



Douglas Partners

Geotechnics | Environment | Groundwater

Report on
Geotechnical Investigation

Monte Scientia Project
128 Miller Street, North Sydney

Prepared for
Monte Sant' Angelo Mercy College
c/- Bloompark Consulting Pty Ltd

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Integrated Practical Solutions



Monte
Scientia
Project

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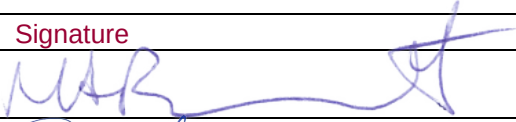
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The undersigned, on behalf of Douglas Partners Pty Ltd, confirm that this document and all attached drawings, logs and test results have been checked and reviewed for errors, omissions and inaccuracies.

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Report on Geotechnical Investigation

Monte Scientia Project

128 Miller Street, North Sydney

1. Introduction

This report prepared by Douglas Partners Pty Ltd (DP) presents the results of a geotechnical investigation undertaken for the proposed Monte Scientia Project at Monte Sant' Angelo Mercy College, 128 Miller Street, North Sydney. The investigation was undertaken for Monte Sant' Angelo Mercy College in consultation with Bloompark Consulting Pty Ltd, project managers. The work was completed in accordance with DP's proposal SYD191047 dated 3 October 2019 and this report has been prepared in support of the SSD-10393 for the development at Monte Sant' Angelo Mercy College.

It is understood that the project will include the redevelopment of a portion of the Monte Sant' Angelo Mercy College campus, excluding the heritage significant buildings, and will include a new science and innovation building, carpark, sports gymnasium and recreation facility, and public domain. Three basement levels are proposed for the site, including two levels for the sports gymnasium and a single level basement carpark beneath the gymnasium.

The investigation included the drilling of three boreholes, the installation of one groundwater well and laboratory testing of selected samples. Details of the field work are presented in this report, together with comments and recommendations relevant to the design and construction, including comments about the nearby Sydney Metro tunnels/station cavern.

A preliminary contamination assessment was also undertaken for the project and is reported separately.

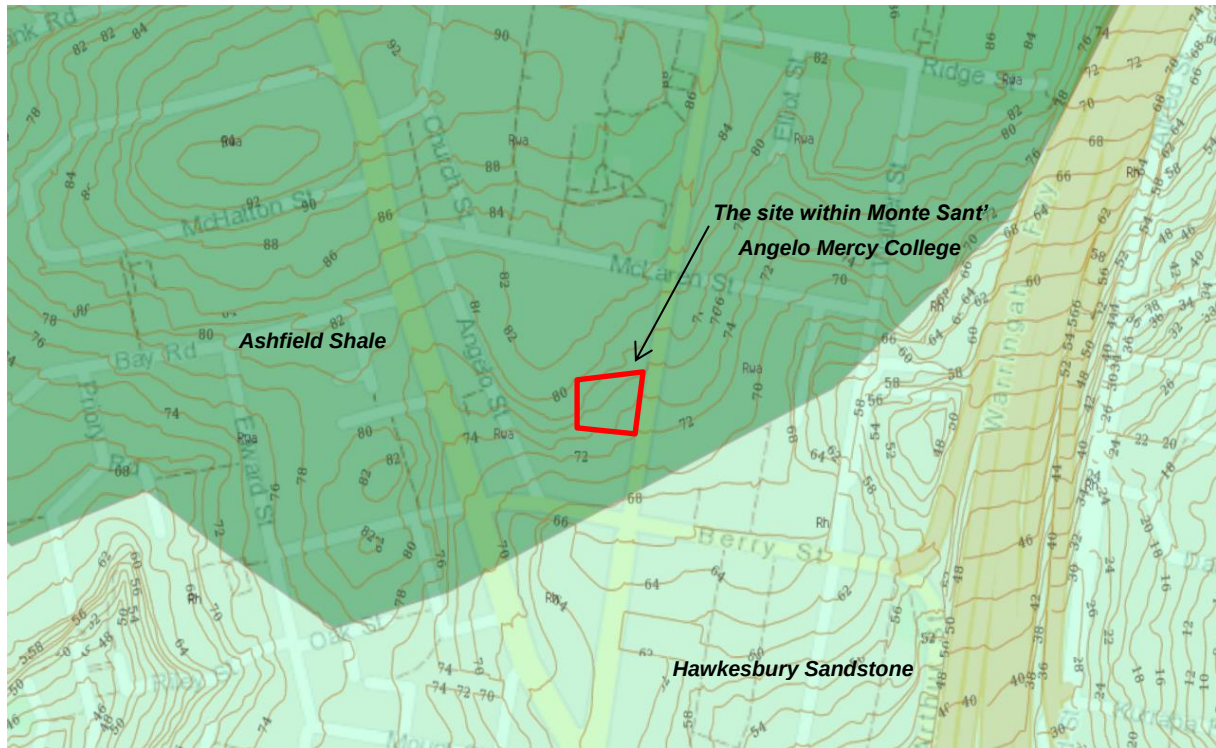
2. Site Description and Geology

Monte Sant' Angelo Mercy College is located on a truncated triangular block bounded by Miller Street to the east, McLaren Street to the north, Angelo Street to the west and Berry Street to the south. Several residential properties along McLaren Street are also included within the block. The site for this investigation is the central-east portion of Monte Sant' Angelo Mercy College adjacent to Miller Street and is shown on Drawing 1 in Appendix B. The site spans the parcels of land legally known as Lots 3, 4 and 5 in Deposited Plan (DP) 262534.

The ground surface across the site generally slopes downwards to the south-east, with changes in elevation from about RL 80 m relative to Australian Height Datum (AHD) at the north-west corner to about RL 72 m AHD at the south-east corner. Terracing and retaining structures are present across the site.

