boreholes (BH1, 5 and 8) drilled with tracked auger/rotary drilling rig. The boreholes were drilled to depths of 2.0 – 4.5 m with 110 mm diameter continuous spiral flight augers, and thereafter in BH 8 to a depth of 3 m by rotary mud flush techniques through HW sized top casing. Core drilling at the three locations was then carried out using NMLC (50 mm diameter core) diamond drilling equipment for a penetration of 1 – 4 m into the rock. In soil, standard penetration tests (SPT) were carried out at 1.2 - 1.5 m depth intervals and auger samples recovered at regular intervals for strata identification and physical or chemical laboratory testing.

A further seven boreholes (BH2, 3, 6, 7, 9 10 and 11, note: BH 4 not drilled) were drilled using a mini excavator fitted with a 150 mm diameter auger. Samples were recovered from the auger blades at regular intervals for strata identification and physical or chemical laboratory testing. Dynamic cone penetrometer (DCP) testing was also carried out at each mini excavator boreholes location to determine the penetration resistance of the near surface soils.

The field work was supervised full time by an experienced geotechnical engineer who recovered samples, logged the boreholes, carried out DCP testing, surveyed test locations and reinstated boreholes.

Each borehole was surveyed using a high precision differential global positioning system (DGPS) with a stated accuracy of approximately 20 mm in each dimension. The borehole locations and ground surface levels are recorded on the borehole logs and shown on Drawing 1 attached.

4.1.2 Results

The results of the boreholes are given in detail in the borehole logs attached, together with notes defining classification methods and descriptive terms.

The boreholes encountered relatively uniform conditions with the typical succession of strata comprising:

TOPSOIL/FILLING:	in all boreholes except BH 3, 8 and 11, typically organic rich silty clay topsoil filling to depths of 0.1 – 0.5 m, overlying
FILLING:	in all boreholes except BH 8 and11, variable density predominantly silty clay filling to depths in the range 0.4 - 3.2 m. Boreholes 6, 7 and 10 terminated in filling at depths of 2.0 m;
SILTY CLAY:	In all boreholes except BH 6, 7 and 10, predominantly stiff to very stiff residual clay to depths in the range 1.1 - 4.5 m. BH 2, 3 and 11 terminated in silty clay at depths of 2 m;
SHALE:	Initially extremely low strength, then becoming very low strength from depths of 1.2 - 5 m, generally increasing in strength with depth. BH 1 were terminated in at least medium strength shale at depths of 5.5 - 7.0 m

Free groundwater was observed in BH1 at a depth of 2.0 m whilst augering. No free groundwater was observed in any of the other boreholes. The boreholes were backfilled immediately on completion precluding monitoring of the boreholes in the longer term. It should be noted that groundwater levels are variable and will change with rainfall, watering of grounds and alterations to drainage.

4.2 Waste Classification

The collection of soil samples for contamination purposes was undertaken to take advantage of the geotechnical boreholes already drilled (as per above) and subsequently to provide preliminary information on likely waste classification of the soils and an indication if widespread contamination is present in the investigation areas. The collected samples were recorded on DP's borehole logs with essential information included in the chain-of-custody sheets. The general sampling procedure adopted for the collection of environmental samples is summarised below:

- Collection of disturbed soil samples (at the near surface, regular intervals, changes in strata and signs of contamination) directly from the auger whilst wearing disposable gloves.
- Transfer of samples into laboratory-prepared glass jars, filled to the top to minimise the headspace within the sample jar and capping immediately to minimise loss of volatiles;
- Labelling of sample containers with individual and unique identification, including project number, sample location and sample depth; and
- Placement of the glass jars, with Teflon lined lid, into an ice cooled, insulated and sealed container for transport to the laboratory.

5. Laboratory Testing

Selected samples recovered from the field investigation were tested in the laboratory to determine Atterberg Limits, linear shrinkage, and Aggressivity (pH, Chloride, Sulphates and Electrical Conductivity). The detailed results are given in Appendix D and are summarised in Tables 1 and 2.

Table 1 – Summary Shrink-Swell and Atterberg Laboratory Test Results

Borehole	Depth (m)	Material	LL (%)	PI (%)	Linear Shrinkage (%)
8	1.0	Silty Clay	52	30	13.0

Where:
FMC = Natural Moisture Content
LL = Liquid Limit
PL = Plastic Limit

The results of the laboratory testing indicate that the sample tested was of medium plasticity and will be susceptible to changes in volume with variations in soil moisture content.

Table 2 – Summary of Aggressivity Laboratory Test Results

Borehole	Depth (m)	Material	pH	Cl (%)	SO_4 (%)	EC (µS/cm)
1	3.0	Silty Clay	5.5	49	140	150

Where: Cl = Chloride SO_4 = Sulphate EC = Electrical Conductivity

The results of aggressivity testing, and comparison with Tables 6.4.2(C) and 6.4.3 in AS 2159 - 2009 "Piling: Design and Installation" indicates that an exposure classification of 'Non-aggressive' to subsurface concrete or steel elements in clay soil.

Selected samples collected for contamination purposes were subject to laboratory analysis. Samples were analysed for a combination of the following common contaminants: heavy metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc); benzene, toluene, ethylbenzene and xylene (BTEX); total recoverable hydrocarbons (TRH); polycyclic aromatic hydrocarbons (PAH); organochlorine pesticides (OCP); organophosphorus pesticides (OPP); polychlorinated biphenyls (PCB); phenols and asbestos. A summary of the laboratory results are presented in Table A1: Summary of Contamination Laboratory Results. This table along with the laboratory certificates and chain-of-custody documentation are attached.

6. Proposed Development

The construction of a two storey school building on an elevated base is proposed. No detailed information on the structural loads or design levels was available at the time of reporting. Based on previous experience on similar school site, with similar developments, up to 2 m of cut to fill earthworks may be expected with column loads expected to be in the order of 500 – 1000 kN.

7. Comments

7.1 Excavation Conditions

Excavation within the filling, natural clays and weathered rock should be readily achievable using conventional earth moving equipment. Some light to medium ripping assistance or the careful use of rock hammers, grinders or rock saws may be required for layers of higher strength within the weathered shale. Low productivity during excavation should be expected within such materials.

Groundwater was encountered during drilling in only one borehole (BH1 at 2.0 m depth, RL 41.0 m), if seepage of groundwater into the excavation occurs, it will need to be collected during construction by the judicious placement of drainage sumps and by intermittent pumping or gravity discharge. At this stage, it is not possible to estimate the likely extent and rate of seepage although it is anticipated from the extent of fracturing in the rock that it should be readily handled by sump and pump measures. It is suggested that monitoring of flow during the early phases of excavation below the groundwater table be undertaken to assess long term drainage requirements.

All excavated materials will need to be disposed in accordance with current DECC policies. Under the Environmental Guidelines: Assessment, Classification and Management of Non-Liquid Wastes (NSW EPA, 2014) a waste/fill receiving site must be satisfied that materials received meet the environmental criteria for proposed land use. This includes filling and virgin excavated natural materials (VENM), such as may be removed from site. The type and extent of testing undertaken will depend on the final use or destination of the spoil, and requirements of the receiving site. A preliminary Waste Classification has been carried out in conjunction with this investigation with the results presented in Section 8 of this report.

7.2 Batters and Retaining Walls

Retaining walls and batters up to 2 m high are anticipated for the development.

Batters within stiff (or better) clay should be constructed to gradients no steeper than 1.5:1 (H:V) in the temporary condition or 2:1 in the permanent condition. Permanent batters must be protected against erosion with shotcrete or similar material. Batters will probably need to be 3:1 (H:V) or flatter if to be covered with topsoil and vegetation used to limit the potential for erosion.

Retaining walls may be constructed during the earthworks operations. Cantilevered retaining walls, up to 2 m high, for which some deflection is acceptable may be designed on the basis of a triangular earth pressure distribution using a bulk unit weight of 20 kN/m^3 for the retained soil material, and an active earth pressure coefficient (k_a) of 0.38 (level backfill conditions). In situations where the wall movements must be reduced, an ‘at rest’ coefficient (k_0) of 0.55 should be used instead of the above K_a values. Due allowance should be made for surcharge pressures acting on the walls (e.g. existing foundations or construction loads). The corresponding passive earth pressure coefficient (k_p) of 2.6.

Subsoil drainage should be included behind the wall to prevent the build-up of hydrostatic pressure.

7.3 Site Preparation and Earthworks

The following subgrade preparation measures are recommended below building floor slabs and pavements:

- Remove all organic topsoil and vegetation affected materials. This will include grubbing out any tree roots.
- Excavate to design subgrade level where required.
- Moisture condition any exposed filling or natural clay beneath floor slabs and pavements prior to test rolling.
- Moisture conditioning should include tyning of the exposed clays (to about 300 mm depth) and either adding moisture or drying out of clays so that they are within 2% of standard optimum moisture content (SOMC). Field moisture contents are generally dependent on climatic conditions, therefore assessment of the extent of moisture conditioning of subgrades required will need to be made at the commencement (and during) earthworks on-site.
- Test roll the exposed surface using a minimum 12 tonne smooth drum roller in non-vibration mode. The surface should be rolled a minimum of six times with the last two passes observed by an experienced geotechnical engineer to detect any ‘soft spots’.
- Any heaving materials identified during test rolling should be treated as directed by the geotechnical engineer.
- Any new filling should be placed in layers of 250 mm maximum loose thickness. The filling should be free of oversize particles (>100 mm) and deleterious material.

- Compaction of each layer to dry density ratio (DDR) between 98% and 102% relative to standard compaction for fill beneath floor slabs and to a minimum of 100% relative to standard compaction for 0.5 m of fill beneath pavements. Moisture contents should be maintained within 2 % of SOMC.
- Engineering control of the filling as defined in AS3798 “Guidelines for earthworks for commercial and residential developments.” Where filling to support structural loads is proposed (i.e. within the building footprint) Level 1 geotechnical inspection and testing should be carried out.

7.4 Foundations

7.4.1 Site Classification

The results of field work indicate that the site is underlain by filling at most test locations up to 3.2 m in depth, overlying residual clay soils then weathered shale. The presence of greater than 0.4 m depth of uncontrolled filling together with the presence of mature trees within the proposed building footprint, will result in a ‘P’ classification for the site when assessed in accordance with the “uncontrolled fill” and “abnormal moisture condition” provisions of AS 2870 - 2011 “Residential Slabs and Footings”.

Notwithstanding this classification, the laboratory testing indicates that the clays at the site are of generally moderate reactivity and likely to be susceptible to shrink-swell movements in response to seasonal variations in soil moisture content. Based on the soil depth, and the results of laboratory testing, the natural soil profile, prior to cut and fill activities, would generally be consistent with a Class ‘M’ site.

If the uncontrolled filling is removed and replaced as controlled structural filling, it should be feasible to re-classify the site.

7.4.2 Footings

If the uncontrolled filling is removed from beneath building footprints and replaced as engineered filling under Level 1 control, it should be feasible to found lightly loaded structures with footing loads up to about 500 kN, uniformly within natural clay (stiff or better) or controlled filling. For settlement sensitive structures or for footing loads greater than 500 kN it is suggested that the building loads be transferred into the underlying shale bedrock using either pad, strip or piled footings.

The design of shallow or piled footings, for axial compression loading, may be based on the maximum Limit State Design or Working Stress parameters given in Table 3.

Table 3: Maximum Foundation Design Parameters

Material	Allowable End Bearing Pressure (kPa)	Allowable Shaft Adhesion (kPa)	Ultimate End Bearing Pressure (kPa)	Ultimate Shaft Adhesion (kPa)	Elastic Modulus (MPa)
Natural Clays (stiff or better)	150	20	300	150	20
Shale, very low to low strength	1500	150	3000	300	100
Shale, low to medium strength or better	2500	250	10000	1000	200

The near surface rock is variably weathered and highly variable in strength for the upper 1 – 3 m. the deeper boreholes were terminated in low to medium strength rock, which suggests that if high building loads result from the design, it should be feasible to optimise footing design by founding in the higher strength rock that appears to underlie the site at depths below approximately 7 m.

It should be noted that the allowable pressures for “Working Stress Design Values” given in Table 3 are based on a ‘limiting settlement’ of 1% of the footing width. The design of footings is usually governed by settlement criteria and performance rather than the ultimate bearing capacity or Ultimate Limit State condition.

Footings founded on natural clay soils will also need to consider the effect of soil reactivity, equivalent to a ‘M’ classification, and the effect of adjacent trees (refer to Appendix H of AS2870).

The foundation design parameters require that the foundation excavations (e.g. for pad footings or bored piers) are clean and free of loose debris and water immediately prior to the placement of concrete.

The design of piers to resist uplift loads (e.g. tension piles) may be based on two-thirds of the allowable shaft adhesion value given above for axial compression (“cone pull-out” failure mechanisms should also be considered).

All foundations should be constructed below the zone of influence of any existing or proposed service trenches. The zone of influence can be conservatively defined by a plane extending upwards at 45º from the base of the service trench.

Where footings are located immediately adjacent and upslope of a retaining wall the footings should extend 0.5 m below the ‘zone of influence’ of the retaining wall. The ‘zone of influence’ is defined by an imaginary line extending up at 45º from the base of the wall.

Foundation excavations should be inspected by an experienced geotechnical professional prior to pouring concrete to confirm that the material is adequate for the required bearing capacity.

7.4.3 Floor Slabs

The lowest risk approach for the support of floor slabs is to fully suspend the slabs with appropriate measures to accommodate free surface movements equivalent to a Class ‘M’ site. This may require the use of void formers below any slab and subfloor beams.

Alternatively, the floor slab could act independently of the footing system and designed to be supported by the soil profile, although this would require sufficient tolerance for differential movement of the slab due to seasonal shrinking and swelling of the clays.

Weathered siltstone will provide adequate support for a slab-on-grade. The final surface should be trimmed and scraped clean of debris etc. prior to pouring concrete. A gravel layer should be provided beneath the floor slab and should slope towards the sump pit to allow sub-floor drainage. Adequate provision for access and maintenance of drains should be incorporated into the design.

Where a combination of natural clays and weathered siltstone are exposed at the bulk excavation level and a slab-on-ground is adopted an articulation joint should be placed in the ground slab at this transition point to allow for movements associated with the shrink-swell or settlement of natural clays.

7.4.4 Soil Salinity

The results of the chemical testing indicate that the sample tested had an estimated salinity of 520 mg/kg. The aggressivity results suggest that provided that surfaces of concrete or steel structures are protected by damp proof membranes, the exposure classification in AS3600 – 2009 and AS4100 - 2009 would be A1 and A respectively.

7.4.5 Seismicity

Based on the results of the investigation, the site would be classified as Class Ce (Shallow soil) when assessed in accordance with AS 1170.4 – 2007 Earthquake Actions in Australia. The hazard factor (Z) for the site is 0.8.

7.4.6 Site Maintenance

Reference is made to Appendix B of AS2870 – 2011, which provides advice on normal maintenance requirements to ensure the adequate performance of structures that have been designed and constructed in accordance with AS2870 – 2011.

Attached is a copy of the CSIRO Building Technology File BTF 18 entitled, ‘Foundation Maintenance and Footing Performance, A Homeowners Guide’, which further describes appropriate site maintenance requirements set out within Appendix B of AS2870 – 2011.

8. Preliminary Waste Classification

To assess the waste classification of the material for off-site disposal purposes a preliminary waste classification assessment was undertaken in accordance with the six step process outlined in the NSW EPA *Waste Classification Guidelines 2014*. The soil results are assessed against the general solid waste criteria outlined in Tables 1 and 2 of the guidelines and which are shown in Table A1 (attached).

With respect to the natural materials at the site, these were also assessed for their potential classification as Virgin Excavated Natural Material (VENM). For the purpose of providing a screening criteria to compare laboratory results against for assessing VENM DP has compared the results of the natural soils to published background concentrations in ANZECC/NHMRC (1992) *Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites, Environmental Soil Quality Guidelines* Background A [ANZECC A] as a screening criteria. In the case of organics where no reference values exist the laboratory reporting limit (LRL) has been adopted as the screening level.

The laboratory results recorded generally low concentrations of contaminates with all results for cadmium, mercury, BTEX, TRH, PAH, OCP, OPP and asbestos below the LRL. The recorded concentrations for the remaining heavy metals (arsenic, chromium, copper, lead, nickel and zinc) were all below the general solid waste criteria without TCLP[1] analysis. Moreover, sample BH11/0.5 from the natural silty clays recorded results within background ranges.

Based on the results the brown (silty clay, silty sand, clayey silt and silt) topsoil and the red, brown and grey silty clay filling are preliminary classified as general solid waste (non-putrescible). The natural grey, brown and orange silty clays and the underlying shale bedrock have a preliminary classification of VENM.

Prior to off-site disposal the soils are to be inspected (and sampled if considered necessary) by an appropriately qualified Environmental Consultant to confirm the above classifications. Moreover, if during construction materials not outlined herein or displaying signs of environmental concern (e.g. asbestos, odours, staining) are encountered, these are to be segregated, stockpiled and reassessed prior to off-site disposal.

It should be noted that the sporadic presence of asbestos on school sites is not uncommon given the nature of (past and present) buildings structures. Therefore, whilst asbestos has not been encountered in the laboratory screening analysis for the preliminary waste classification, DP recommends the incorporation of an unexpected finds protocol in the works management plan so a strategy for asbestos management (or other unexpected finds) is established prior to commencement of works.

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[1] Total characteristic leaching procdure.

Additionally, the laboratory results have also been compared to heath investigation levels, health screening levels and maintenance levels for primary schools (Residential A criteria) as set out in Schedule B1 of the National Environment Protection Council (NEPC) *National Environment Protection (Assessment of Site Contamination) Measure 1999* (amended 2013). These screening levels are summarised in Table A1. All laboratory results were below the aforesaid criteria, indicating a low risk of wide spread chemical contamination within the investigation areas.

9. Limitations

Douglas Partners (DP) has prepared this report for this project at 425 Hume Highway Yagoona in accordance with DP's proposal SYD170171 Rev1 dated 8 June 2018 and acceptance received from Ms Joelle Sarkis of Conrad Cargett Pty Ltd dated 26 June 2017. The work was carried out under an Architect and Sub-consultants agreement dated 12 July 2017. This report is provided for the exclusive use of Conrad Cargett Pty Ltd for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the sub-surface conditions on the site only at the specific sampling and/or testing locations, and then only to the depths investigated and at the time the work was carried out. Sub-surface conditions can change abruptly due to variable geological processes and also as a result of human 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 affected by undetected variations in ground conditions across the site between and beyond the sampling and/or testing locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

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 stated 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 scope for work for this investigation/report did not include the assessment of surface or sub-surface materials or groundwater for contaminants, within or adjacent to the site. Should evidence of filling of unknown origin be noted in the report, and in particular the presence of building demolition materials, it should be recognised that there may be some risk that such filling may contain contaminants and hazardous building materials.

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 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.

Please contact the undersigned if you have any questions on this matter.

Yours faithfully
Douglas Partners Pty Ltd

Konrad Schultz
Principal

Reviewed by

MJT per

Michael J Thom
Principal

Attachments:	About this Report
	Sampling Methods
	Soil Descriptions
	Symbols and Abbreviations
	Borehole Logs
	Table A1: Summary of Contamination Laboratory Results
	Laboratory Test Results
	CSIRO Sheet
	Drawing 1

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.

Sampling Methods

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

Douglas Partners

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 Descriptions

Douglas Partners

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

Douglas Partners

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

Symbols & Abbreviations

Graphic Symbols for Soil and Rock

General

■	Asphalt
░	Road base
△	Concrete
▩	Filling

Soils

▨	Topsoil
✱	Peat
▨	Clay
▨	Silty clay
▨	Sandy clay
▨	Gravelly clay
▨	Shaly clay
▥	Silt
▥	Clayey silt
▥	Sandy silt
░	Sand
░	Clayey sand
░	Silty sand
◌	Gravel
◌	Sandy gravel
◯	Cobbles, boulders
△	Talus

Sedimentary Rocks

◯	Boulder conglomerate
◯	Conglomerate
░	Conglomeratic sandstone
░	Sandstone
▤	Siltstone
▤	Laminite
▤	Mudstone, claystone, shale
■	Coal
▦	Limestone

Metamorphic Rocks

∿	Slate, phyllite, schist
+	Gneiss
·	Quartzite

Igneous Rocks

+	Granite
<	Dolerite, basalt, andesite
×	Dacite, epidote
∨	Tuff, breccia
▭	Porphyry

BOREHOLE LOG

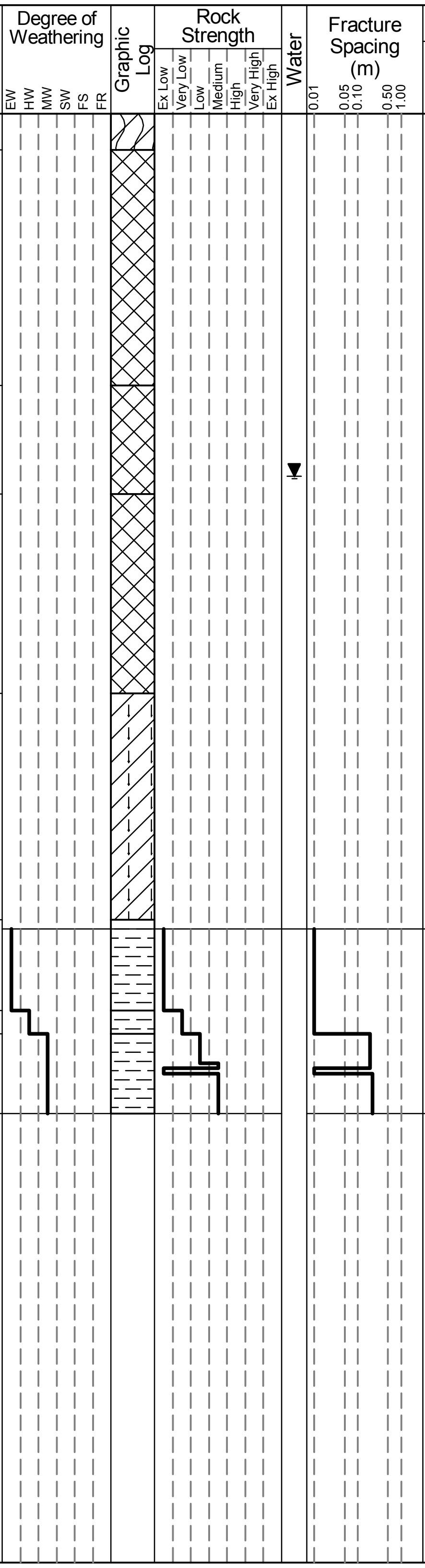
CLIENT: Conrad Gargett Pty Ltd
PROJECT: DoEAMD-16-78 Group 2 - Parramatta
LOCATION: 425 Hume Highway, Public School, Yagoona

SURFACE LEVEL: 43 AHD
EASTING: 317603.2
NORTHING: 6246126.1
DIP/AZIMUTH: 90°/--

BORE No: BH1
PROJECT No: 86030.00
DATE: 4/7/2017
SHEET 1 OF 1

RL	Depth (m)
43	
42	1
41	2
40	3
39	4
38	5
37	6
36	7

Depth (m)	Description of Strata	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Type	Core Rec. %	RQD %	Test Results & Comments
0.2	TOPSOIL - dark brown clayey silt topsoil filling with some fine sand and rootlets, damp		A/E			
1.5	FILLING - red, brown, dark grey and grey, silty clay filling with some fine to medium gravel and rootlets, generally in a stiff condition, damp		A/E A/E A/E S			3,5,4 N = 9
2.1	FILLING - dark brown, silty clay filling with some fine to medium gravel, rootlets and bark, damp (possible buried topsoil) - becoming moist at 2.0m		A/E A/E			
3.2	FILLING - brown and red-brown mottled grey, silty clay filling with some fine to medium gravel, generally in a very stiff condition, wet		A/E S A/E			4,8,12 N = 20
4.45	SILTY CLAY - very stiff, orange-brown and grey, silty clay with a slightly shaly texture, damp	Note: Unless otherwise stated, rock is fractured along rough planar bedding dipping 0°- 10°	A/E A/E S			14,12,10 N = 22
4.95	SHALE - extremely low strength, extremely weathered, orange-brown and grey shale		C	100	40	PL(A) = 0.03
5.08	SHALE - very low strength, highly weathered, grey shale					
5.52	SHALE - low then medium strength, moderately weathered, slightly fractured, dark grey and brown shale with some carbonaceous laminations to 5.25m	5.27m: Ds, 30mm				PL(A) = 0.51
	Bore discontinued at 5.52m - target depth reached					



RIG: Dando Terrier **DRILLER:** BG Drilling-Lanaway **LOGGED:** RMM/LS **CASING:** HW to 4.3m

TYPE OF BORING: Solid flight auger (TC-bit) to 4.5m; NMLC-Coring to 5.52m

WATER OBSERVATIONS: Free groundwater observed at approximately 2.0m 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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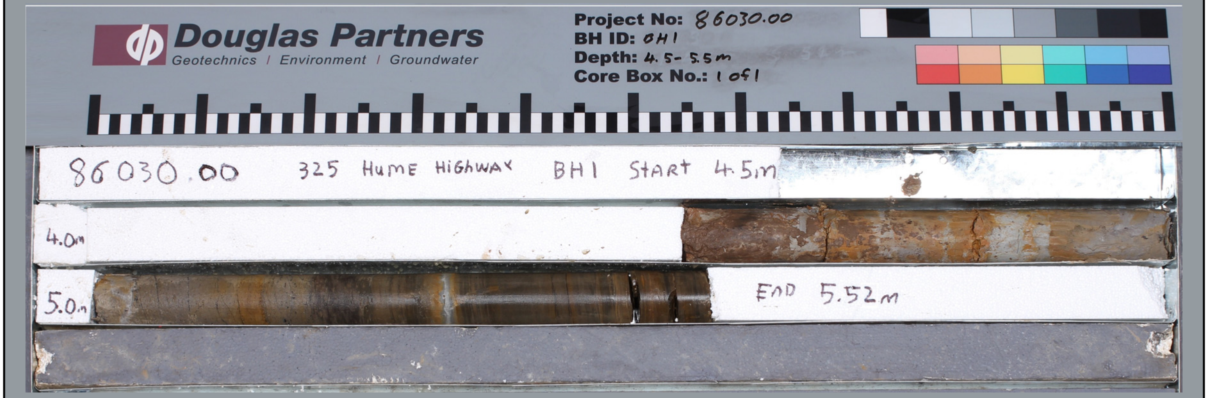
Geotechnics / Environment / Groundwater

BORE: BH1 **PROJECT: YAGOONA - 86030.00** **JULY 2017**



4.5 m – 5.52 m

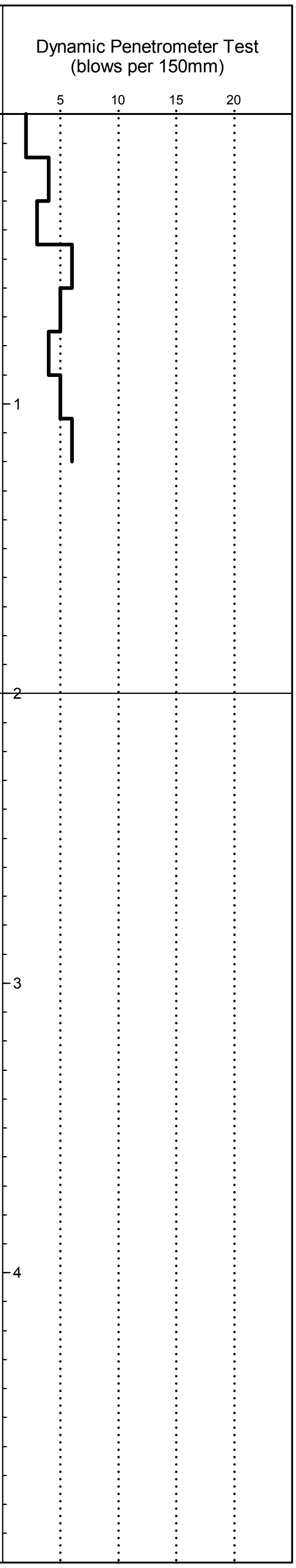
BOREHOLE LOG

CLIENT: Conrad Gargett Pty Ltd
PROJECT: DoEAMD-16-78 Group 2 - Parramatta
LOCATION: 425 Hume Highway, Public School, Yagoona

SURFACE LEVEL: 43.3 AHD
EASTING: 317582.5
NORTHING: 6246131
DIP/AZIMUTH: 90°/--

BORE No: BH2
PROJECT No: 86030.00
DATE: 4/7/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		TOPSOIL - dark brown silt topsoil filling with some fine sand and rootlets, damp - becoming silty clay filling at 0.2m		A/E	0.1			
43	0.3	FILLING - brown and grey mottled red, silty clay filling with some fine to medium gravel, generally in a stiff condition, damp		A/E	0.3			
				A/E	0.5			
	1			A/E	1.0			
42								
				A/E	1.5			
	1.7	SILTY CLAY - apparently stiff to very stiff, grey mottled brown silty clay, apparently low to medium plasticity, humid						
	2 2.0	Bore discontinued at 2.0m - target depth reached		A/E	2.0			
41								
	3							
40								
	4							
39								



RIG: Kubota U35-3 **DRILLER:** BM **LOGGED:** RMM/LS **CASING:** Uncased
TYPE OF BORING: 150mm diameter solid flight auger to 2.0m
WATER OBSERVATIONS: No free groundwater observed whilst augering
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

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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Geotechnics / Environment / Groundwater

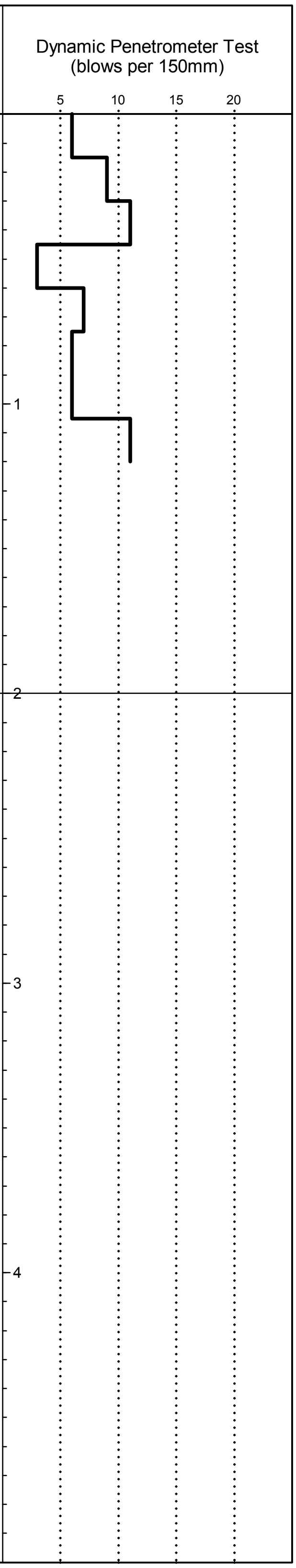
BOREHOLE LOG

CLIENT: Conrad Gargett Pty Ltd
PROJECT: DoEAMD-16-78 Group 2 - Parramatta
LOCATION: 425 Hume Highway, Public School, Yagoona

SURFACE LEVEL: 44.1 AHD
EASTING: 317583.2
NORTHING: 6246148.9
DIP/AZIMUTH: 90°/--

BORE No: BH3
PROJECT No: 86030.00
DATE: 4/7/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
44		FILLING - dark brown, silty clay filling with some fine sand and fine to medium angular gravel, humid						
43	1.2	SILTY CLAY - apparently stiff to very stiff, light grey and brown, silty clay with some fine grained sand and fine ironstone gravel, apparently medium plasticity, humid						
	1.6	SILTY CLAY - apparently stiff, red and grey silty clay, humid						
42	2.0	Bore discontinued at 2.0m - target depth reached						



RIG: Kubota U35-3 **DRILLER:** BM **LOGGED:** RMM/LS **CASING:** Uncased
TYPE OF BORING: 150mm diameter solid flight auger to 2.0m
WATER OBSERVATIONS: No free groundwater observed whilst augering
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

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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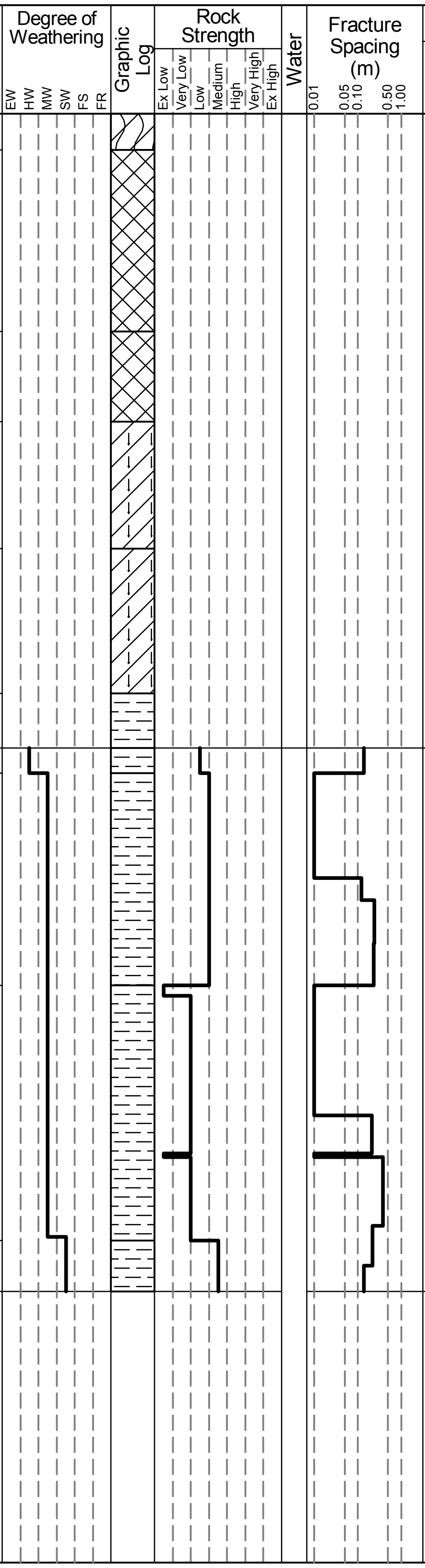
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Conrad Gargett Pty Ltd
PROJECT: DoEAMD-16-78 Group 2 - Parramatta
LOCATION: 425 Hume Highway, Public School, Yagoona