The *Sydney 1:100 000 Geological Series Sheet* indicates that the site is underlain by Ashfield Shale (Rwa) but is close to the mapped boundary between Ashfield Shale and Hawkesbury Sandstone (Rh). Ashfield Shale typically comprises dark-grey to black shale, claystone and siltstone with fine sandstone laminae. Hawkesbury Sandstone typically comprises medium to coarse grained quartz sandstone with

minor shale and laminite lenses. An intermediate unit, the Mittagong Formation, is often present below Ashfield Shale and above Hawkesbury Sandstone. The Mittagong Formation comprises interbedded shale, laminite and medium-grained quartz sandstone. An extract from the geological map overlain by 2 m surface contours is shown in Figure 1.



3. Field Work Methods

The field work for the current investigation included the drilling of three boreholes (BH01 to BH03) to depths of between 15.0 m and 16.5 m using two truck-mounted Hydrapower Scout drilling rigs and one track-mounted Hanjin DB8 drilling rig. The boreholes were commenced using solid flight augers until bedrock was encountered. Standard penetration tests (SPTs) were carried out and soil samples were collected for laboratory testing in each borehole. The boreholes were then extended into bedrock using NMLC diamond core drilling techniques to obtain continuous core samples of the bedrock.

One borehole (BH03) was converted into a groundwater monitoring well by installing Class 18 uPVC screen and casing.

The locations of the boreholes were measured from existing site features and are shown on Drawing 1 in Appendix B. The surface RLs of the tests were interpolated from the survey plan for the site, which was provided by Bloompark Consulting Pty Ltd (Plan No. 192082_A, dated 9/09/2019, prepared by TSS Total Surveying Solutions). Coordinates are in GDA94/MGA Zone 56 format (Geocentric Datum of Australia 1994 base with Map Grid of Australia projection) and RLs are relative to AHD.

4. Field Work Results

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

The boreholes encountered:

- BRICK PAVERS & ASPHALTIC CONCRETE – 0.065 m thick brick pavers from the surface of BH01 and BH02, and 0.055 m thick asphaltic concrete from the surface of BH03;
- FILL – sandy gravel, sandy clay and clayey sand with varying proportions of igneous, ironstone and sandstone gravel, moderately and well compacted to depths of between 0.3 m and 1.1 m;
- RESIDUAL SOIL – generally very stiff and hard sandy clay to depths of between 1.3 m and 1.4 m. Residual soil was encountered in BH01 and BH02 only;
- BEDROCK – very low, low and medium strength sandstone from depths of between 0.3 m and 1.4 m, generally becoming medium and/or high strength with depth. Some weathered seams and bands of very low and low strength sandstone and siltstone were present throughout the boreholes.

Table 1 summarises the levels at which different materials were encountered in the boreholes. The rock classifications refer to a system developed by Pells, Douglas et al (1978) which classifies rock on the basis of strength, fracturing and defects. Class V rock is typically very low strength and fractured whereas Class II rock is typically medium to high strength and unbroken. Lower classifications may, however, contain strong rock with significant defects and/or fracturing.

Table 1: Summary of Inferred Material Strata Levels

Stratum	Depth (m) [RL (m, AHD)] of Top of Stratum		
	BH01	BH02	BH03
Ground Surface	0 [79.1]	0 [75.7]	0 [73.0]
Fill	0.07 [79.03]	0.07 [75.63]	0.06 [72.94]
Residual Soil	1.1 [78.0]	0.8 [74.9]	NE
Class V Sandstone	NE	1.0 [74.7]	0.3 [72.7]
Class IV Sandstone	NE	1.4 [74.3]	2.3 [70.7]
Class III Sandstone	1.4 [77.7]	3.0 [72.7]	4.3 [68.7]
Class II Sandstone	6.6 [72.5]	11.4 [64.3]	11.2 [61.8]
Base of Borehole	15.0 [64.1]	15.0 [60.7]	16.5 [56.5]

Notes: NE = not encountered

Free groundwater was not observed during auger drilling in any of the boreholes. The use of drilling fluid during coring prevented further observations with depth. The level in the groundwater well was measured on 19 November 2019 and the results are summarised in Table 2.

Table 2: Groundwater Level Observations (Depth, m and [RL, m AHD])

Date	BH03
19 November 2019	9.6 [63.4]

5. Laboratory Testing

5.1 Rock

A total of 51 samples were tested for axial point load strength index (IS_{50}). The results ranged between 0.1 MPa and 2.0 MPa which correspond to very low to low strength and high strength rock, respectively. The individual results are shown on the relevant borehole logs in Appendix C.

5.2 Soil

Three samples were sent to a NATA accredited analytical laboratory and were analysed to assess the exposure classification to steel and concrete below ground. The results are summarised in Table 3 and the detailed results are included in Appendix D.

Table 3: Analytical Results for Aggressivity in Soil

Sample/Depth (m)	Description	pH (pH units)	EC (µS/cm)	Cl- (mg/kg)	SO42- (mg/kg)
BH01/0.9-1.0	FILL/Sandy CLAY	5.4	79	<10	120
BH02/0.9-1.0	Sandy CLAY	5.6	28	<10	36
BH03/0.9-1.0	SANDSTONE	5.7	31	10	22

Notes: EC = electrical conductivity; Cl⁻ = chloride ion; SO₄²⁻ = sulphate ion; samples mixed with 1:5 soil:water

One sample was tested for Atterberg limits. The results are summarised in Table 4 and the detailed results are included in Appendix D.

Table 4: Results for Atterberg Limits in Soil

Sample/Depth (m)	Description	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Linear Shrinkage (%)	Field Moisture (%)
BH02/0.9-1.0	Sandy CLAY	33	15	18	8.0	15.0

6. Geotechnical Model

The development areas are underlain by variable depths of fill, typically deeper uphill at the northern end of the site. Residual sandy clays underly the fill at some areas, which are derived from weathering of the Hawkesbury Sandstone and are expected to be of low plasticity and slightly reactive. The laboratory testing confirms this.

The sandy clays are typically underlain by a weathered Hawkesbury Sandstone profile which is initially very low and low strength (Class V and Class IV in Table 1). The sandstone increases to medium and high strength with depth (Class II/III in Table 1) and was observed to the termination depths of the boreholes. Defects and weathered seams were present throughout the sandstone profile.

Suspected potential or actual acid sulphate soils were not encountered during the investigation and it is considered highly unlikely that the proposed development would disturb any potential or actual acid sulphate soils.

Groundwater was measured at a depth of 9.6 m (RL 63.4 m AHD) in the monitoring well at BH03. The water observed in the monitoring well is considered to be perched seepage rather than the regional groundwater table. The groundwater table is likely to be well below the bedrock surface. Seepage near the rock surface and through joints/partings within the bedrock would be expected to occur.

The geotechnical model is illustrated in cross-section A-A' in Drawing 2 in Appendix B.

7. Proposed Development

It is understood that the proposed Monte Scientia Project will include the demolition of some existing structures on the site and construction of a new 3-4 storey building for the science and innovation centre. Three basement levels are proposed beneath the new building to approximately RL 63.9 m AHD, including two levels for the sports gymnasium and a single level basement carpark beneath the gymnasium.

The proposed development is close to the Sydney Metro tunnels/station cavern beneath Miller Street and heritage buildings on the Monte Sant' Angelo Mercy College campus. Based on drawings provided by Sydney Metro, the Sydney Metro subsurface property stratum, in plan view, extends about 6 m within Monte Sant' Angelo Mercy College from Miller Street. The top of the Sydney Metro property stratum is at RL 56.6 m AHD, approximately 15-20 m below existing ground surface.

The geotechnical issues considered relevant to the proposed development include site preparation, excavation, excavation support, groundwater and foundations. Comments on aggressivity, seismicity, dilapidation surveys, ground vibrations and the nearby Sydney Metro infrastructure are also provided.

8. Comments

8.1 Site Preparation

Any existing fill that is required to support structures and pavements will need to be reworked to reduce the potential for unacceptable settlements associated with poorly or variably compacted fill. New fill will also need to be placed in accordance with an engineering specification.

The following procedure could be followed during earthworks activities:

- Strip any organic-rich topsoil from areas of the site in which fill, structures and/or pavements are proposed;
- Excavate existing fill in areas of the site in which fill, structures and/or pavements are proposed;
- Compact the exposed surface and proof-roll using a roller of 10 t deadweight (or equivalent) in the presence of a geotechnical engineer. Any areas exhibiting unacceptable movements during the proof-roll may require further rectification;
- Place fill in maximum 250 mm thick layers and compact to achieve a dry density ratio of between 98% and 102% relative to Standard compaction. The upper 0.5 m of pavement subgrade areas should be compacted to achieve a dry density ratio of between 100% and 102% relative to Standard compaction;
- The moisture content should be within 2% of the Standard optimum moisture content of the material if it exhibits clay-like properties;
- A layer of granular product (e.g. roadbase, recycled crushed concrete etc.) should be considered as the top layer of fill to improve trafficability on site, particularly during and following periods of wet weather;
- Density testing should be undertaken in accordance with the requirements of AS 3798 – 2007 *Guidelines on earthworks for commercial and residential developments*.

The existing fill should be suitable for re-use from a geotechnical perspective provided that any deleterious materials are removed during placement. If fill is imported to the site then the engineering properties (e.g. plasticity, reactivity, CBR etc.) should ideally be equivalent, or superior, to the existing materials on the site.

8.2 Dilapidation Surveys

Prior to the commencement of demolition and excavation work on the site, it is recommended that dilapidation (existing building condition) surveys be undertaken on sections of neighbouring buildings close to the excavations, as well as footpaths, roads and Sydney Metro infrastructure adjacent to the site boundaries. The condition of the heritage items on and surrounding the site should also be documented. The purpose of the dilapidation survey is to document any existing defects so that any potential claims for damage due to construction related activities can be accurately assessed.

8.3 Excavation

It is anticipated that the proposed excavation across the site will intersect fill, sandy clay, layers of very low and low strength sandstone and then medium and high strength sandstone. Excavation should be carried out with due consideration to adjacent buildings, heritage items/structures and the Sydney Metro infrastructure.

Excavation of the near-surface fill/soil and weathered bedrock (Class V) encountered in the boreholes should be readily achievable using conventional earthmoving equipment such as excavators. Excavation of low strength or stronger rock, including bands within Class V, will likely require the use of heavy ripping equipment and/or rock hammers/saws for efficient excavation. Rock saws with diamond-tipped blades could be used along or close to the site boundary and existing buildings/structures to reduce vibrations and to reduce over-break and fracturing of the rock.

8.4 Ground Vibrations

It is anticipated that the excavation within fill/soils and weathered bedrock will result in relatively insignificant vibrations. Excavation of rock with rock hammers will result in vibration of the surrounding ground and it would be important to manage vibrations on the adjacent buildings/structures, especially the sensitive/heritage items and Sydney Metro infrastructure in close proximity.

During excavation it will be necessary to use appropriate methods and equipment to keep ground vibrations within acceptable limits. The standards listed below are considered appropriate documents on which to base the management of ground vibration:

- German Standard DIN 4150-3 – 1999, “Structural Vibration – Part 3: Effects of Vibration on Structures”; and
- Australian Standard AS 2670.2 – 1990, “Evaluation of human exposure to whole-body vibrations – Part 2: Continuous and shock-induced vibrations in buildings (1 to 80 Hz)”.