SURFACE LEVEL: 44.7 AHD
EASTING: 317614.3
NORTHING: 6246166.2
DIP/AZIMUTH: 90°/--

BORE No: BH5
PROJECT No: 86030.00
DATE: 4/7/2017
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
0.2	TOPSOIL - dark brown silty sand topsoil filling with some clay, fine gravel and rootlets, damp		A/E			
1.2	FILLING - brown, red-brown and grey, slightly silty clay filling with some fine sand and fine to medium angular gravel, humid		A/E A/E E			
1.7	FILLING - dark brown, slightly silty clay filling with some fine sand, rootlets, fine gravel and ash, generally in a firm condition, apparently high plasticity, damp		S E			1,2,3 N = 5
2.4	SILTY CLAY - stiff, red-brown, brown and grey silty clay with some ironstone gravel, apparently high plasticity, humid		A/E			
3.2	SILTY CLAY - stiff, brown and grey silty clay with a slightly shaly texture, apparently low plasticity, humid - becoming grey at 2.9m	Note: Unless otherwise stated, rock is fractured along rough planar bedding dipping 0°- 10°	S A			2,3,6 N = 9
3.5	SHALE - extremely low strength, extremely weathered, grey shale, humid					
3.64	SHALE - low strength, highly weathered, brown and grey shale		C	100	51	PL(A) = 0.21
4.81	SHALE - low to medium strength, moderately weathered, fractured, dark grey and brown shale with some ironstaining	3.64m: J70°- 90°, ro, un, cly vn 4.34m: J80°- 90°, ro, un, fe stn 4.58-4.75m: J70°- 90°, ro, un, fe stn				PL(A) = 0.28 PL(A) = 0.42
6.22	SHALE - very low to low strength, moderately weathered, dark grey and grey shale	4.81m: Ds, 60mm 5.74m: Ds, 20mm 6.14m: J80°- 90°, un, ro, partially he				PL(A) = 0.09 PL(A) = 0.11 PL(A) = 0.11
6.5	SHALE - medium strength, slightly weathered, grey shale	6.36m: J7°, un, ro, cln				PL(A) = 0.89
	Bore discontinued at 6.5m - target depth reached					

RIG: Dando Terrier **DRILLER:** BG Drilling-Lanaway **LOGGED:** RMM **CASING:** HW to 3.9m

TYPE OF BORING: Solid flight auger (TC-bit) to 3.5m; NMLC-Coring to 6.5m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Rock core fragmented from 4.08m to 4.22m and 4.81m to 5.53m due to complications removing core from barrel.

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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BORE: BH5 **PROJECT: YAGOONA - 86030.00** **JULY 2017**

Project No: 86030.00
BH ID: BH5
Depth: 3.5m - 6.5m
Core Box No.: 1/1

86030.00 YAGOONA BH5 Start at 3.5m

End at 6.5m

3.5 – 6.5 m

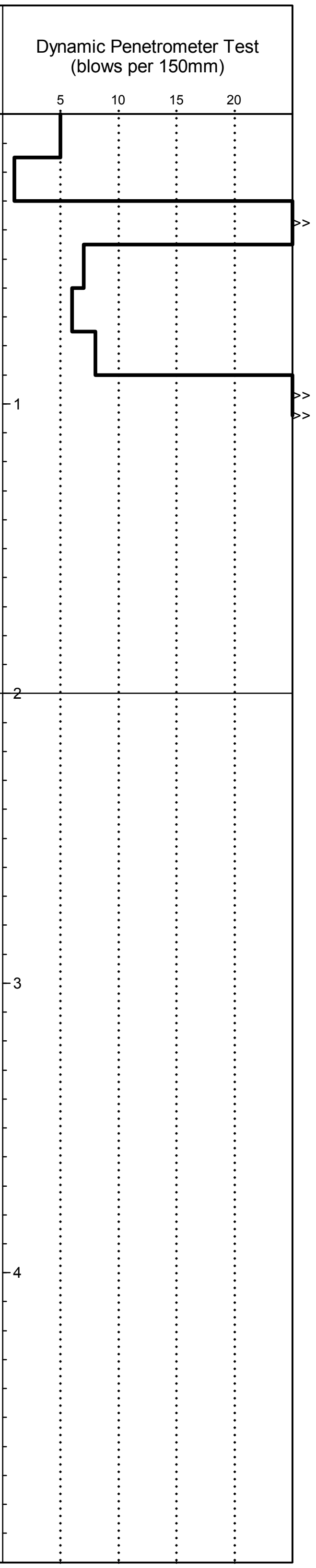
BOREHOLE LOG

CLIENT: Conrad Gargett Pty Ltd
PROJECT: DoEAMD-16-78 Group 2 - Parramatta
LOCATION: 425 Hume Highway, Public School, Yagoona

SURFACE LEVEL: 45.1 AHD
EASTING: 317597.3
NORTHING: 6246168
DIP/AZIMUTH: 90°/--

BORE No: BH6
PROJECT No: 86030.00
DATE: 4/7/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Sampling & In Situ Testing Type	Sampling & In Situ Testing Depth	Sample	Results & Comments	Water
45		TOPSOIL - dark brown silt topsoil filling with some fine sand and clay, fine to medium gravel and rootlets, varied consistency, humid	A/E A/E	0.1 0.3			
44	0.5	FILLING - red-brown mottled grey and brown, silty clay filling with some fine to medium gravel, generally in a stiff condition, humid	A/E A/E	0.5 1.0			
	1.5	FILLING - light brown and grey mottled dark grey and red-brown, silty clay filling with some fine to medium gravel, humid	A/E A/E	1.9 2.0			
43 42 41	2.0	Bore discontinued at 2.0m - target depth reached					



RIG: Kubota U35-3 **DRILLER:** BM **LOGGED:** RMM/LS **CASING:** Uncased
TYPE OF BORING: 150mm diameter solid flight auger to 2.0m
WATER OBSERVATIONS: No free groundwater observed whilst augering
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

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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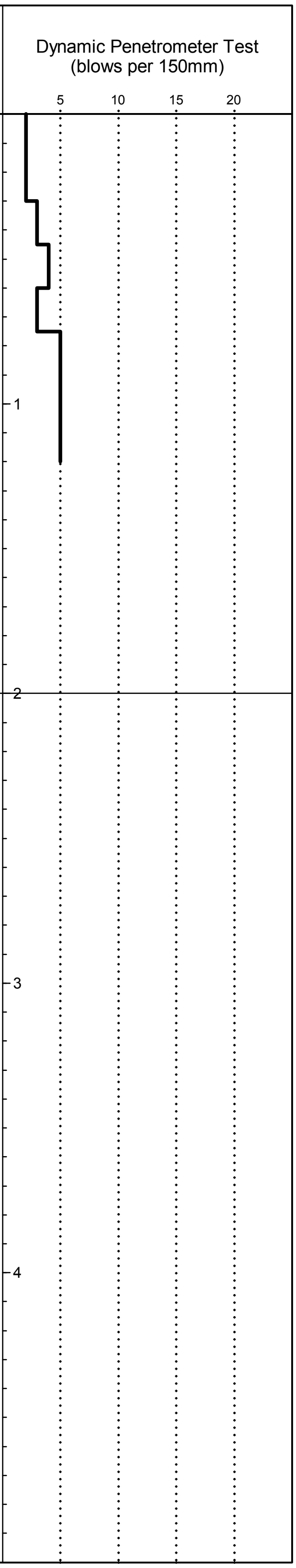
BOREHOLE LOG

CLIENT: Conrad Gargett Pty Ltd
PROJECT: DoEAMD-16-78 Group 2 - Parramatta
LOCATION: 425 Hume Highway, Public School, Yagoona

SURFACE LEVEL: 43.7 AHD
EASTING: 317611
NORTHING: 6246144.8
DIP/AZIMUTH: 90°/--

BORE No: BH7
PROJECT No: 86030.00
DATE: 4/7/2017
SHEET 1 OF 1

Depth (m)	Description of Strata	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
0.05	TOPSOIL - dark brown silty sand topsoil filling with some clay, fine angular gravel and rootlets, damp	A/E	0.1			
	FILLING - brown, dark brown, red-brown and grey, silty clay filling with some fine to medium angular shale and ironstone gravel and trace rootlets, generally in a firm to stiff condition, humid	A/E	0.3			
		A/E	0.5			
		A/E	1.0			
		A/E	1.5			
1.6	FILLING - dark brown mottled brown, silty clay filling with some rootlets (possible buried topsoil)					
2.0	Bore discontinued at 2.0m - target depth reached	A/E	2.0			



RIG: Kubota U35-3 **DRILLER:** BM **LOGGED:** RMM/LS **CASING:** Uncased

TYPE OF BORING: 150mm diameter solid flight auger to 2.0m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

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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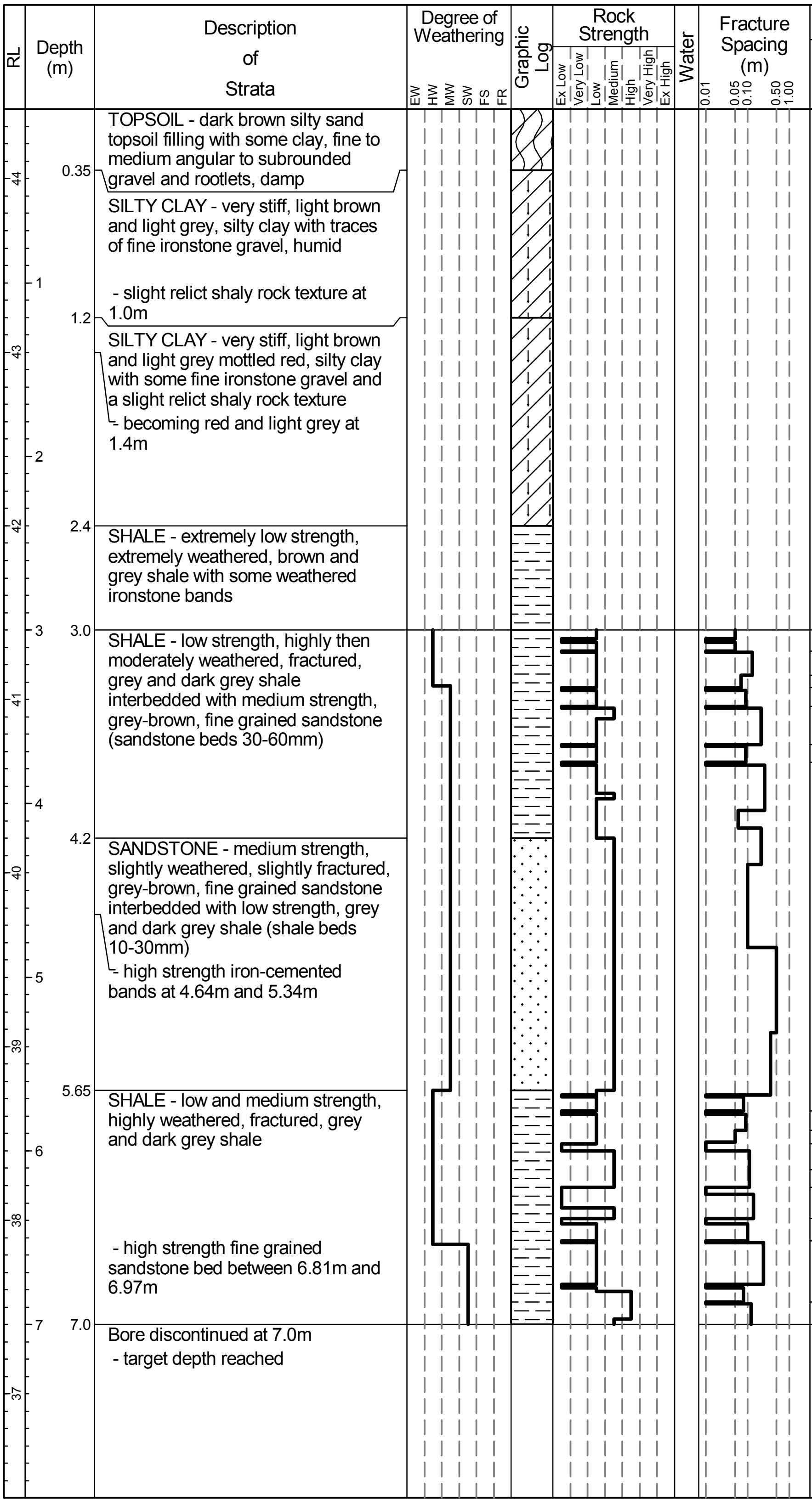
BOREHOLE LOG

CLIENT: Conrad Gargett Pty Ltd
PROJECT: DoEAMD-16-78 Group 2 - Parramatta
LOCATION: 425 Hume Highway, Public School, Yagoona

SURFACE LEVEL: 44.4 AHD
EASTING: 317570.6
NORTHING: 6246156.6
DIP/AZIMUTH: 90°/--

BORE No: BH8
PROJECT No: 86030.00
DATE: 4/7/2017
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
0.35	TOPSOIL - dark brown silty sand topsoil filling with some clay, fine to medium angular to subrounded gravel and rootlets, damp		A/E A/E			
1.2	SILTY CLAY - very stiff, light brown and light grey, silty clay with traces of fine ironstone gravel, humid - slight relict shaly rock texture at 1.0m		A/E			
2.4	SILTY CLAY - very stiff, light brown and light grey mottled red, silty clay with some fine ironstone gravel and a slight relict shaly rock texture - becoming red and light grey at 1.4m	Note: Unless otherwise stated, rock is fractured along rough planar bedding dipping 0°- 10°	S A A			5,9,14 N = 23
3.0	SHALE - extremely low strength, extremely weathered, brown and grey shale with some weathered ironstone bands		S			8,27,30/110mm refusal
4.2	SHALE - low strength, highly then moderately weathered, fractured, grey and dark grey shale interbedded with medium strength, grey-brown, fine grained sandstone (sandstone beds 30-60mm)	3.05m: Cs, 20mm, gravelly 3.12m: Ds, 10mm 3.26m: B0°- 5°, pl, he 3.33m: Cs, 20mm, gravelly 3.44m: Ds, 10mm 3.66m: Ds, 10mm 3.76m: Ds, 20mm 4.04-4.14m: B (x3) 0°- 5°, un, he, fe stn	C	100	61	PL(A) = 0.11 PL(A) = 0.49 PL(A) = 0.48 PL(A) = 0.19
5.65	SANDSTONE - medium strength, slightly weathered, slightly fractured, grey-brown, fine grained sandstone interbedded with low strength, grey and dark grey shale (shale beds 10-30mm) - high strength iron-cemented bands at 4.64m and 5.34m	4.35-4.83m: B (x5) 0°- 10°, ro, un, fe stn 4.64m: B0°- 10°, fe stn 5.32m: B0°, fe stn				PL(A) = 0.4 PL(A) = 0.44
7.0	SHALE - low and medium strength, highly weathered, fractured, grey and dark grey shale - high strength fine grained sandstone bed between 6.81m and 6.97m	5.68m: Ds, 10mm 5.77m: Cs, 20mm 5.88-5.95m: B (x3) 5°- 10°, ro, un, cly 5mm 5.96m: Ds, 40mm 6.11m: J80°, pl, he 6.21m: Ds, 40mm 6.39m: Cs, 30mm 6.52m: Ds, 10mm 6.77m: Ds, 20mm 6.87m: B5°- 10°, ro, un, cly 10mm	C	100	59	PL(A) = 0.23 PL(A) = 0.29 PL(A) = 1.18
	Bore discontinued at 7.0m - target depth reached					

RIG: Dando Terrier **DRILLER:** BG Drilling-Lanaway **LOGGED:** RMM **CASING:** HW to 3.0m
TYPE OF BORING: Solid flight auger (TC-bit) to 2.91m; Rotary to 3.0m; NMLC-Coring to 7.0m
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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BORE: BH8 **PROJECT: YAGOONA - 86030.00** **JULY 2017**

3.0 m – 7.0 m

BOREHOLE LOG

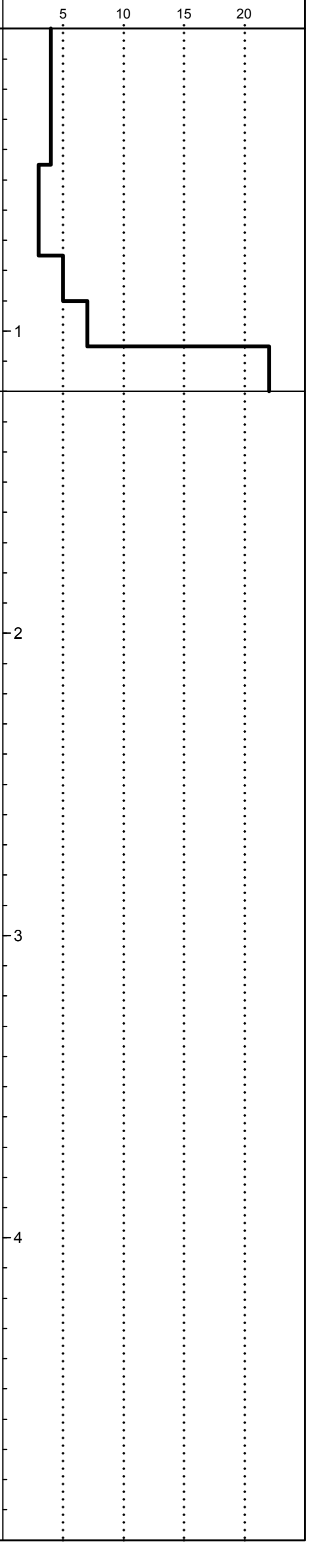
CLIENT: Conrad Gargett Pty Ltd
PROJECT: DoEAMD-16-78 Group 2 - Parramatta
LOCATION: 425 Hume Highway, Public School, Yagoona