Ground vibrations can be strongly perceptible to humans at levels above 3 mm/s component peak particle velocity (PPV). AS 2670.2 – 1990 indicates an acceptable day time limit of 8 mm/s component PPV for human comfort (for daytime occupants of residential buildings).

It is likely that the sensitivity of heritage items on the site will probably necessitate a lower vibration limit for excavation than the daytime limit for human comfort. Based on previous experience with rock excavations adjacent to sensitive structures in Sydney and reference to DIN 4150 – 1999, it is suggested that a maximum vector sum peak particle velocity (VSPPV) of 5 mm/s be adopted to reduce the risk of structural damage to surrounding sensitive buildings/structures. This vibration limit is applicable at the foundation level of existing buildings and may need to be modified following review of dilapidation surveys, vibration trials and/or proposed excavation plant.

As the rate of vibration attenuation is site specific, it is recommended that a vibration trial be undertaken at the commencement of rock excavation with each major plant item, for confirmation of suitability of plant and determination of the theoretical distance of closest approach to the adjacent receptors in order to reduce vibration exceedances with respect to the allowed limit.

8.5 Excavation Support

8.5.1 General

Vertical excavations in fill/soil and very low and low strength sandstone (Class IV/V) are not expected to be stable. The maximum batter slopes given in Table 5 are recommended for the design of temporary and permanent excavations for cuts up to 3 m deep with a horizontal ground surface at the crest and with no surcharge loadings (e.g. existing structures, stockpiled material or construction plant and equipment).

Table 5: Maximum Batter Slopes for Cuts up to 3 m Deep

Material	Batter Slopes (Horizontal:Vertical)	
	Temporary (During Construction)	Permanent
Fill and Residual Soil	1:1	2:1
Class V Sandstone	0.75:1	1:1*
Class IV Sandstone	0.5:1*	1:1*
Class III/II Sandstone	Vertical*	Vertical*

Note: *Subject to geotechnical inspection at 1.5 m depth intervals to check for adversely inclined joints.

Deeper excavations in fill/soil and very low and low strength sandstone may need to incorporate intermediate benches to reduce the overall slope angle.

Excavations in sandstone of medium and high strength will generally be stable (subject to joint orientation) and may be cut vertically. All vertical rock faces must be progressively inspected by a geotechnical engineer at 1.5 m depth intervals to check for adversely inclined joints and detached blocks, and to assess whether additional stabilisation measures are required. Stabilisation of vertical

rock faces may include shotcrete of fractured or highly weathered zones or rock bolts/anchors where adverse joints form potentially unstable wedges of rock.

Excavations retained either temporarily or permanently will be subjected to earth pressures. Table 6 outlines material and strength parameters that could be used for the design of excavation support structures.

Table 6: Material and Strength Parameters for Excavation Support Structures

Material	Bulk Density (kN/m ³)	Coefficient of Active Earth Pressure (K_a)	Coefficient of Earth Pressure at Rest (K_o)	Ultimate Passive Earth Pressure (kPa)
Fill	20	0.4	0.6	-
Very Stiff to Hard Residual Clay	20	0.3	0.45	150 ¹
Class V Sandstone	22	0.2	0.3	400 ¹
Class IV Sandstone	22	0.1 ²	0.15 ²	2000 ¹
Class III/II Sandstone	24	0 ²	0 ²	6000 ¹

Notes: ¹Only below bulk/detailed excavation level

²Provided that adverse jointing is not encountered

The lateral earth pressure distribution for a multi-anchored or propped wall could be assumed to be trapezoidal; the maximum lateral earth pressure acting over the central 60% of the wall, decreasing to zero at the top and base. The lateral earth pressure distribution for a cantilevered wall could be assumed to be triangular. Cantilevered walls should not be used to support adjacent structures.

'Active' earth pressure coefficient (K_a) values may be used for walls where some wall movement is acceptable, and 'at rest' earth pressure (K_o) values should be used where the wall movement needs to be reduced (i.e. adjacent to existing structures or utilities).

Lateral pressures due to surcharge loads from adjacent buildings, existing road corridors, sloping ground surfaces and construction machinery should be included where relevant. Hydrostatic pressure acting on the shoring walls should also be included in the design where adequate drainage is not provided behind the full height of the wall.

8.5.2 Ground Anchors

Where necessary, the use of inclined tie-back (ground) anchors is suggested for the lateral restraint of shoring walls. Such ground anchors should be inclined below the horizontal to allow anchorage into the stronger bedrock materials at depth. The design of temporary ground anchors for the support of piled wall systems may be carried out using the allowable average bond stresses at the grout-rock interface given in Table 7.

Table 7: Allowable Bond Stresses for Anchor Design

Material Description	Allowable Bond Stress (kPa)
Class V/IV Sandstone	100
Class III Sandstone	600
Class II Sandstone	1000

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

The parameters given in Table 7 assume that the anchor holes are clean and adequately flushed, with grouting and other installation procedures carried out carefully and in accordance with good anchoring practice. Careful installation and close supervision by a geotechnical specialist may allow increased bond stresses to be adopted during construction, subject to testing.

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

It will be necessary to obtain permission from neighbouring landowners prior to installing anchors that will extend beyond the perimeter of the site. In addition, care should be taken to avoid damaging buried services, pipes and subsurface structures during anchor installation, especially given the proximity of Sydney Metro infrastructure.

8.6 Groundwater

Measurement within the monitoring well installed at BH03 indicated a groundwater level at 9.6 m depth (RL 63.4 m AHD), which is considered consistent with encountered subsurface geology and anticipated seepage along bedding planes, joints and other defects with the bedrock. Seepage should be expected through the fill, soils and rock, and along strata boundaries. The rate of seepage is likely to vary with climatic conditions.