SURFACE LEVEL: 43.6 AHD
EASTING: 317565.3
NORTHING: 6246134.6
DIP/AZIMUTH: 90°/--

BORE No: BH9
PROJECT No: 86030.00
DATE: 4/7/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Type	Depth	Sample	Results & Comments	Water
		TOPSOIL - dark brown, clayey silt topsoil filling with some fine sand and rootlets, humid	A/E	0.1			
	0.2	FILLING - red-brown mottled grey and brown, silty clay filling with traces of fine to medium gravel, generally in a stiff condition, humid	A/E	0.3			
43	0.4	SILTY CLAY - stiff, brown and grey mottled red-brown silty clay with a slight relict shale rock texture, apparently medium plasticity, humid	A/E	0.5			
	1		A/E	1.0			
	1.1	SHALE - extremely low strength, extremely weathered, brown and grey shale, humid					
	1.2	Bore discontinued at 1.2m - refusal on possible very low strength shale					
42	2						
41	3						
40	4						
39							

Dynamic Penetrometer Test (blows per 150mm)



RIG: Kubota U35-3 **DRILLER:** BM **LOGGED:** RMM/LS **CASING:** Uncased
TYPE OF BORING: 150mm diameter solid flight auger to 1.2m
WATER OBSERVATIONS: No free groundwater observed whilst augering
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

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)

BOREHOLE LOG

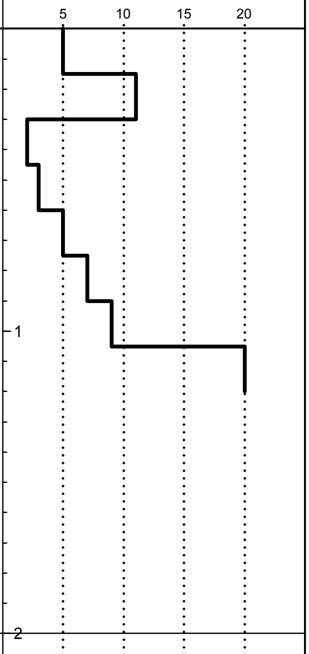
CLIENT: Conrad Gargett Pty Ltd
PROJECT: DoEAMD-16-78 Group 2 - Parramatta
LOCATION: 425 Hume Highway, Public School, Yagoona

SURFACE LEVEL: 45.6 AHD
EASTING: 317556
NORTHING: 6246166.7
DIP/AZIMUTH: 90°/--

BORE No: BH10
PROJECT No: 86030.00
DATE: 4/7/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Type	Depth	Sample	Results & Comments	Water
		TOPSOIL - dark brown silt topsoil filling, slightly clayey and gravelly, with some rootlets, generally in a stiff condition, damp	A/E	0.1			
	0.3	FILLING - dark brown and grey, silty clay filling with some fine to medium gravel, generally in a firm to stiff condition, damp	A/E	0.3			
45			A/E	0.5			
	1		A/E	1.0			
44			A/E	1.5			
	1.7	FILLING - red-brown mottled grey, dark grey and brown, silty clay filling with some fine to medium gravel and fine to medium sand, humid					
	2.0	Bore discontinued at 2.0m - target depth reached	A/E	2.0			
43	3						
42	4						
41							

Dynamic Penetrometer Test (blows per 150mm)



RIG: Kubota U35-3 **DRILLER:** BM **LOGGED:** RMM/LS **CASING:** Uncased
TYPE OF BORING: 150mm diameter solid flight auger to 2.0m
WATER OBSERVATIONS: No free groundwater observed whilst augering
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

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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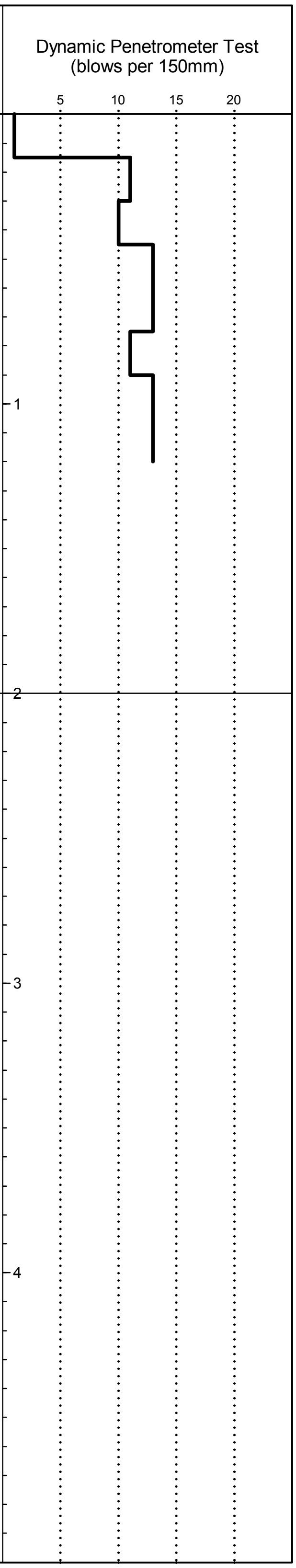
BOREHOLE LOG

CLIENT: Conrad Gargett Pty Ltd
PROJECT: DoEAMD-16-78 Group 2 - Parramatta
LOCATION: 425 Hume Highway, Public School, Yagoona

SURFACE LEVEL: 45.8 AHD
EASTING: 317536.2
NORTHING: 6246161.8
DIP/AZIMUTH: 90°/--

BORE No: BH11
PROJECT No: 86030.00
DATE: 4/7/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		TOPSOIL - dark brown fine to medium sand and silt topsoil filling with some rootlets, generally in a loose condition, humid		A/E	0.1			
	0.3	SILTY CLAY - very stiff to hard, brown silty clay, apparently low plasticity, humid		A/E	0.3			
				A/E	0.5			
45								
	1			A/E	1.0			
		- possible roots at 1.2m						
				A/E	1.5			
44								
		- becoming mottled red and grey with a slightly shaly texture at 1.9m						
	2 2.0	Bore discontinued at 2.0m - target depth reached		A/E	2.0			
43								
	3							
42								
	4							
41								



RIG: Kubota U35-3 **DRILLER:** BM **LOGGED:** RMM/LS **CASING:** Uncased
TYPE OF BORING: 150mm diameter solid flight auger to 2.0m
WATER OBSERVATIONS: No free groundwater observed whilst augering
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

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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Results of Dynamic Penetrometer Tests

Client Conrad Gargett Pty Ltd
Project DoEAMD-16-78 - Parramatta
Location 425 Hume Highway, Public School, Yagoona

Project No. 86030.00
Date 4/7/17
Page No. 1 of 1

Test Locations	BH2	BH3	BH6	BH7	BH9	BH10	BH11			
RL of Test (AHD)	43.3	44.1	45.1	43.7	43.6	45.6	45.8			
Depth (m)	**Penetration Resistance** Blows/150 mm									
0.00 – 0.15	2	6	5	2	4	5	1			
0.15 – 0.30	4	9	1	2	4	11	11			
0.30 – 0.45	3	11	26	3	4	2	10			
0.45 – 0.60	6	3	7	4	3	3	13			
0.60 – 0.75	5	7	6	3	3	5	13			
0.75 – 0.90	4	6	8	5	5	7	11			
0.90 – 1.05	5	6	30/140	5	7	9	13			
1.05 – 1.20	6	11	R	5	22	20	13			
1.20 – 1.35										
1.35 – 1.50										
1.50 – 1.65										
1.65 – 1.80										
1.80 – 1.95										
1.95 – 2.10										
2.10 – 2.25										
2.25 – 2.40										
2.40 – 2.55										
2.55 – 2.70										
2.70 – 2.85										
2.85 – 3.00										

Test Method AS 1289.6.3.2, Cone Penetrometer ☑
AS 1289.6.3.3, Sand Penetrometer ☐

Tested By RMM
Checked By HDS

Remarks 30/140 = 30 blow counts for 140mm penetration
R = Refusal

Table A1: Summary of Contamination Laboratory Results

				BTEX							Metals							
				Benzene	Ethylbenzene	Toluene	Xylene (m & p)	Xylene (o)	Xylene Total	C6-C10 less BTEX (F1)	Arsenic	Cadmium	Chromium (III+VI)	Copper	Lead	Mercury	Nickel	Zinc
				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				0.2	1	0.5	2	1	1	25	4	0.4	1	1	1	0.1	1	1
NEPM 2013 HILs/HSLs Res A Soil				100	4500	14,000			12,000	4400	100	20	100	6000	300	40	400	7400
NEPM 2013 Res A/B Soil HSL for Vapour Intrusion, Sand 0-1m				0.5	55	160			40	45								
NEPM 2013 Management Limits in Res / Parkland, Coarse Soil																		
NSW 2014 General Solid Waste (CT1)				10	600	288			1000		100	20	100		100	4	40	
NSW 2014 General Solid Waste (SCC1 and TCLP1)				18	1080	518			1800		500	100	1900		1500	50	1050	
ANZECC (1992) - For Natural Material				0.05-1		0.1-1					0.2-30	0.04-2	0.5-110	1-190	<2-200	0.001-0.1	2-400	2-180
Location	**Sample Depth**	**Sample Date**	**Srtata**															
BH1	0.5	4/07/2017	Filling	<0.2	<1	<0.5	<2	<1	<1	<25	5	<0.4	13	30	18	<0.1	10	55
BH2	0.1	4/07/2017	Filling	<0.2	<1	<0.5	<2	<1	<3	<25	13	<0.4	11	20	40	<0.1	7	66
BH2	0.5	4/07/2017	Filling	<0.2	<1	<0.5	<2	<1	<3	<25	8	<0.4	13	34	27	<0.1	13	77
BH5	0.5	4/07/2017	Filling	<0.2	<1	<0.5	<2	<1	<3	<25	7	<0.4	22	22	35	<0.1	8	6
BH5	1.5	4/07/2017	Filling	<0.2	<1	<0.5	<2	<1	<3	<25	6	<0.4	18	18	20	<0.1	13	45
BH6	0.1	4/07/2017	Filling	<0.2	<1	<0.5	<2	<1	<3	<25	5	<0.4	12	27	24	<0.1	12	61
BH6	1	4/07/2017	Filling	<0.2	<1	<0.5	<2	<1	<3	<25	6	<0.4	15	29	15	<0.1	10	52
BH8	0.1	4/07/2017	Filling	<0.2	<1	<0.5	<2	<1	<3	<25	4	<0.4	12	24	14	<0.1	12	39
BH9	0.1	4/07/2017	Filling	<0.2	<1	<0.5	<2	<1	<3	<25	5	<0.4	12	34	13	<0.1	10	68
BH10	0.5	4/07/2017	Filling	<0.2	<1	<0.5	<2	<1	<3	<25	13	<0.4	12	24	13	<0.1	12	36
BH11	0.5	4/07/2017	Natural	<0.2	<1	<0.5	<2	<1	<3	<25	6	<0.4	14	23	17	<0.1	7	42

				OCP						OPP		PAH					
				OCP (Sum of total)	Aldrin + Dieldrin	DDT+DDE+DDD	Endrin	Heptachlor	Methoxychlor	OPP (sum of total)	Chlorpyrifos	Benzo(a) pyrene	B(a)P Total Potency Equivalent	Naphthalene	PAHs (Sum of total)	Phenolics Total	PCB (Sum of total)
				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				2	0.2	0.1	0.1	0.1	0.1	1.2	0.1	0.05	0.5	0.1	0.05	5	0.8
NEPM 2013 HILs/HSLs Res A Soil					6	240	10	6	300		160		3	1400	300	100	1
NEPM 2013 Res A/B Soil HSL for Vapour Intrusion, Sand 0-1m														3			
NEPM 2013 Management Limits in Res / Parkland, Coarse Soil																	
NSW 2014 General Solid Waste (CT1)				50						50	4	0.8			200		50
NSW 2014 General Solid Waste (SCC1 and TCLP1)				50						50	7.5	10			200		50
ANZECC (1992) - For Natural Material															0.95-5	0.03-0.5	
Location	**Sample Depth**	**Sample Date**	**Srtata**														
BH1	0.5	4/07/2017	Filling	<2	<0.2	<0.1	<0.1	<0.1	<0.1	<1.2	<0.1	<0.05	<0.5	<0.1	<0.05	<5	<0.8
BH2	0.1	4/07/2017	Filling	-	-	-	-	-	-	-	-	<0.05	<0.5	<0.1	<0.05	-	-
BH2	0.5	4/07/2017	Filling	-	-	-	-	-	-	-	-	<0.05	<0.5	<0.1	<0.05	-	-
BH5	0.5	4/07/2017	Filling	-	-	-	-	-	-	-	-	<0.05	<0.5	<0.1	<0.05	-	-
BH5	1.5	4/07/2017	Filling	-	-	-	-	-	-	-	-	<0.05	<0.5	<0.1	<0.05	-	-
BH6	0.1	4/07/2017	Filling	-	-	-	-	-	-	-	-	<0.05	<0.5	<0.1	<0.05	-	-
BH6	1	4/07/2017	Filling	-	-	-	-	-	-	-	-	<0.05	<0.5	<0.1	<0.05	-	-
BH8	0.1	4/07/2017	Filling	-	-	-	-	-	-	-	-	<0.05	<0.5	<0.1	<0.05	-	-
BH9	0.1	4/07/2017	Filling	-	-	-	-	-	-	-	-	<0.05	<0.5	<0.1	<0.05	-	-
BH10	0.5	4/07/2017	Filling	<2	<0.2	<0.1	<0.1	<0.1	<0.1	<1.2	<0.1	<0.05	<0.5	<0.1	<0.05	<5	<0.8
BH11	0.5	4/07/2017	Natural	-	-	-	-	-	-	-	-	<0.05	<0.5	<0.1	<0.05	-	-

				TRH										
				C10-C16	C16-C34	C34-C40	F2-NAPHTHALENE	C6 - C9	C10 - C14	C15 - C28	C29-C36	>C10 - C40 (Sum of total +'ve)	C6-C10	Asbestos
				mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	g/kg
EQL				50	100	100	50	25	50	100	100	50	25	0.1
NEPM 2013 HILs/HSLs Res A Soil					4500	6300	3300							
NEPM 2013 Res A/B Soil HSL for Vapour Intrusion, Sand 0-1m							110							
NEPM 2013 Management Limits in Res / Parkland, Coarse Soil				1000	2500	10,000							700	
NSW 2014 General Solid Waste (CT1)								650				10,000		NAD
NSW 2014 General Solid Waste (SCC1 and TCLP1)								650				10,000		NAD
ANZECC (1992) - For Natural Material														
Location	**Sample Depth**	**Sample Date**	**Srtata**											
BH1	0.5	4/07/2017	Filling	<50	<100	<100	<50	<25	<50	<100	<100	<50	<25	<0.1
BH2	0.1	4/07/2017	Filling	<50	<100	<100	<50	<25	<50	<100	<100	<50	<25	<0.1
BH2	0.5	4/07/2017	Filling	<50	<100	<100	<50	<25	<50	<100	<100	<50	<25	<0.1
BH5	0.5	4/07/2017	Filling	<50	<100	<100	<50	<25	<50	<100	<100	<50	<25	<0.1
BH5	1.5	4/07/2017	Filling	<50	<100	<100	<50	<25	<50	<100	<100	<50	<25	<0.1
BH6	0.1	4/07/2017	Filling	<50	<100	<100	<50	<25	<50	<100	<100	<50	<25	<0.1
BH6	1	4/07/2017	Filling	<50	<100	<100	<50	<25	<50	<100	<100	<50	<25	<0.1
BH8	0.1	4/07/2017	Filling	<50	<100	<100	<50	<25	<50	<100	<100	<50	<25	<0.1
BH9	0.1	4/07/2017	Filling	<50	<100	<100	<50	<25	<50	<100	<100	<50	<25	<0.1
BH10	0.5	4/07/2017	Filling	<50	<100	<100	<50	<25	<50	<100	<100	<50	<25	<0.1
BH11	0.5	4/07/2017	Natural	<50	<100	<100	<50	<25	<50	<100	<100	<50	<25	-

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CERTIFICATE OF ANALYSIS 171427

Client:

Douglas Partners Pty Ltd
96 Hermitage Rd
West Ryde
NSW 2114

Attention: David Holden, Zoe Maher

Sample log in details:

Your Reference:	**86030.00, Yagoona**
No. of samples:	11 soils
Date samples received / completed instructions received	14/07/17 / 14/07/17

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:	21/07/17 / 21/07/17
Date of Preliminary Report:	Not Issued

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Results Approved By:

David Springer
General Manager

NATA
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COMPETENCE

vTRH(C6-C10)/BTEXN in Soil						
Our Reference:	UNITS	171427-1	171427-2	171427-3	171427-4	171427-5
Your Reference	-------------	BH1	BH2	BH2	BH5	BH6
Depth	------------	0.5	0.5	0.1	0.5	0.1
Type of sample		Soil	Soil	Soil	Soil	Soil
Date extracted	-	18/07/2017	18/07/2017	18/07/2017	18/07/2017	18/07/2017
Date analysed	-	19/07/2017	19/07/2017	19/07/2017	19/07/2017	19/07/2017
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
Total +ve Xylenes	mg/kg	<1	<1	<1	<1	<1
naphthalene	mg/kg	<1	<1	<1	<1	<1
Surrogate aaa-Trifluorotoluene	%	90	90	94	83	93

vTRH(C6-C10)/BTEXN in Soil						
Our Reference:	UNITS	171427-6	171427-7	171427-8	171427-9	171427-10
Your Reference	-------------	BH6	BH5	BH8	BH9	BH10
Depth	------------	1.0	1.5	0.1	0.1	0.5
Type of sample		Soil	Soil	Soil	Soil	Soil
Date extracted	-	18/07/2017	18/07/2017	18/07/2017	18/07/2017	18/07/2017
Date analysed	-	19/07/2017	19/07/2017	19/07/2017	19/07/2017	19/07/2017
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
Total +ve Xylenes	mg/kg	<1	<1	<1	<1	<1
naphthalene	mg/kg	<1	<1	<1	<1	<1
Surrogate aaa-Trifluorotoluene	%	95	91	88	91	105

vTRH(C6-C10)/BTEXN in Soil		
Our Reference:	UNITS	171427-11
Your Reference	------------ -	BH11
Depth	------------	0.5
Type of sample		Soil
Date extracted	-	18/07/2017
Date analysed	-	19/07/2017
TRH C_6 - C_9	mg/kg	<25
TRH C_6 - C_{10}	mg/kg	<25
vTPH C_6 - C_{10} less BTEX (F1)	mg/kg	<25
Benzene	mg/kg	<0.2
Toluene	mg/kg	<0.5
Ethylbenzene	mg/kg	<1
m+p-xylene	mg/kg	<2
o-Xylene	mg/kg	<1
Total +ve Xylenes	mg/kg	<1
naphthalene	mg/kg	<1
Surrogate aaa-Trifluorotoluene	%	97

svTRH (C10-C40) in Soil						
Our Reference:	UNITS	171427-1	171427-2	171427-3	171427-4	171427-5
Your Reference	-------------	BH1	BH2	BH2	BH5	BH6
Depth	------------	0.5	0.5	0.1	0.5	0.1
Type of sample		Soil	Soil	Soil	Soil	Soil
Date extracted	-	18/07/2017	18/07/2017	18/07/2017	18/07/2017	18/07/2017
Date analysed	-	19/07/2017	19/07/2017	19/07/2017	19/07/2017	19/07/2017
TRHC $_{10}$ - C $_{14}$	mg/kg	<50	<50	<50	<50	<50
TRHC $_{15}$ - C $_{28}$	mg/kg	<100	<100	<100	<100	<100
TRHC $_{29}$ - C $_{36}$	mg/kg	<100	<100	<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	<100	<100	<100	<100
TRH>C $_{34}$-C $_{40}$	mg/kg	<100	<100	<100	<100	<100
Total +ve TRH (>C10-C40)	mg/kg	<50	<50	<50	<50	<50
Surrogate o-Terphenyl	%	87	88	91	88	87

svTRH (C10-C40) in Soil						
Our Reference:	UNITS	171427-6	171427-7	171427-8	171427-9	171427-10
Your Reference	-------------	BH6	BH5	BH8	BH9	BH10
Depth	------------	1.0	1.5	0.1	0.1	0.5
Type of sample		Soil	Soil	Soil	Soil	Soil
Date extracted	-	18/07/2017	18/07/2017	18/07/2017	18/07/2017	18/07/2017
Date analysed	-	19/07/2017	19/07/2017	19/07/2017	19/07/2017	19/07/2017
TRHC $_{10}$ - C $_{14}$	mg/kg	<50	<50	<50	<50	<50
TRHC $_{15}$ - C $_{28}$	mg/kg	<100	<100	<100	<100	<100
TRHC $_{29}$ - C $_{36}$	mg/kg	<100	<100	<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	<100	<100	<100	<100
TRH>C $_{34}$-C $_{40}$	mg/kg	<100	<100	<100	<100	<100
Total +ve TRH (>C10-C40)	mg/kg	<50	<50	<50	<50	<50
Surrogate o-Terphenyl	%	92	91	92	111	87

svTRH (C10-C40) in Soil		
Our Reference:	UNITS	171427-11
Your Reference	------------- -	BH11
Depth	------------	0.5
Type of sample		Soil
Date extracted	-	18/07/2017
Date analysed	-	19/07/2017
TRHC$_{10}$ - C$_{14}$	mg/kg	<50
TRHC$_{15}$ - C$_{28}$	mg/kg	<100
TRHC$_{29}$ - C$_{36}$	mg/kg	<100
TRH>C$_{10}$-C$_{16}$	mg/kg	<50
TRH>C$_{10}$ - C$_{16}$ less Naphthalene (F2)	mg/kg	<50
TRH>C$_{16}$-C$_{34}$	mg/kg	<100
TRH>C$_{34}$-C$_{40}$	mg/kg	<100
Total +ve TRH (>C10-C40)	mg/kg	<50
Surrogate o-Terphenyl	%	93

PAHs in Soil						
Our Reference:	UNITS	171427-1	171427-2	171427-3	171427-4	171427-5
Your Reference	------------ -	BH1	BH2	BH2	BH5	BH6
Depth	------------	0.5	0.5	0.1	0.5	0.1
Type of sample		Soil	Soil	Soil	Soil	Soil
Date extracted	-	18/07/2017	18/07/2017	18/07/2017	18/07/2017	18/07/2017
Date analysed	-	18/07/2017	18/07/2017	18/07/2017	18/07/2017	18/07/2017
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	<0.1	<0.1	<0.1	<0.1
Anthracene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Fluoranthene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Pyrene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(a)anthracene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Chrysene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(b,j+k)fluoranthene	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Benzo(a)pyrene	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Indeno(1,2,3-c,d)pyrene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Dibenzo(a,h)anthracene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(g,h,i)perylene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(a)pyrene TEQ calc (zero)	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo(a)pyrene TEQ calc(half)	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo(a)pyrene TEQ calc(PQL)	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Total +ve PAH's	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Surrogate p-Terphenyl-d14	%	106	98	105	99	103

PAHs in Soil Our Reference: Your Reference	UNITS ------------- -	171427-6 BH6	171427-7 BH5	171427-8 BH8	171427-9 BH9	171427-10 BH10
Depth	------------	1.0	1.5	0.1	0.1	0.5
Type of sample		Soil	Soil	Soil	Soil	Soil
Date extracted	-	18/07/2017	18/07/2017	18/07/2017	18/07/2017	18/07/2017
Date analysed	-	18/07/2017	18/07/2017	18/07/2017	18/07/2017	18/07/2017
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	<0.1	<0.1	<0.1	<0.1
Anthracene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Fluoranthene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Pyrene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(a)anthracene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Chrysene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(b,j+k)fluoranthene	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Benzo(a)pyrene	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Indeno(1,2,3-c,d)pyrene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Dibenzo(a,h)anthracene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(g,h,i)perylene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(a)pyrene TEQ calc (zero)	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo(a)pyrene TEQ calc(half)	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo(a)pyrene TEQ calc(PQL)	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Total +ve PAH's	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Surrogate p-Terphenyl-d14	%	92	91	91	100	95

PAHs in Soil Our Reference:	UNITS	171427-11
Your Reference	-------------	BH11
Depth	------------	0.5
Type of sample		Soil
Date extracted	-	18/07/2017
Date analysed	-	18/07/2017
Naphthalene	mg/kg	<0.1
Acenaphthylene	mg/kg	<0.1
Acenaphthene	mg/kg	<0.1
Fluorene	mg/kg	<0.1
Phenanthrene	mg/kg	<0.1
Anthracene	mg/kg	<0.1
Fluoranthene	mg/kg	<0.1
Pyrene	mg/kg	<0.1
Benzo(a)anthracene	mg/kg	<0.1
Chrysene	mg/kg	<0.1
Benzo(b,j+k)fluoranthene	mg/kg	<0.2
Benzo(a)pyrene	mg/kg	<0.05
Indeno(1,2,3-c,d)pyrene	mg/kg	<0.1
Dibenzo(a,h)anthracene	mg/kg	<0.1
Benzo(g,h,i)perylene	mg/kg	<0.1
Benzo(a)pyrene TEQ calc (zero)	mg/kg	<0.5
Benzo(a)pyrene TEQ calc(half)	mg/kg	<0.5
Benzo(a)pyrene TEQ calc(PQL)	mg/kg	<0.5
Total +ve PAH's	mg/kg	<0.05
Surrogate p-Terphenyl-d14	%	103

Organochlorine Pesticides in soil			
Our Reference:	UNITS	171427-1	171427-10
Your Reference	------------- -	BH1	BH10
Depth	------------	0.5	0.5
Type of sample		Soil	Soil
Date extracted	-	18/07/2017	18/07/2017
Date analysed	-	18/07/2017	18/07/2017
HCB	mg/kg	<0.1	<0.1
alpha-BHC	mg/kg	<0.1	<0.1
gamma-BHC	mg/kg	<0.1	<0.1
beta-BHC	mg/kg	<0.1	<0.1
Heptachlor	mg/kg	<0.1	<0.1
delta-BHC	mg/kg	<0.1	<0.1
Aldrin	mg/kg	<0.1	<0.1
Heptachlor Epoxide	mg/kg	<0.1	<0.1
gamma-Chlordane	mg/kg	<0.1	<0.1
alpha-chlordane	mg/kg	<0.1	<0.1
Endosulfan I	mg/kg	<0.1	<0.1
pp-DDE	mg/kg	<0.1	<0.1
Dieldrin	mg/kg	<0.1	<0.1
Endrin	mg/kg	<0.1	<0.1
pp-DDD	mg/kg	<0.1	<0.1
Endosulfan II	mg/kg	<0.1	<0.1
pp-DDT	mg/kg	<0.1	<0.1
Endrin Aldehyde	mg/kg	<0.1	<0.1
Endosulfan Sulphate	mg/kg	<0.1	<0.1
Methoxychlor	mg/kg	<0.1	<0.1
Total +ve DDT+DDD+DDE	mg/kg	<0.1	<0.1
Surrogate TCMX	%	88	89

Organophosphorus Pesticides			
Our Reference:	UNITS	171427-1	171427-10
Your Reference	------------- -	BH1	BH10
Depth	------------	0.5	0.5
Type of sample		Soil	Soil
Date extracted	-	18/07/2017	18/07/2017
Date analysed	-	18/07/2017	18/07/2017
Azinphos-methyl (Guthion)	mg/kg	<0.1	<0.1
Bromophos-ethyl	mg/kg	<0.1	<0.1
Chlorpyriphos	mg/kg	<0.1	<0.1
Chlorpyriphos-methyl	mg/kg	<0.1	<0.1
Diazinon	mg/kg	<0.1	<0.1
Dichlorvos	mg/kg	<0.1	<0.1
Dimethoate	mg/kg	<0.1	<0.1
Ethion	mg/kg	<0.1	<0.1
Fenitrothion	mg/kg	<0.1	<0.1
Malathion	mg/kg	<0.1	<0.1
Parathion	mg/kg	<0.1	<0.1
Ronnel	mg/kg	<0.1	<0.1
Surrogate TCMX	%	88	89

PCBs in Soil Our Reference:	UNITS	171427-1	171427-10
Your Reference	-------------	BH1	BH10
Depth	------------	0.5	0.5
Type of sample		Soil	Soil
Date extracted	-	18/07/2017	18/07/2017
Date analysed	-	18/07/2017	18/07/2017
Aroclor 1016	mg/kg	<0.1	<0.1
Aroclor 1221	mg/kg	<0.1	<0.1
Aroclor 1232	mg/kg	<0.1	<0.1
Aroclor 1242	mg/kg	<0.1	<0.1
Aroclor 1248	mg/kg	<0.1	<0.1
Aroclor 1254	mg/kg	<0.1	<0.1
Aroclor 1260	mg/kg	<0.1	<0.1
Total +ve PCBs (1016-1260)	mg/kg	<0.1	<0.1
Surrogate TCLMX	%	88	89

Acid Extractable metals in soil						
Our Reference:	UNITS	171427-1	171427-2	171427-3	171427-4	171427-5
Your Reference	-------------	BH1	BH2	BH2	BH5	BH6
Depth	------------	0.5	0.5	0.1	0.5	0.1
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	18/07/2017	18/07/2017	18/07/2017	18/07/2017	18/07/2017
Date analysed	-	18/07/2017	18/07/2017	18/07/2017	18/07/2017	18/07/2017
Arsenic	mg/kg	5	8	13	7	5
Cadmium	mg/kg	<0.4	<0.4	<0.4	<0.4	<0.4
Chromium	mg/kg	13	13	11	22	12
Copper	mg/kg	30	34	20	22	27
Lead	mg/kg	18	27	40	35	24
Mercury	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Nickel	mg/kg	10	13	7	8	12
Zinc	mg/kg	55	77	66	65	61

Acid Extractable metals in soil						
Our Reference:	UNITS	171427-6	171427-7	171427-8	171427-9	171427-10
Your Reference	-------------	BH6	BH5	BH8	BH9	BH10
Depth	------------	1.0	1.5	0.1	0.1	0.5
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	18/07/2017	18/07/2017	18/07/2017	18/07/2017	18/07/2017
Date analysed	-	18/07/2017	18/07/2017	18/07/2017	18/07/2017	18/07/2017
Arsenic	mg/kg	6	6	4	5	13
Cadmium	mg/kg	<0.4	<0.4	<0.4	<0.4	<0.4
Chromium	mg/kg	15	18	12	12	12
Copper	mg/kg	29	18	24	34	24
Lead	mg/kg	15	20	14	13	13
Mercury	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Nickel	mg/kg	10	13	12	10	12
Zinc	mg/kg	52	45	39	68	36

Acid Extractable metals in soil		
Our Reference:	UNITS	171427-11
Your Reference	-------------	BH11
Depth	------------	0.5
Type of sample		Soil
Date prepared	-	18/07/2017
Date analysed	-	18/07/2017
Arsenic	mg/kg	6
Cadmium	mg/kg	<0.4
Chromium	mg/kg	14
Copper	mg/kg	23
Lead	mg/kg	17
Mercury	mg/kg	<0.1
Nickel	mg/kg	7
Zinc	mg/kg	42

Misc Soil - Inorg			
Our Reference:	UNITS	171427-1	171427-10
Your Reference	------------- -	BH1	BH10
Depth	------------	0.5	0.5
Type of sample		Soil	Soil
Date prepared	-	18/07/2017	18/07/2017
Date analysed	-	18/07/2017	18/07/2017
Total Phenolics (as Phenol)	mg/kg	<5	<5

Moisture Our Reference:	UNITS	171427-1	171427-2	171427-3	171427-4	171427-5
Your Reference	-------------	BH1	BH2	BH2	BH5	BH6
Depth	------------	0.5	0.5	0.1	0.5	0.1
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	18/07/2017	18/07/2017	18/07/2017	18/07/2017	18/07/2017
Date analysed	-	19/07/2017	19/07/2017	19/07/2017	19/07/2017	19/07/2017
Moisture	%	15	18	26	22	14

Moisture Our Reference:	UNITS	171427-6	171427-7	171427-8	171427-9	171427-10
Your Reference	-------------	BH6	BH5	BH8	BH9	BH10
Depth	------------	1.0	1.5	0.1	0.1	0.5
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	18/07/2017	18/07/2017	18/07/2017	18/07/2017	18/07/2017
Date analysed	-	19/07/2017	19/07/2017	19/07/2017	19/07/2017	19/07/2017
Moisture	%	19	19	16	18	15

Moisture Our Reference:	UNITS	171427-11
Your Reference	-------------	BH11
Depth	------------	0.5
Type of sample		Soil
Date prepared	-	18/07/2017
Date analysed	-	19/07/2017
Moisture	%	16

Asbestos ID - soils						
Our Reference:	UNITS	171427-1	171427-2	171427-3	171427-4	171427-5
Your Reference	------------ -	BH1	BH2	BH2	BH5	BH6
Depth	------------	0.5	0.5	0.1	0.5	0.1
Type of sample		Soil	Soil	Soil	Soil	Soil
Date analysed	-	21/07/2017	21/07/2017	21/07/2017	21/07/2017	21/07/2017
Sample mass tested	g	Approx. 35g	Approx. 35g	Approx. 30g	Approx. 35g	Approx. 35g
Sample Description	-	Brown clayey soil	Brown clayey soil	Brown coarse-grained soil & rocks	Brown coarse-grained soil & rocks	Brown coarse-grained 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	171427-6	171427-7	171427-8	171427-9	171427-10
Your Reference	------------ -	BH6	BH5	BH8	BH9	BH10
Depth	------------	1.0	1.5	0.1	0.1	0.5
Type of sample		Soil	Soil	Soil	Soil	Soil
Date analysed	-	21/07/2017	21/07/2017	21/07/2017	21/07/2017	21/07/2017
Sample mass tested	g	Approx. 40g	Approx. 45g	Approx. 40g	Approx. 40g	Approx. 40g
Sample Description	-	Brown clayey soil	Brown coarse-grained soil & rocks	Brown coarse-grained soil & rocks	Brown coarse-grained soil & rocks	Brown coarse-grained 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

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-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. Note, the Total +ve Xylene PQL is reflective of the lowest individual PQL and is therefore "Total +ve Xylenes" is simply a sum of the positive individual Xylenes.
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-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. Note, the Total +ve TRH PQL is reflective of the lowest individual PQL and is therefore "Total +ve TRH" is simply a sum of the positive individual TRH fractions (>C10-C40).
Org-012	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-005	Soil samples are extracted with dichloromethane/acetone and waters with dichloromethane and analysed by GC with dual ECD's. Note, the Total +ve reported DDD+DDE+DDT PQL is reflective of the lowest individual PQL and is therefore simply a sum of the positive individually report DDD+DDE+DDT.
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.
Org-006	Soil samples are extracted with dichloromethane/acetone and waters with dichloromethane and analysed by GC-ECD. Note, the Total +ve PCBs PQL is reflective of the lowest individual PQL and is therefore" Total +ve PCBs" is simply a sum of the positive individual PCBs.