The subsurface conditions encountered in the boreholes indicate that seepage can probably be controlled using a sub-floor drainage and collection system in any basement levels. A pump will be required to periodically remove stored water from the lowest part of any basements. A pump may also be needed to remove seepage from footing/pile excavations prior to the placement of concrete.

8.7 Foundations

8.7.1 Spread Footings

Given the relatively shallow depth to sandstone and proposed excavation depth, it is likely that all footings will be founded within sandstone. Spread footings could be designed using the parameters outlined in Table 8.

Table 8: Allowable Footing Design Parameters for Spread Footings

Material	Allowable Bearing Pressure (kPa)
Class V Sandstone	1000
Class IV Sandstone	2000
Class III Sandstone	3500
Class II Sandstone	6000*

Note: *Subject to spoon testing to a depth at least 1.5 times the width of the footing

Settlement of a spread footing is dependent on the loads applied to the footing and the foundation conditions below the footing. The total settlement of a spread footing designed using the parameters provided in this report may be in the order of 1% of the width of the footing upon application of the working load. Differential settlements between footings may be in the order of 50% of the value of total settlement.

Spread footings will not be able to be used within the zone of influence of any existing batters, retaining walls or existing/proposed excavations. The zone of influence can be described as a line drawn up at 2(H):1(V) from the base of the batter/wall.

All spread footing excavations should be inspected by an experienced geotechnical professional to check the adequacy of the foundation material. Spoon testing will be required in at least 50% of footing excavations for pad footings that are designed for an allowable end bearing pressure of 6000 kPa.

8.7.2 Piles

Bored piles could be used to support significant column loads and could be designed using the parameters provided in Table 9, overleaf.

It should be noted that the serviceability limit-state is likely to govern the design of the piles and the ultimate bearing pressures provided in Table 9 are unlikely to be able to be achieved in practice. An appropriate geotechnical strength reduction factor should be applied when using the limit-state approach as outlined in AS 2159 – 2009 *Piling – Design and installation*. An initial value of 0.4 could be assumed in the first instance.

Settlement of a pile is dependent on the loads applied to the pile and the foundation conditions below the pile toe and within the socket zone. The total settlement of a pile designed using the allowable parameters provided in this report may be in the order of 1% of the diameter of the pile. Differential settlements between piles may be in the order of 50% of the value of total settlement. Serviceability analysis should be undertaken when using the ultimate (limit-state) parameters.

Table 9: Design Parameters for Bored Piles

Material	Allowable End-Bearing Pressure (kPa)	Allowable Shaft Adhesion (kPa) ¹	Ultimate End-Bearing Pressure (kPa)	Ultimate Shaft Adhesion (kPa) ¹	Young's Modulus (MPa)
Class V Sandstone	1000	100	3,000	150	75
Class IV Sandstone	2000	200	6000	250	150
Class III/II Sandstone	3500	350	20000	700	500

Notes: ¹Pile socket should be clean and roughened to achieve these shaft adhesion values

Due to the presence of a number of lower strength seams within all three boreholes and the impracticality of observing seams within pile excavations, it is not feasible to provide upgraded design parameters for bored piles founded within Class II Sandstone.

All bored pile excavations should be inspected by an experienced geotechnical professional to check the adequacy of the foundation material and socket roughness/cleanliness.

8.8 Pavements

On the basis of the subsurface conditions encountered on the site and our previous experience in the area, it is recommended that a design subgrade CBR of 5% be adopted. This assumes that the site preparation recommendations provided in Section 8.1 of this report are adopted.

8.9 Aggressivity

The laboratory test results indicate non-aggressive to mild conditions for concrete and non-aggressive conditions for steel as outlined in Australian Standard AS 2159 – 2009 *Piling – Design and installation*.

8.10 Seismicity

A Hazard Factor (Z) of 0.08 would be appropriate for the development site in accordance with Australian Standard AS 1170.4 – 2007 *Structural design actions – Part 4: Earthquake actions in Australia*. The site sub-soil class would be Class B_e.

8.11 Sydney Metro Infrastructure

The design and construction of the proposed Monte Scientia Project will need to consider development induced effects on Sydney Metro infrastructure and the associated risks. General guidance is provided on the Sydney Metro website in their document "Sydney Metro – Technical Service, Sydney Metro

Underground Corridor Protection, Technical Guidelines”, Document Number NWRLSRT-PBA-SRT-TU-REP-000008, dated 16 October 2017.

Excavation for basements, shallow footings or piled foundations, installation of ground anchors and demolition of existing subsurface structures are not allowed within the first protection reserve (as defined in the Technical Guidelines). Construction activities are permitted in the second reserve, subject to assessment. The proposed development is likely to be within the second protection reserve. Planning, design and construction should be undertaken in general accordance with the Sydney Metro Technical Guidelines and this report.

An engineering impact assessment will be required by Sydney Metro for the proposed development. This generally involves numerical modelling to analyse the potential impact of the proposed development on the Sydney Metro infrastructure. The timing and requirements of the engineering impact assessment should be confirmed during consultation with Sydney Metro as part of the post lodgement agency consultation process.

9. Conclusion

Subject to the comments above, and any additional mitigation measures imposed by Sydney Metro or recommended as an outcome of further assessment, the Sydney Metro infrastructure, nearby existing heritage buildings and other school buildings can be protected during the redevelopment works.

10. Limitations

Douglas Partners Pty Ltd (DP) has prepared this report for this project at Monte Sant’ Angelo Mercy College at 128 Miller Street, North Sydney in accordance with DP’s proposal SYD191047 dated 3 October 2019 and acceptance received from Peter Brogan of Bloompark Consulting Pty Ltd on behalf of Monte Sant’ Angelo Mercy College, dated 11 October 2019. The work was carried out under DP’s Conditions of Engagement. This report is provided for the exclusive use of Monte Sant’ Angelo Mercy College and their agents 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 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 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 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.

This report did not include the assessment of surface or sub-surface materials or groundwater for contaminants, within or adjacent to the site. Refer to DP's Report on Preliminary Site Investigation (Contamination), 73019.03.R.002 for the results of the contamination investigation.

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.

Douglas Partners Pty Ltd

Appendix A

About This Report

About this Report

Douglas Partners



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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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

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

Sampling Methods

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.



Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are generally based on Australian Standard AS1726:2017, Geotechnical Site Investigations. 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	19 - 63
Medium gravel	6.7 - 19
Fine gravel	2.36 - 6.7
Coarse sand	0.6 - 2.36
Medium sand	0.21 - 0.6
Fine sand	0.075 - 0.21

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

The proportions of secondary constituents of soils are described as follows:

In fine grained soils (>35% fines)

Term	Proportion of sand or gravel	Example
And	Specify	Clay (60%) and Sand (40%)
Adjective	>30%	Sandy Clay
With	15 - 30%	Clay with sand
Trace	0 - 15%	Clay with trace sand

In coarse grained soils (>65% coarse)

- with clays or silts

Term	Proportion of fines	Example
And	Specify	Sand (70%) and Clay (30%)
Adjective	>12%	Clayey Sand
With	5 - 12%	Sand with clay
Trace	0 - 5%	Sand with trace clay

In coarse grained soils (>65% coarse)

- with coarser fraction

Term	Proportion of coarser fraction	Example
And	Specify	Sand (60%) and Gravel (40%)
Adjective	>30%	Gravelly Sand
With	15 - 30%	Sand with gravel
Trace	0 - 15%	Sand with trace gravel

The presence of cobbles and boulders shall be specifically noted by beginning the description with 'Mix of Soil and Cobbles/Boulders' with the word order indicating the dominant first and the proportion of cobbles and boulders described together.

Soil Descriptions

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
Friable	Fr	-

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	Density Index (%)
Very loose	VL	<15
Loose	L	15-35
Medium dense	MD	35-65
Dense	D	65-85
Very dense	VD	>85

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;
- Extremely weathered material – formed from in-situ weathering of geological formations. Has soil strength but retains the structure or fabric of the parent rock;
- Alluvial soil – deposited by streams and rivers;

- Estuarine soil – deposited in coastal estuaries;
- Marine soil – deposited in a marine environment;
- Lacustrine soil – deposited in freshwater lakes;
- Aeolian soil – carried and deposited by wind;
- Colluvial soil – soil and rock debris transported down slopes by gravity;
- Topsoil – mantle of surface soil, often with high levels of organic material.
- Fill – any material which has been moved by man.

Moisture Condition – Coarse Grained Soils

For coarse grained soils the moisture condition should be described by appearance and feel using the following terms:

- Dry (D) Non-cohesive and free-running.
- Moist (M) Soil feels cool, darkened in colour.
Soil tends to stick together.
Sand forms weak ball but breaks easily.
- Wet (W) Soil feels cool, darkened in colour.
Soil tends to stick together, free water forms when handling.

Moisture Condition – Fine Grained Soils

For fine grained soils the assessment of moisture content is relative to their plastic limit or liquid limit, as follows:

- 'Moist, dry of plastic limit' or 'w < PL' (i.e. hard and friable or powdery).
- 'Moist, near plastic limit' or 'w ≈ PL' (i.e. soil can be moulded at moisture content approximately equal to the plastic limit).
- 'Moist, wet of plastic limit' or 'w > PL' (i.e. soils usually weakened and free water forms on the hands when handling).
- 'Wet' or 'w ≈ LL' (i.e. near the liquid limit).
- 'Wet' or 'w > LL' (i.e. wet of the liquid limit).



Rock Strength

Rock strength is defined by the Unconfined Compressive Strength and it 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 Point Load Strength Index $IS_{(50)}$ is commonly used to provide an estimate of the rock strength and site specific correlations should be developed to allow UCS values to be determined. The point load strength test procedure is described by Australian Standard AS4133.4.1-2007. The terms used to describe rock strength are as follows:

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

* Assumes a ratio of 20:1 for UCS to $IS_{(50)}$. It should be noted that the UCS to $IS_{(50)}$ ratio varies significantly for different rock types and specific ratios should be determined for each site.

Degree of Weathering

The degree of weathering of rock is classified as follows:

Term	Abbreviation	Description
Residual Soil	RS	Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are no longer visible, but the soil has not been significantly transported.
Extremely weathered	XW	Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are still visible
Highly weathered	HW	The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable. Rock strength is significantly changed by weathering. Some primary minerals have weathered to clay minerals. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores.
Moderately weathered	MW	The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable, but shows little or no change of strength from fresh rock.
Slightly weathered	SW	Rock is partially discoloured with staining or bleaching along joints but shows little or no change of strength from fresh rock.
Fresh	FR	No signs of decomposition or staining.
<i>Note: If HW and MW cannot be differentiated use DW (see below)</i>		
Distinctly weathered	DW	Rock strength usually changed by weathering. The rock may be highly discoloured, usually by iron staining. Porosity may be increased by leaching or may be decreased due to deposition of weathered products in pores.