Method ID	Methodology Summary
Metals-020	Determination of various metals by ICP-AES.
Metals-021	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 °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 || Duplicate || %RPD	Spike Sm#	Spike % Recovery
Date extracted	-			18/07/2017	171427-1	18/07/2017 || 18/07/2017	LCS-3	18/07/2017
Date analysed	-			19/07/2017	171427-1	19/07/2017 || 19/07/2017	LCS-3	19/07/2017
TRHC_6 - C_9	mg/kg	25	Org-016	<25	171427-1	<25 || <25	LCS-3	78%
TRHC_6 - C_{10}	mg/kg	25	Org-016	<25	171427-1	<25 || <25	LCS-3	78%
Benzene	mg/kg	0.2	Org-016	<0.2	171427-1	<0.2 || <0.2	LCS-3	80%
Toluene	mg/kg	0.5	Org-016	<0.5	171427-1	<0.5 || <0.5	LCS-3	74%
Ethylbenzene	mg/kg	1	Org-016	<1	171427-1	<1 || <1	LCS-3	75%
m+p-xylene	mg/kg	2	Org-016	<2	171427-1	<2 || <2	LCS-3	81%
o-Xylene	mg/kg	1	Org-016	<1	171427-1	<1 || <1	LCS-3	80%
naphthalene	mg/kg	1	Org-014	<1	171427-1	<1 || <1	[NR]	[NR]
Surrogate aaa-Trifluorotoluene	%		Org-016	91	171427-1	90 || 94 || RPD: 4	LCS-3	70%

QUALITY CONTROL svTRH (C10-C40) in Soil	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base || Duplicate || %RPD	Spike Sm#	Spike % Recovery
Date extracted	-			18/07/2017	171427-1	18/07/2017 || 18/07/2017	LCS-3	18/07/2017
Date analysed	-			19/07/2017	171427-1	19/07/2017 || 19/07/2017	LCS-3	19/07/2017
TRHC_{10} - C_{14}	mg/kg	50	Org-003	<50	171427-1	<50 || <50	LCS-3	104%
TRHC_{15} - C_{28}	mg/kg	100	Org-003	<100	171427-1	<100 || <100	LCS-3	104%
TRHC_{29} - C_{36}	mg/kg	100	Org-003	<100	171427-1	<100 || <100	LCS-3	106%
TRH>C_{10}-C_{16}	mg/kg	50	Org-003	<50	171427-1	<50 || <50	LCS-3	104%
TRH>C_{16}-C_{34}	mg/kg	100	Org-003	<100	171427-1	<100 || <100	LCS-3	104%
TRH>C_{34}-C_{40}	mg/kg	100	Org-003	<100	171427-1	<100 || <100	LCS-3	106%
Surrogate o-Terphenyl	%		Org-003	97	171427-1	87 || 88 || RPD: 1	LCS-3	98%

QUALITY CONTROL PAHs in Soil	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base || Duplicate || %RPD	Spike Sm#	Spike % Recovery
Date extracted	-			18/07/2017	171427-1	18/07/2017 || 18/07/2017	LCS-3	18/07/2017
Date analysed	-			18/07/2017	171427-1	18/07/2017 || 18/07/2017	LCS-3	18/07/2017
Naphthalene	mg/kg	0.1	Org-012	<0.1	171427-1	<0.1 || <0.1	LCS-3	104%
Acenaphthylene	mg/kg	0.1	Org-012	<0.1	171427-1	<0.1 || <0.1	[NR]	[NR]
Acenaphthene	mg/kg	0.1	Org-012	<0.1	171427-1	<0.1 || <0.1	[NR]	[NR]
Fluorene	mg/kg	0.1	Org-012	<0.1	171427-1	<0.1 || <0.1	LCS-3	97%
Phenanthrene	mg/kg	0.1	Org-012	<0.1	171427-1	<0.1 || <0.1	LCS-3	104%
Anthracene	mg/kg	0.1	Org-012	<0.1	171427-1	<0.1 || <0.1	[NR]	[NR]
Fluoranthene	mg/kg	0.1	Org-012	<0.1	171427-1	<0.1 || <0.1	LCS-3	102%
Pyrene	mg/kg	0.1	Org-012	<0.1	171427-1	<0.1 || <0.1	LCS-3	101%
Benzo(a)anthracene	mg/kg	0.1	Org-012	<0.1	171427-1	<0.1 || <0.1	[NR]	[NR]
Chrysene	mg/kg	0.1	Org-012	<0.1	171427-1	<0.1 || <0.1	LCS-3	116%
Benzo(b,j +k)fluoranthene	mg/kg	0.2	Org-012	<0.2	171427-1	<0.2 || <0.2	[NR]	[NR]

QUALITY CONTROL PAHs in Soil	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Benzo(a)pyrene	mg/kg	0.05	Org-012	<0.05	171427-1	<0.05 || <0.05	LCS-3	97%
Indeno(1,2,3-c,d)pyrene	mg/kg	0.1	Org-012	<0.1	171427-1	<0.1 || <0.1	[NR]	[NR]
Dibenzo(a,h)anthracene	mg/kg	0.1	Org-012	<0.1	171427-1	<0.1 || <0.1	[NR]	[NR]
Benzo(g,h,i)perylene	mg/kg	0.1	Org-012	<0.1	171427-1	<0.1 || <0.1	[NR]	[NR]
Surrogate p-Terphenyl-d14	%		Org-012	103	171427-1	106 || 100 || RPD: 6	LCS-3	123%

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	-			18/07/2017	171427-1	18/07/2017 || 18/07/2017	LCS-3	18/07/2017
Date analysed	-			18/07/2017	171427-1	18/07/2017 || 18/07/2017	LCS-3	18/07/2017
HCB	mg/kg	0.1	Org-005	<0.1	171427-1	<0.1 || <0.1	[NR]	[NR]
alpha-BHC	mg/kg	0.1	Org-005	<0.1	171427-1	<0.1 || <0.1	LCS-3	85%
gamma-BHC	mg/kg	0.1	Org-005	<0.1	171427-1	<0.1 || <0.1	[NR]	[NR]
beta-BHC	mg/kg	0.1	Org-005	<0.1	171427-1	<0.1 || <0.1	LCS-3	105%
Heptachlor	mg/kg	0.1	Org-005	<0.1	171427-1	<0.1 || <0.1	LCS-3	106%
delta-BHC	mg/kg	0.1	Org-005	<0.1	171427-1	<0.1 || <0.1	[NR]	[NR]
Aldrin	mg/kg	0.1	Org-005	<0.1	171427-1	<0.1 || <0.1	LCS-3	103%
Heptachlor Epoxide	mg/kg	0.1	Org-005	<0.1	171427-1	<0.1 || <0.1	LCS-3	105%
gamma-Chlordane	mg/kg	0.1	Org-005	<0.1	171427-1	<0.1 || <0.1	[NR]	[NR]
alpha-chlordane	mg/kg	0.1	Org-005	<0.1	171427-1	<0.1 || <0.1	[NR]	[NR]
Endosulfan I	mg/kg	0.1	Org-005	<0.1	171427-1	<0.1 || <0.1	[NR]	[NR]
pp-DDE	mg/kg	0.1	Org-005	<0.1	171427-1	<0.1 || <0.1	LCS-3	108%
Dieldrin	mg/kg	0.1	Org-005	<0.1	171427-1	<0.1 || <0.1	LCS-3	116%
Endrin	mg/kg	0.1	Org-005	<0.1	171427-1	<0.1 || <0.1	LCS-3	108%
pp-DDD	mg/kg	0.1	Org-005	<0.1	171427-1	<0.1 || <0.1	LCS-3	113%
Endosulfan II	mg/kg	0.1	Org-005	<0.1	171427-1	<0.1 || <0.1	[NR]	[NR]
pp-DDT	mg/kg	0.1	Org-005	<0.1	171427-1	<0.1 || <0.1	[NR]	[NR]
Endrin Aldehyde	mg/kg	0.1	Org-005	<0.1	171427-1	<0.1 || <0.1	[NR]	[NR]
Endosulfan Sulphate	mg/kg	0.1	Org-005	<0.1	171427-1	<0.1 || <0.1	LCS-3	71%
Methoxychlor	mg/kg	0.1	Org-005	<0.1	171427-1	<0.1 || <0.1	[NR]	[NR]
Surrogate TCMX	%		Org-005	92	171427-1	88 || 88 || RPD: 0	LCS-3	116%

QUALITY CONTROL Organophosphorus Pesticides	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date extracted	-			18/07/2017	171427-1	18/07/2017 || 18/07/2017	LCS-3	18/07/2017
Date analysed	-			18/07/2017	171427-1	18/07/2017 || 18/07/2017	LCS-3	18/07/2017
Azinphos-methyl (Guthion)	mg/kg	0.1	Org-008	<0.1	171427-1	<0.1 || <0.1	[NR]	[NR]
Bromophos-ethyl	mg/kg	0.1	Org-008	<0.1	171427-1	<0.1 || <0.1	[NR]	[NR]
Chlorpyriphos	mg/kg	0.1	Org-008	<0.1	171427-1	<0.1 || <0.1	LCS-3	86%
Chlorpyriphos-methyl	mg/kg	0.1	Org-008	<0.1	171427-1	<0.1 || <0.1	[NR]	[NR]
Diazinon	mg/kg	0.1	Org-008	<0.1	171427-1	<0.1 || <0.1	[NR]	[NR]
Dichlorvos	mg/kg	0.1	Org-008	<0.1	171427-1	<0.1 || <0.1	LCS-3	84%
Dimethoate	mg/kg	0.1	Org-008	<0.1	171427-1	<0.1 || <0.1	[NR]	[NR]
Ethion	mg/kg	0.1	Org-008	<0.1	171427-1	<0.1 || <0.1	LCS-3	96%
Fenitrothion	mg/kg	0.1	Org-008	<0.1	171427-1	<0.1 || <0.1	LCS-3	95%
Malathion	mg/kg	0.1	Org-008	<0.1	171427-1	<0.1 || <0.1	LCS-3	77%
Parathion	mg/kg	0.1	Org-008	<0.1	171427-1	<0.1 || <0.1	LCS-3	114%
Ronnel	mg/kg	0.1	Org-008	<0.1	171427-1	<0.1 || <0.1	LCS-3	95%
Surrogate TCMX	%		Org-008	92	171427-1	88 || 88 || RPD: 0	LCS-3	91%

QUALITY CONTROL PCBs in Soil	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date extracted	-			18/07/2017	171427-1	18/07/2017 || 18/07/2017	LCS-3	18/07/2017
Date analysed	-			18/07/2017	171427-1	18/07/2017 || 18/07/2017	LCS-3	18/07/2017
Aroclor 1016	mg/kg	0.1	Org-006	<0.1	171427-1	<0.1 || <0.1	[NR]	[NR]
Aroclor 1221	mg/kg	0.1	Org-006	<0.1	171427-1	<0.1 || <0.1	[NR]	[NR]
Aroclor 1232	mg/kg	0.1	Org-006	<0.1	171427-1	<0.1 || <0.1	[NR]	[NR]
Aroclor 1242	mg/kg	0.1	Org-006	<0.1	171427-1	<0.1 || <0.1	[NR]	[NR]
Aroclor 1248	mg/kg	0.1	Org-006	<0.1	171427-1	<0.1 || <0.1	[NR]	[NR]
Aroclor 1254	mg/kg	0.1	Org-006	<0.1	171427-1	<0.1 || <0.1	LCS-3	98%
Aroclor 1260	mg/kg	0.1	Org-006	<0.1	171427-1	<0.1 || <0.1	[NR]	[NR]
Surrogate TCLMX	%		Org-006	92	171427-1	88 || 88 || RPD: 0	LCS-3	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 prepared	-			18/07/2017	171427-1	18/07/2017 || 18/07/2017	LCS-3	18/07/2017
Date analysed	-			18/07/2017	171427-1	18/07/2017 || 18/07/2017	LCS-3	18/07/2017
Arsenic	mg/kg	4	Metals-020	<4	171427-1	5 || 5 || RPD: 0	LCS-3	109%
Cadmium	mg/kg	0.4	Metals-020	<0.4	171427-1	<0.4 || <0.4	LCS-3	106%
Chromium	mg/kg	1	Metals-020	<1	171427-1	13 || 12 || RPD: 8	LCS-3	108%
Copper	mg/kg	1	Metals-020	<1	171427-1	30 || 28 || RPD: 7	LCS-3	109%
Lead	mg/kg	1	Metals-020	<1	171427-1	18 || 18 || RPD: 0	LCS-3	103%
Mercury	mg/kg	0.1	Metals-021	<0.1	171427-1	<0.1 || <0.1	LCS-3	95%
Nickel	mg/kg	1	Metals-020	<1	171427-1	10 || 9 || RPD: 11	LCS-3	102%
Zinc	mg/kg	1	Metals-020	<1	171427-1	55 || 52 || RPD: 6	LCS-3	105%

QUALITY CONTROL Misc Soil - Inorg	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			18/07/2017	[NT]	[NT]	LCS-3	18/07/2017
Date analysed	-			18/07/2017	[NT]	[NT]	LCS-3	18/07/2017
Total Phenolics (as Phenol)	mg/kg	5	Inorg-031	<5	[NT]	[NT]	LCS-3	103%

QUALITY CONTROL vTRH(C6-C10)/BTEXN in Soil	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Spike % Recovery
Date extracted	-	171427-11	18/07/2017 || 18/07/2017	171427-10	18/07/2017
Date analysed	-	171427-11	19/07/2017 || 19/07/2017	171427-10	19/07/2017
TRHC$_6$ - C$_9$	mg/kg	171427-11	<25 || <25	171427-10	93%
TRHC$_6$ - C$_{10}$	mg/kg	171427-11	<25 || <25	171427-10	93%
Benzene	mg/kg	171427-11	<0.2 || <0.2	171427-10	112%
Toluene	mg/kg	171427-11	<0.5 || <0.5	171427-10	99%
Ethylbenzene	mg/kg	171427-11	<1 || <1	171427-10	83%
m+p-xylene	mg/kg	171427-11	<2 || <2	171427-10	86%
o-Xylene	mg/kg	171427-11	<1 || <1	171427-10	84%
naphthalene	mg/kg	171427-11	<1 || <1	[NR]	[NR]
Surrogate aaa-Trifluorotoluene	%	171427-11	97 || 93 || RPD: 4	171427-10	85%

QUALITY CONTROL svTRH (C10-C40) in Soil	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Spike % Recovery
Date extracted	-	171427-11	18/07/2017 || 18/07/2017	171427-10	18/07/2017
Date analysed	-	171427-11	19/07/2017 || 19/07/2017	171427-10	19/07/2017
TRH C_{10} - C_{14}	mg/kg	171427-11	<50 || <50	171427-10	109%
TRH C_{15} - C_{28}	mg/kg	171427-11	<100 || <100	171427-10	103%
TRH C_{29} - C_{36}	mg/kg	171427-11	<100 || <100	171427-10	118%
TRH >C_{10}-C_{16}	mg/kg	171427-11	<50 || <50	171427-10	109%
TRH >C_{16}-C_{34}	mg/kg	171427-11	<100 || <100	171427-10	103%
TRH >C_{34}-C_{40}	mg/kg	171427-11	<100 || <100	171427-10	118%
Surrogate o-Terphenyl	%	171427-11	93 || 93 || RPD: 0	171427-10	87%