Rock Descriptions

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 occasional fragments
Fractured	Core lengths of 30-100 mm with occasional shorter and longer sections
Slightly Fractured	Core lengths of 300 mm or longer with occasional sections of 100-300 mm
Unbroken	Core contains very few fractures

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 stronger. 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

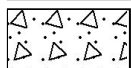
General



Asphalt



Road base



Concrete



Filling

Soils



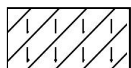
Topsoil



Peat



Clay



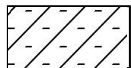
Silty clay



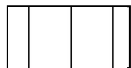
Sandy clay



Gravelly clay



Shaly clay



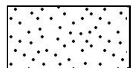
Silt



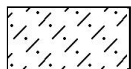
Clayey silt



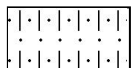
Sandy silt



Sand



Clayey sand



Silty sand



Gravel



Sandy gravel



Cobbles, boulders



Talus

Sedimentary Rocks



Boulder conglomerate



Conglomerate



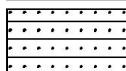
Conglomeratic sandstone



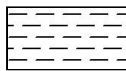
Sandstone



Siltstone



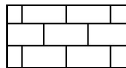
Laminite



Mudstone, claystone, shale

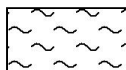


Coal

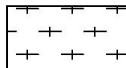


Limestone

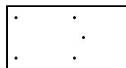
Metamorphic Rocks



Slate, phyllite, schist

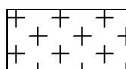


Gneiss



Quartzite

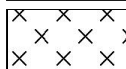
Igneous Rocks



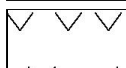
Granite



Dolerite, basalt, andesite



Dacite, epidote



Tuff, breccia



Porphyry

Appendix B

Drawings



Legend

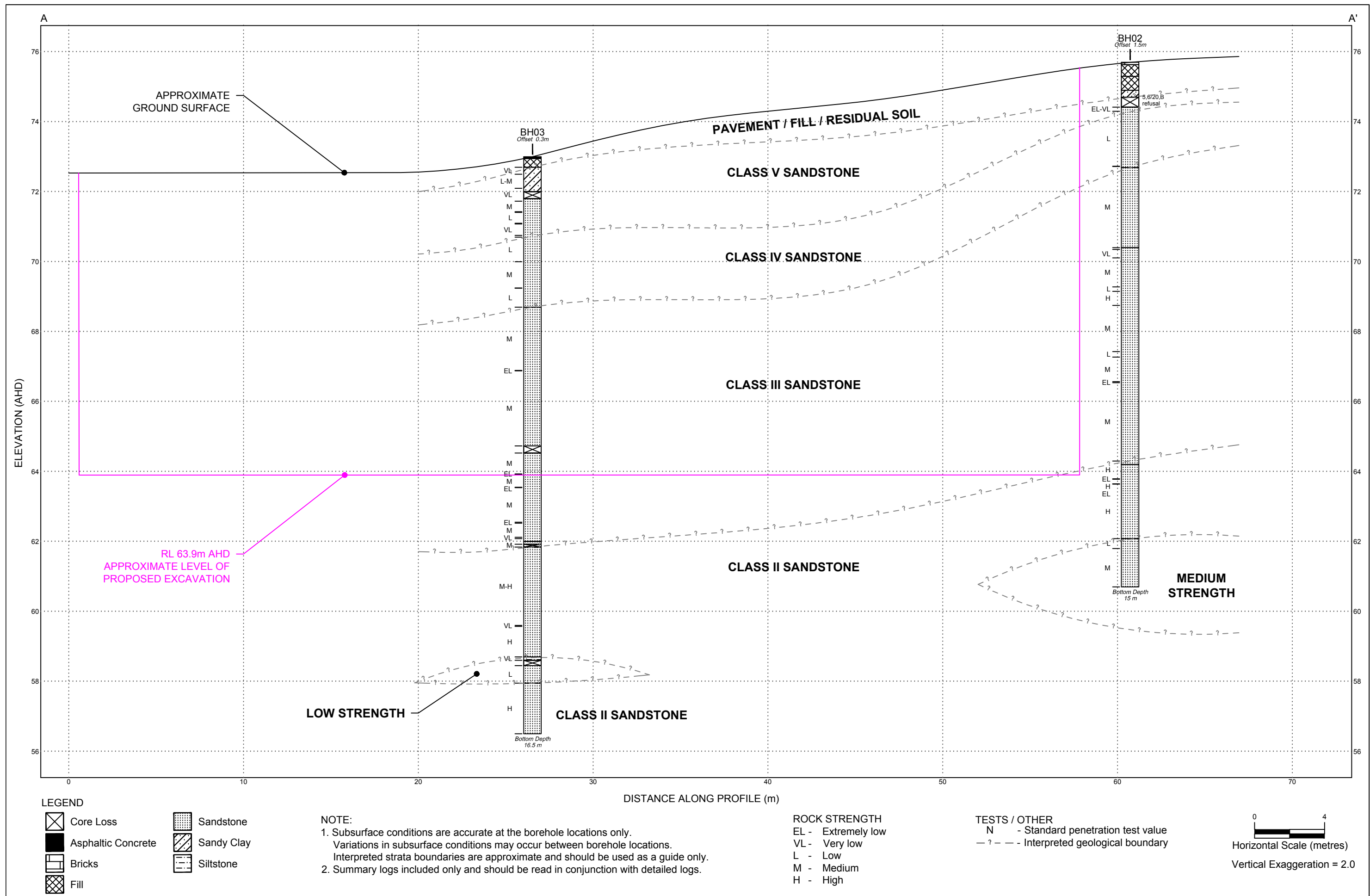
Borehole

Borehole and Monitoring Well

Site Boundary

Geotechnical Cross-Section

 Douglas Partners Geotechnics Environment Groundwater	CLIENT: Monte Sant' Angelo Mercy College		TITLE: Test Location Plan Monte Scientia Project 128 Miller Street, North Sydney		PROJECT No: 73019.03
	OFFICE: Sydney	DRAWN BY: MB			DRAWING No: 1
	SCALE: 1:1000 @ A3	DATE: 02/12/2019			REVISION: 2