QUALITY CONTROL PAHs in Soil	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Spike % Recovery
Date extracted	-	171427-11	18/07/2017 || 18/07/2017	171427-10	18/07/2017
Date analysed	-	171427-11	18/07/2017 || 18/07/2017	171427-10	18/07/2017
Naphthalene	mg/kg	171427-11	<0.1 || <0.1	171427-10	105%
Acenaphthylene	mg/kg	171427-11	<0.1 || <0.1	[NR]	[NR]
Acenaphthene	mg/kg	171427-11	<0.1 || <0.1	[NR]	[NR]
Fluorene	mg/kg	171427-11	<0.1 || <0.1	171427-10	96%
Phenanthrene	mg/kg	171427-11	<0.1 || <0.1	171427-10	98%
Anthracene	mg/kg	171427-11	<0.1 || <0.1	[NR]	[NR]
Fluoranthene	mg/kg	171427-11	<0.1 || <0.1	171427-10	96%
Pyrene	mg/kg	171427-11	<0.1 || <0.1	171427-10	100%
Benzo(a)anthracene	mg/kg	171427-11	<0.1 || <0.1	[NR]	[NR]
Chrysene	mg/kg	171427-11	<0.1 || <0.1	171427-10	115%
Benzo(b,j+k)fluoranthene	mg/kg	171427-11	<0.2 || <0.2	[NR]	[NR]
Benzo(a)pyrene	mg/kg	171427-11	<0.05 || <0.05	171427-10	106%
Indeno(1,2,3-c,d)pyrene	mg/kg	171427-11	<0.1 || <0.1	[NR]	[NR]
Dibenzo(a,h)anthracene	mg/kg	171427-11	<0.1 || <0.1	[NR]	[NR]
Benzo(g,h,i)perylene	mg/kg	171427-11	<0.1 || <0.1	[NR]	[NR]
Surrogate p-Terphenyl-d14	%	171427-11	103 || 105 || RPD: 2	171427-10	124%

QUALITY CONTROL Organochlorine Pesticides in soil	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Spike % Recovery
Date extracted	-	[NT]	[NT]	171427-10	18/07/2017
Date analysed	-	[NT]	[NT]	171427-10	18/07/2017
HCB	mg/kg	[NT]	[NT]	[NR]	[NR]
alpha-BHC	mg/kg	[NT]	[NT]	171427-10	86%
gamma-BHC	mg/kg	[NT]	[NT]	[NR]	[NR]
beta-BHC	mg/kg	[NT]	[NT]	171427-10	105%
Heptachlor	mg/kg	[NT]	[NT]	171427-10	106%
delta-BHC	mg/kg	[NT]	[NT]	[NR]	[NR]
Aldrin	mg/kg	[NT]	[NT]	171427-10	102%
Heptachlor Epoxide	mg/kg	[NT]	[NT]	171427-10	104%
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]	171427-10	106%
Dieldrin	mg/kg	[NT]	[NT]	171427-10	114%
Endrin	mg/kg	[NT]	[NT]	171427-10	107%
pp-DDD	mg/kg	[NT]	[NT]	171427-10	113%
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]	171427-10	82%
Methoxychlor	mg/kg	[NT]	[NT]	[NR]	[NR]
Surrogate TCMX	%	[NT]	[NT]	171427-10	117%

QUALITY CONTROL Organophosphorus Pesticides	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Spike % Recovery
Date extracted	-	[NT]	[NT]	171427-10	18/07/2017
Date analysed	-	[NT]	[NT]	171427-10	18/07/2017
Azinphos-methyl (Guthion)	mg/kg	[NT]	[NT]	[NR]	[NR]
Bromophos-ethyl	mg/kg	[NT]	[NT]	[NR]	[NR]
Chlorpyriphos	mg/kg	[NT]	[NT]	171427-10	89%
Chlorpyriphos-methyl	mg/kg	[NT]	[NT]	[NR]	[NR]
Diazinon	mg/kg	[NT]	[NT]	[NR]	[NR]
Dichlorvos	mg/kg	[NT]	[NT]	171427-10	86%
Dimethoate	mg/kg	[NT]	[NT]	[NR]	[NR]
Ethion	mg/kg	[NT]	[NT]	171427-10	102%
Fenitrothion	mg/kg	[NT]	[NT]	171427-10	82%
Malathion	mg/kg	[NT]	[NT]	171427-10	76%
Parathion	mg/kg	[NT]	[NT]	171427-10	83%
Ronnel	mg/kg	[NT]	[NT]	171427-10	97%
Surrogate TCMX	%	[NT]	[NT]	171427-10	89%

QUALITY CONTROL PCBs in Soil	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Spike % Recovery
Date extracted	-	[NT]	[NT]	171427-10	18/07/2017
Date analysed	-	[NT]	[NT]	171427-10	18/07/2017
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]	171427-10	102%
Aroclor 1260	mg/kg	[NT]	[NT]	[NR]	[NR]
Surrogate TCLMX	%	[NT]	[NT]	171427-10	89%

QUALITY CONTROL Acid Extractable metals in soil	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Spike % Recovery
Date prepared	-	171427-11	18/07/2017 || 18/07/2017	171427-10	18/07/2017
Date analysed	-	171427-11	18/07/2017 || 18/07/2017	171427-10	18/07/2017
Arsenic	mg/kg	171427-11	6 || 6 || RPD: 0	171427-10	91%
Cadmium	mg/kg	171427-11	<0.4 || <0.4	171427-10	96%
Chromium	mg/kg	171427-11	14 || 14 || RPD: 0	171427-10	99%
Copper	mg/kg	171427-11	23 || 22 || RPD: 4	171427-10	112%
Lead	mg/kg	171427-11	17 || 15 || RPD: 12	171427-10	90%
Mercury	mg/kg	171427-11	<0.1 || <0.1	171427-10	97%
Nickel	mg/kg	171427-11	7 || 8 || RPD: 13	171427-10	89%
Zinc	mg/kg	171427-11	42 || 44 || RPD: 5	171427-10	97%

Report Comments:

Asbestos: A portion of the supplied sample was sub-sampled for asbestos analysis according to Envirolab procedures. We cannot guarantee that this sub-sample is indicative of the entire sample. Envirolab recommends supplying 40-50g of sample in its own container.
Note: Samples 171427-1 to 10 were sub-sampled from jars provided by the client.

Asbestos ID was analysed by Approved Identifier:	Lucy Zhu
Asbestos ID was authorised by Approved Signatory:	Lulu Scott

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

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

CHAIN OF CUSTODY

Douglas Partners
Geotechnics / Environment / Groundwater

Client: Douglas Partners
Contact Person: DAVID HOLDEN / ZOE MAHER
Project Mgr: DAVID HOLDEN

Address: 96 Hermitage Road
West Ryde NSW 2114

Phone: 9809 0666 **Mob:**
Email: zoe.maher@douglaspartners.com.au

Project Number: 86030.00
Project Name: YAGOONA
PO No.:
lab Quote No. :
Date results required:
Standard 5 day TAT
Note: Inform lab in advance if urgent turnaround is required - surcharges apply
Report format: Esdat/PDF / Excel
Comments:

To: Envirolab Services
Contact Person: Aileen Hie
Address: 12 Ashley Street
Chatswood NSW 2068
Phone: 02 9910 6200
Fax: 02 9910 6201
Email: ahie@envirolab.com.au
Laboratory Report No:
Lab Comments:

Sample information						Tests Required						Comments
Lab Sample ID	Field Sample ID	Depth	Date sampled	Container Type	Type of sample	Combo 3a	Combo 3	Combo 8A	Combo 8	Asbestos		Provide as much information about the sample as you can
1	BH1	0.5						X				*please prepare ASAP analysis, reporting standard'
2	BH2	0.5				X						
3	BH2	0.1				X						
4	BH5	0.5				X						
5	BH6	0.1				X						
6	BH6	1.0				X						
7	BH5	1.5				X						
8	BH8	0.1				X						
9	BH9	0.1				X						
10	BH10	0.5				X		X				
11	BH11	0.5		X								

ENVIROLAB
Envirolab Services
12 Ashley St
Chatswood NSW 2067
Ph: (02) 9910 6200
Job No: 171427
Date Received: 14/7
Time Received: 17.30
Received by: DW
Temp: [✓ Cool]/Ambient
Cooling: Ice/[✓ Icepack]
Security: [✓ Intact]/Broken/None

Relinquished by: Douglas Partners
Courier (by whom)
Condition of Sample at dispatch Cool or Ambient (circle)
Temperature (if Applicable):
Print Name:
Date & Time:
Signature:

Sample Receipt
Received by (Company): ELS
Print Name: DW
Date & Time: 14/7/17 17.30
Signature:

Lab use only:
Samples Received: Cool or Ambient (circle one)
Temperature Received at: 8.8 **(if applicable)**
Transported by: Hand delivered / courier

CERTIFICATE OF ANALYSIS 171377

Client:

Douglas Partners Pty Ltd
96 Hermitage Rd
West Ryde
NSW 2114

Attention: Huw Smith

Sample log in details:

Your Reference:	**DoEAMD-16-78 Group 2 Parramatta**	
No. of samples:	5 soils	
Date samples received / completed instructions received	14/07/17	/ 14/07/17

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:	21/07/17	/ 20/07/17
Date of Preliminary Report:	Not Issued	

NATA accreditation number 2901. This document shall not be reproduced except in full.
Accredited for compliance with ISO/IEC 17025 - Testing **Tests not covered by NATA are denoted with *.**

Results Approved By:

David Springer
General Manager

Misc Inorg - Soil Our Reference: Your Reference Depth Date Sampled Type of sample	UNITS ------------- ------------	171377-1 AN_BH9 0.3 7/07/2017 Soil	171377-2 YA_BH1 3.0 4/07/2017 Soil	171377-3 PW_BH7 1.0 10/07/2017 Soil	171377-4 PH_BH10 1.0 5/07/2017 Soil	171377-5 RH_BH3 0.5 6/07/2017 Soil
Date prepared	-	17/07/2017	17/07/2017	17/07/2017	17/07/2017	17/07/2017
Date analysed	-	18/07/2017	18/07/2017	18/07/2017	18/07/2017	18/07/2017
pH 1:5 soil:water	pH Units	7.6	5.5	5.6	5.8	5.9
Electrical Conductivity 1:5 soil:water	µS/cm	740	150	63	26	190
Chloride, Cl 1:5 soil:water	mg/kg	57	49	10	<10	110
Sulphate, SO4 1:5 soil:water	mg/kg	1,100	140	47	20	110
Resistivity in soil*	ohm m	14	65	160	390	53
Estimated Salinity*	mg/kg	2,500	520	210	88	640

Method ID	Methodology Summary
Inorg-001	pH - Measured using pH meter and electrode in accordance with APHA latest edition, 4500-H+. Please note that the results for water analyses are indicative only, as analysis outside of the APHA storage times.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell at 25°C in accordance with APHA latest edition 2510 and Rayment & Lyons.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA latest edition, 4110-B. Alternatively determined by colourimetry/turbidity using Discrete Analyer.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell at 25oC in accordance with APHA 22nd ED 2510 and Rayment & Lyons. Resistivity is calculated from Conductivity.
Inorg-034	Soil samples are extracted and measured using a conductivity cell and dedicated meter.

QUALITY CONTROL Misc Inorg - Soil	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			17/07/2017	171377-5	17/07/2017 || 17/07/2017	LCS-1	17/07/2017
Date analysed	-			18/07/2017	171377-5	18/07/2017 || 18/07/2017	LCS-1	18/07/2017
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	171377-5	5.9 || 5.8 || RPD: 2	LCS-1	102%
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	<1	171377-5	190 || 190 || RPD: 0	LCS-1	100%
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	171377-5	110 || 110 || RPD: 0	LCS-1	86%
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	171377-5	110 || 100 || RPD: 10	LCS-1	97%
Resistivity in soil*	ohm m	1	Inorg-002	<1.0	171377-5	53 || 54 || RPD: 2	[NR]	[NR]
Estimated Salinity*	mg/kg	5	Inorg-034	<5	171377-5	640 || 630 || RPD: 2	[NR]	[NR]

Report Comments:

Asbestos ID was analysed by Approved Identifier:	Not applicable for this job
Asbestos ID was authorised by Approved Signatory:	Not applicable for this job

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Measurement Uncertainty estimates are available for most tests upon request.

Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater

Douglas Partners Pty Ltd
Sydney Laboratory
96 Hermitage Road West Ryde NSW 2114
Phone: (02) 9809 0666
Fax: (02) 9809 0666
Email: mark.matthews@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Mark Matthews
Nata Accredited Laboratory Number: 828

Report Number: **86030.00-1**
Issue Number: 1
Date Issued: 27/07/2017
Client: Conrad Gargett Pty Ltd
Suite C.3.18/22-36 Mountain Street, ULTIMO NSW 2007
Contact: Laura Cockburn
Project Number: 86030.00
Project Name: DoEAMD-16-78 Group 2 - Parramatta Region
Project Location: 425 Hume Highway, Public School, Yagoona
Work Request: 1212
Sample Number: 17-1212A
Date Sampled: 04/07/2017
Sampling Method: Sampled by Engineering Department
Sample Location: **BH8 (1.0m)**
Material: Silty clay

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Preparation Method	Dry Sieve		
Sample History	Oven Dried		
Liquid Limit (%)	52		
Plastic Limit (%)	22		
Plasticity Index (%)	**30**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)	13.0		
Cracking Crumbling Curling	None		

Foundation Maintenance and Footing Performance:

A Homeowner's Guide

CSIRO

BTF 18
replaces
Information
Sheet 10/91

Buildings can and often do move. This movement can be up, down, lateral or rotational. The fundamental cause of movement in buildings can usually be related to one or more problems in the foundation soil. It is important for the homeowner to identify the soil type in order to ascertain the measures that should be put in place in order to ensure that problems in the foundation soil can be prevented, thus protecting against building movement.

This Building Technology File is designed to identify causes of soil-related building movement, and to suggest methods of prevention of resultant cracking in buildings.

Soil Types

The types of soils usually present under the topsoil in land zoned for residential buildings can be split into two approximate groups – granular and clay. Quite often, foundation soil is a mixture of both types. The general problems associated with soils having granular content are usually caused by erosion. Clay soils are subject to saturation and swell/shrink problems.

Classifications for a given area can generally be obtained by application to the local authority, but these are sometimes unreliable and if there is doubt, a geotechnical report should be commissioned. As most buildings suffering movement problems are founded on clay soils, there is an emphasis on classification of soils according to the amount of swell and shrinkage they experience with variations of water content. The table below is Table 2.1 from AS 2870, the Residential Slab and Footing Code.

Causes of Movement

Settlement due to construction

There are two types of settlement that occur as a result of construction:

- Immediate settlement occurs when a building is first placed on its foundation soil, as a result of compaction of the soil under the weight of the structure. The cohesive quality of clay soil mitigates against this, but granular (particularly sandy) soil is susceptible.
- Consolidation settlement is a feature of clay soil and may take place because of the expulsion of moisture from the soil or because of the soil's lack of resistance to local compressive or shear stresses. This will usually take place during the first few months after construction, but has been known to take many years in exceptional cases.

These problems are the province of the builder and should be taken into consideration as part of the preparation of the site for construction. Building Technology File 19 (BTF 19) deals with these problems.

Erosion

All soils are prone to erosion, but sandy soil is particularly susceptible to being washed away. Even clay with a sand component of say 10% or more can suffer from erosion.

Saturation

This is particularly a problem in clay soils. Saturation creates a bog-like suspension of the soil that causes it to lose virtually all of its bearing capacity. To a lesser degree, sand is affected by saturation because saturated sand may undergo a reduction in volume – particularly imported sand fill for bedding and blinding layers. However, this usually occurs as immediate settlement and should normally be the province of the builder.

Seasonal swelling and shrinkage of soil

All clays react to the presence of water by slowly absorbing it, making the soil increase in volume (see table below). The degree of increase varies considerably between different clays, as does the degree of decrease during the subsequent drying out caused by fair weather periods. Because of the low absorption and expulsion rate, this phenomenon will not usually be noticeable unless there are prolonged rainy or dry periods, usually of weeks or months, depending on the land and soil characteristics.

The swelling of soil creates an upward force on the footings of the building, and shrinkage creates subsidence that takes away the support needed by the footing to retain equilibrium.

Shear failure

This phenomenon occurs when the foundation soil does not have sufficient strength to support the weight of the footing. There are two major post-construction causes:

- Significant load increase.
- Reduction of lateral support of the soil under the footing due to erosion or excavation.
- In clay soil, shear failure can be caused by saturation of the soil adjacent to or under the footing.

GENERAL DEFINITIONS OF SITE CLASSES

Class	Foundation
A	Most sand and rock sites with little or no ground movement from moisture changes
S	Slightly reactive clay sites with only slight ground movement from moisture changes
M	Moderately reactive clay or silt sites, which can experience moderate ground movement from moisture changes
H	Highly reactive clay sites, which can experience high ground movement from moisture changes
E	Extremely reactive sites, which can experience extreme ground movement from moisture changes
A to P	Filled sites
P	Sites which include soft soils, such as soft clay or silt or loose sands; landslip; mine subsidence; collapsing soils; soils subject to erosion; reactive sites subject to abnormal moisture conditions or sites which cannot be classified otherwise

Tree root growth

Trees and shrubs that are allowed to grow in the vicinity of footings can cause foundation soil movement in two ways:

- Roots that grow under footings may increase in cross-sectional size, exerting upward pressure on footings.
- Roots in the vicinity of footings will absorb much of the moisture in the foundation soil, causing shrinkage or subsidence.

Unevenness of Movement

The types of ground movement described above usually occur unevenly throughout the building's foundation soil. Settlement due to construction tends to be uneven because of:

- Differing compaction of foundation soil prior to construction.
- Differing moisture content of foundation soil prior to construction.

Movement due to non-construction causes is usually more uneven still. Erosion can undermine a footing that traverses the flow or can create the conditions for shear failure by eroding soil adjacent to a footing that runs in the same direction as the flow.

Saturation of clay foundation soil may occur where subfloor walls create a dam that makes water pond. It can also occur wherever there is a source of water near footings in clay soil. This leads to a severe reduction in the strength of the soil which may create local shear failure.

Seasonal swelling and shrinkage of clay soil affects the perimeter of the building first, then gradually spreads to the interior. The swelling process will usually begin at the uphill extreme of the building, or on the weather side where the land is flat. Swelling gradually reaches the interior soil as absorption continues. Shrinkage usually begins where the sun's heat is greatest.

Effects of Uneven Soil Movement on Structures

Erosion and saturation

Erosion removes the support from under footings, tending to create subsidence of the part of the structure under which it occurs. Brickwork walls will resist the stress created by this removal of support by bridging the gap or cantilevering until the bricks or the mortar bedding fail. Older masonry has little resistance. Evidence of failure varies according to circumstances and symptoms may include:

- Step cracking in the mortar beds in the body of the wall or above/below openings such as doors or windows.
- Vertical cracking in the bricks (usually but not necessarily in line with the vertical beds or perpends).

Isolated piers affected by erosion or saturation of foundations will eventually lose contact with the bearers they support and may tilt or fall over. The floors that have lost this support will become bouncy, sometimes rattling ornaments etc.

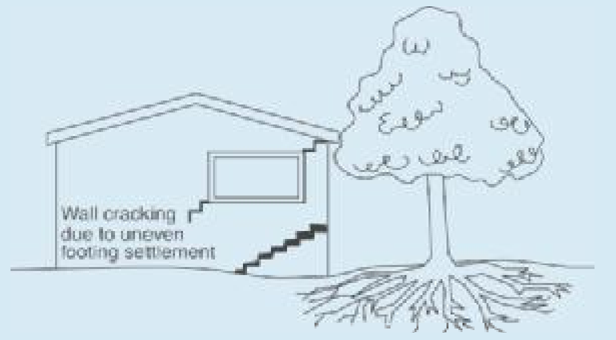
Seasonal swelling/shrinkage in clay

Swelling foundation soil due to rainy periods first lifts the most exposed extremities of the footing system, then the remainder of the perimeter footings while gradually permeating inside the building footprint to lift internal footings. This swelling first tends to create a dish effect, because the external footings are pushed higher than the internal ones.

The first noticeable symptom may be that the floor appears slightly dished. This is often accompanied by some doors binding on the floor or the door head, together with some cracking of cornice mitres. In buildings with timber flooring supported by bearers and joists, the floor can be bouncy. Externally there may be visible dishing of the hip or ridge lines.

As the moisture absorption process completes its journey to the innermost areas of the building, the internal footings will rise. If the spread of moisture is roughly even, it may be that the symptoms will temporarily disappear, but it is more likely that swelling will be uneven, creating a difference rather than a disappearance in symptoms. In buildings with timber flooring supported by bearers and joists, the isolated piers will rise more easily than the strip footings or piers under walls, creating noticeable doming of flooring.

Trees can cause shrinkage and damage



As the weather pattern changes and the soil begins to dry out, the external footings will be first affected, beginning with the locations where the sun's effect is strongest. This has the effect of lowering the external footings. The doming is accentuated and cracking reduces or disappears where it occurred because of dishing, but other cracks open up. The roof lines may become convex.

Doming and dishing are also affected by weather in other ways. In areas where warm, wet summers and cooler dry winters prevail, water migration tends to be toward the interior and doming will be accentuated, whereas where summers are dry and winters are cold and wet, migration tends to be toward the exterior and the underlying propensity is toward dishing.

Movement caused by tree roots

In general, growing roots will exert an upward pressure on footings, whereas soil subject to drying because of tree or shrub roots will tend to remove support from under footings by inducing shrinkage.

Complications caused by the structure itself

Most forces that the soil causes to be exerted on structures are vertical – i.e. either up or down. However, because these forces are seldom spread evenly around the footings, and because the building resists uneven movement because of its rigidity, forces are exerted from one part of the building to another. The net result of all these forces is usually rotational. This resultant force often complicates the diagnosis because the visible symptoms do not simply reflect the original cause. A common symptom is binding of doors on the vertical member of the frame.

Effects on full masonry structures

Brickwork will resist cracking where it can. It will attempt to span areas that lose support because of subsided foundations or raised points. It is therefore usual to see cracking at weak points, such as openings for windows or doors.

In the event of construction settlement, cracking will usually remain unchanged after the process of settlement has ceased.

With local shear or erosion, cracking will usually continue to develop until the original cause has been remedied, or until the subsidence has completely neutralised the affected portion of footing and the structure has stabilised on other footings that remain effective.

In the case of swell/shrink effects, the brickwork will in some cases return to its original position after completion of a cycle, however it is more likely that the rotational effect will not be exactly reversed, and it is also usual that brickwork will settle in its new position and will resist the forces trying to return it to its original position. This means that in a case where swelling takes place after construction and cracking occurs, the cracking is likely to at least partly remain after the shrink segment of the cycle is complete. Thus, each time the cycle is repeated, the likelihood is that the cracking will become wider until the sections of brickwork become virtually independent.

With repeated cycles, once the cracking is established, if there is no other complication, it is normal for the incidence of cracking to stabilise, as the building has the articulation it needs to cope with the problem. This is by no means always the case, however, and monitoring of cracks in walls and floors should always be treated seriously.

Upheaval caused by growth of tree roots under footings is not a simple vertical shear stress. There is a tendency for the root to also exert lateral forces that attempt to separate sections of brickwork after initial cracking has occurred.

The normal structural arrangement is that the inner leaf of brickwork in the external walls and at least some of the internal walls (depending on the roof type) comprise the load-bearing structure on which any upper floors, ceilings and the roof are supported. In these cases, it is internally visible cracking that should be the main focus of attention, however there are a few examples of dwellings whose external leaf of masonry plays some supporting role, so this should be checked if there is any doubt. In any case, externally visible cracking is important as a guide to stresses on the structure generally, and it should also be remembered that the external walls must be capable of supporting themselves.

Effects on framed structures

Timber or steel framed buildings are less likely to exhibit cracking due to swell/shrink than masonry buildings because of their flexibility. Also, the doming/dishing effects tend to be lower because of the lighter weight of walls. The main risks to framed buildings are encountered because of the isolated pier footings used under walls. Where erosion or saturation cause a footing to fall away, this can double the span which a wall must bridge. This additional stress can create cracking in wall linings, particularly where there is a weak point in the structure caused by a door or window opening. It is, however, unlikely that framed structures will be so stressed as to suffer serious damage without first exhibiting some or all of the above symptoms for a considerable period. The same warning period should apply in the case of upheaval. It should be noted, however, that where framed buildings are supported by strip footings there is only one leaf of brickwork and therefore the externally visible walls are the supporting structure for the building. In this case, the subfloor masonry walls can be expected to behave as full brickwork walls.

Effects on brick veneer structures

Because the load-bearing structure of a brick veneer building is the frame that makes up the interior leaf of the external walls plus perhaps the internal walls, depending on the type of roof, the building can be expected to behave as a framed structure, except that the external masonry will behave in a similar way to the external leaf of a full masonry structure.

Water Service and Drainage

Where a water service pipe, a sewer or stormwater drainage pipe is in the vicinity of a building, a water leak can cause erosion, swelling or saturation of susceptible soil. Even a minuscule leak can be enough to saturate a clay foundation. A leaking tap near a building can have the same effect. In addition, trenches containing pipes can become watercourses even though backfilled, particularly where broken rubble is used as fill. Water that runs along these trenches can be responsible for serious erosion, interstrata seepage into subfloor areas and saturation.

Pipe leakage and trench water flows also encourage tree and shrub roots to the source of water, complicating and exacerbating the problem.

Poor roof plumbing can result in large volumes of rainwater being concentrated in a small area of soil:

- Incorrect falls in roof guttering may result in overflows, as may gutters blocked with leaves etc.
- Corroded guttering or downpipes can spill water to ground.
- Downpipes not positively connected to a proper stormwater collection system will direct a concentration of water to soil that is directly adjacent to footings, sometimes causing large-scale problems such as erosion, saturation and migration of water under the building.

Seriousness of Cracking

In general, most cracking found in masonry walls is a cosmetic nuisance only and can be kept in repair or even ignored. The table below is a reproduction of Table C1 of AS 2870.

AS 2870 also publishes figures relating to cracking in concrete floors, however because wall cracking will usually reach the critical point significantly earlier than cracking in slabs, this table is not reproduced here.

Prevention/Cure

Plumbing

Where building movement is caused by water service, roof plumbing, sewer or stormwater failure, the remedy is to repair the problem. It is prudent, however, to consider also rerouting pipes away from the building where possible, and relocating taps to positions where any leakage will not direct water to the building vicinity. Even where gully traps are present, there is sometimes sufficient spill to create erosion or saturation, particularly in modern installations using smaller diameter PVC fixtures. Indeed, some gully traps are not situated directly under the taps that are installed to charge them, with the result that water from the tap may enter the backfilled trench that houses the sewer piping. If the trench has been poorly backfilled, the water will either pond or flow along the bottom of the trench. As these trenches usually run alongside the footings and can be at a similar depth, it is not hard to see how any water that is thus directed into a trench can easily affect the foundation's ability to support footings or even gain entry to the subfloor area.

Ground drainage

In all soils there is the capacity for water to travel on the surface and below it. Surface water flows can be established by inspection during and after heavy or prolonged rain. If necessary, a grated drain system connected to the stormwater collection system is usually an easy solution.

It is, however, sometimes necessary when attempting to prevent water migration that testing be carried out to establish watertable height and subsoil water flows. This subject is referred to in BTF 19 and may properly be regarded as an area for an expert consultant.

Protection of the building perimeter

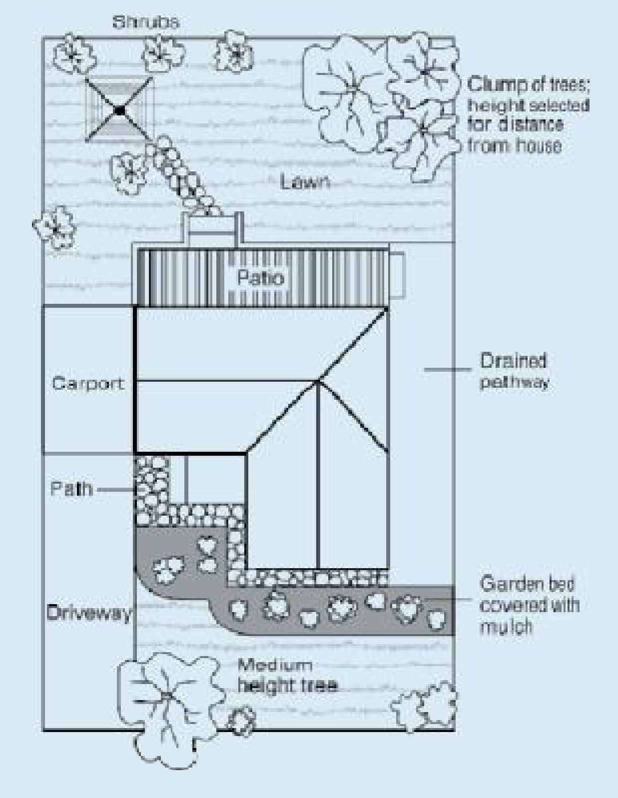
It is essential to remember that the soil that affects footings extends well beyond the actual building line. Watering of garden plants, shrubs and trees causes some of the most serious water problems.

For this reason, particularly where problems exist or are likely to occur, it is recommended that an apron of paving be installed around as much of the building perimeter as necessary. This paving

CLASSIFICATION OF DAMAGE WITH REFERENCE TO WALLS

Description of typical damage and required repair	Approximate crack width limit (see Note 3)	Damage category
Hairline cracks	<0.1 mm	0
Fine cracks which do not need repair	<1 mm	1
Cracks noticeable but easily filled. Doors and windows stick slightly	<5 mm	2
Cracks can be repaired and possibly a small amount of wall will need to be replaced. Doors and windows stick. Service pipes can fracture. Weathertightness often impaired	5–15 mm (or a number of cracks 3 mm or more in one group)	3
Extensive repair work involving breaking-out and replacing sections of walls, especially over doors and windows. Window and door frames distort. Walls lean or bulge noticeably, some loss of bearing in beams. Service pipes disrupted	15–25 mm but also depend on number of cracks	4

Gardens for a reactive site



should extend outwards a minimum of 900 mm (more in highly reactive soil) and should have a minimum fall away from the building of 1:60. The finished paving should be no less than 100 mm below brick vent bases.

It is prudent to relocate drainage pipes away from this paving, if possible, to avoid complications from future leakage. If this is not practical, earthenware pipes should be replaced by PVC and backfilling should be of the same soil type as the surrounding soil and compacted to the same density.

Except in areas where freezing of water is an issue, it is wise to remove taps in the building area and relocate them well away from the building – preferably not uphill from it (see BTF 19).

It may be desirable to install a grated drain at the outside edge of the paving on the uphill side of the building. If subsoil drainage is needed this can be installed under the surface drain.

Condensation

In buildings with a subfloor void such as where bearers and joists support flooring, insufficient ventilation creates ideal conditions for condensation, particularly where there is little clearance between the floor and the ground. Condensation adds to the moisture already present in the subfloor and significantly slows the process of drying out. Installation of an adequate subfloor ventilation system, either natural or mechanical, is desirable.

Warning: Although this Building Technology File deals with cracking in buildings, it should be said that subfloor moisture can result in the development of other problems, notably:

- Water that is transmitted into masonry, metal or timber building elements causes damage and/or decay to those elements.
- High subfloor humidity and moisture content create an ideal environment for various pests, including termites and spiders.
- Where high moisture levels are transmitted to the flooring and walls, an increase in the dust mite count can ensue within the living areas. Dust mites, as well as dampness in general, can be a health hazard to inhabitants, particularly those who are abnormally susceptible to respiratory ailments.

The garden

The ideal vegetation layout is to have lawn or plants that require only light watering immediately adjacent to the drainage or paving edge, then more demanding plants, shrubs and trees spread out in that order.

Overwatering due to misuse of automatic watering systems is a common cause of saturation and water migration under footings. If it is necessary to use these systems, it is important to remove garden beds to a completely safe distance from buildings.

Existing trees

Where a tree is causing a problem of soil drying or there is the existence or threat of upheaval of footings, if the offending roots are subsidiary and their removal will not significantly damage the tree, they should be severed and a concrete or metal barrier placed vertically in the soil to prevent future root growth in the direction of the building. If it is not possible to remove the relevant roots without damage to the tree, an application to remove the tree should be made to the local authority. A prudent plan is to transplant likely offenders before they become a problem.

Information on trees, plants and shrubs

State departments overseeing agriculture can give information regarding root patterns, volume of water needed and safe distance from buildings of most species. Botanic gardens are also sources of information. For information on plant roots and drains, see Building Technology File 17.

Excavation

Excavation around footings must be properly engineered. Soil supporting footings can only be safely excavated at an angle that allows the soil under the footing to remain stable. This angle is called the angle of repose (or friction) and varies significantly between soil types and conditions. Removal of soil within the angle of repose will cause subsidence.

Remediation

Where erosion has occurred that has washed away soil adjacent to footings, soil of the same classification should be introduced and compacted to the same density. Where footings have been undermined, augmentation or other specialist work may be required. Remediation of footings and foundations is generally the realm of a specialist consultant.

Where isolated footings rise and fall because of swell/shrink effect, the homeowner may be tempted to alleviate floor bounce by filling the gap that has appeared between the bearer and the pier with blocking. The danger here is that when the next swell segment of the cycle occurs, the extra blocking will push the floor up into an accentuated dome and may also cause local shear failure in the soil. If it is necessary to use blocking, it should be by a pair of fine wedges and monitoring should be carried out fortnightly.

This BTF was prepared by John Lewer FAIB, MIAMA, Partner, Construction Diagnosis.

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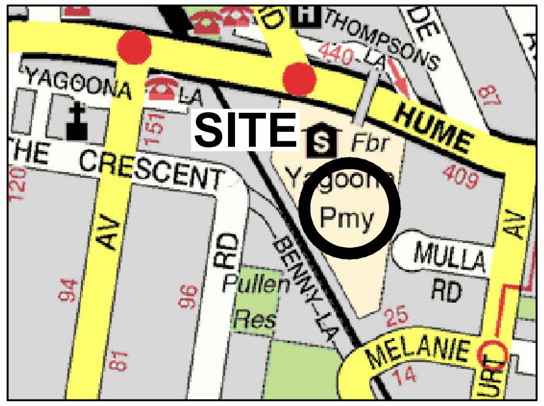

Locality Plan

LEGEND

⊕	Cored Boreholes
⊕	Augered Boreholes (with DCP)
▨	Outline of new building footprint

NOTE:
1: Base drawing from Conrad Gargett Pty Ltd Drawing YA-01-SD-AR-DR-1000 (undated)
2: Test locations are approximate only and are shown with reference to existing site features.

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Conrad Gargett Pty Ltd		TITLE: **Test Location Plan**	PROJECT No: 86030.00
OFFICE: Sydney	DRAWN BY: Vojta	**Yagoona Public School**	DRAWING No: 1
SCALE: 1:1000@A3	DATE: 14.7.2017	**425 Hume Highway, YAGOONA**	REVISION: 0