Appendix C

Results of Field Work

BOREHOLE LOG

CLIENT: Monte Sant' Angelo Mercy College
PROJECT: Monte Scientia Project
LOCATION: 128 Miller Street, North Sydney

SURFACE LEVEL: 79.1 AHD
EASTING: 334078.9
NORTHING: 6254610.5
DIP/AZIMUTH: 90°/-

BORE No: BH01
PROJECT No: 73019.03
DATE: 9/11/2019
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering					Graphic Log	Rock Strength					Water	Fracture Spacing (m)	Discontinuities		Sampling & In Situ Testing			
			EW	HW	MW	SW	FS		FR	Ex Low	Very Low	Low	Medium			High	Very High	Ex High	B - Bedding S - Shear	J - Joint F - Fault	Type
	0.065	BRICK PAVERS																A/E			PID = 1.3 ppm
	0.4	FILL/Sandy GRAVEL: fine to medium, grey, igneous gravel, fine to medium sand, moist, appears generally well compacted																A/E*			PID = 1.4 ppm
	1.1	FILL/Sandy CLAY: low plasticity, orange mottled brown, fine sand, with fine ironstone and sandstone gravel, w<PL, appears generally moderately compacted																A/E*			PID = 0.9 ppm
	1.4	Sandy CLAY CL: low plasticity, pale grey, fine to medium, with fine to medium ironstone gravel, w<PL, hard, residual																S			2,6,6/100 refusal PID = 1.1 ppm PL(A) = 0.5
	2.46	SANDSTONE: medium grained, pale grey brown to red-brown, medium strength with 10% clay bands, moderately weathered, slightly fractured and unbroken, Hawkesbury Sandstone																C	83	72	PL(A) = 0.6
	4.17	SANDSTONE: medium grained, pale grey and red brown, thinly bedded and cross bedded, low to medium strength, moderately weathered, slightly fractured, Hawkesbury Sandstone																C	93	92	PL(A) = 0.3
	6.0	SANDSTONE: medium and coarse grained, pale grey and red brown, thinly bedded, medium then high strength, slightly weathered, slightly fractured and unbroken, Hawkesbury Sandstone																			PL(A) = 0.6
	8.65-8.68m: fg 8.75m: CORE LOSS: 250mm																	C	58	53	PL(A) = 1.5
	9.0																				

RIG: Hydrapower Scout **DRILLER:** Hagstrom Drilling - CN **LOGGED:** SI/KR **CASING:** HQ to 1.4m
TYPE OF BORING: Diatube to 0.065m, Solid flight augering (TC-bit) to 1.40m, NMLC coring to 15.00m
WATER OBSERVATIONS: No free groundwater observed whilst augering
REMARKS: A/E sample at 0.2-0.3m is BD3/9112019, A/E sample at 0.4-0.5m is BD2/9112019

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 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: Monte Sant' Angelo Mercy College
PROJECT: Monte Scientia Project
LOCATION: 128 Miller Street, North Sydney

SURFACE LEVEL: 79.1 AHD
EASTING: 334078.9
NORTHING: 6254610.5
DIP/AZIMUTH: 90°/--

BORE No: BH01
PROJECT No: 73019.03
DATE: 9/11/2019
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering					Graphic Log	Rock Strength					Water	Fracture Spacing (m)	Discontinuities	Sampling & In Situ Testing				
			EW	HW	MW	SW	FS		FR	Ex Low	Very Low	Low	Medium			High	Very High	Ex High	B - Bedding S - Shear	J - Joint F - Fault	Type
	10.2	SANDSTONE: as above																			
	10.46																				PL(A) = 2
	10.85	SANDSTONE: fine grained, pale grey, very low strength, highly weathered Hawkesbury Sandstone (possibly very low or low strength rock washed away)																C	58	53	
	11																				
	11.85																				
	12	SANDSTONE: medium grained, pale grey and brown, thinly bedded and laminated with some cross bedding (5°-20°), micro faults (45°) medium strength, slightly weathered then fresh, slightly fractured Hawkesbury Sandstone																			PL(A) = 0.6
	12.0																				
	13																				PL(A) = 0.6
	14																	C	100	100	
	15	Bore discontinued at 15.0m - Target Depth Reached																			PL(A) = 0.3
	15.0																				
	16																				
	17																				
	18																				
	19																				

RIG: Hydrapower Scout

DRILLER: Hagstrom Drilling - CN

LOGGED: SI/KR

CASING: HQ to 1.4m

TYPE OF BORING: Diatube to 0.065m, Solid flight augering (TC-bit) to 1.40m, NMLC coring to 15.00m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: A/E sample at 0.2-0.3m is BD3/9112019, A/E sample at 0.4-0.5m is BD2/9112019

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	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)

BORE: 01

PROJECT: NORTH SYDNEY

NOVEMBER 2019



Project No: 73019-03
BH ID: BH01
Depth: 1.40 - 5.00 m
Core Box No.: 1



73019-03 NORTH SYDNEY 9.11.19 BH01 START

1.40m



1.40 - 5.00m

BORE: 01

PROJECT: NORTH SYDNEY

NOVEMBER 2019



Project No: 73019-03
BH ID: BH01
Depth: 5.00 - 10.00 m
Core Box No.: 2



5.00 - 10.00m

BORE: 01

PROJECT: NORTH SYDNEY

NOVEMBER 2019



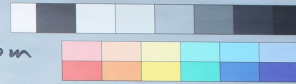
Douglas Partners
Geotechnics | Environment | Groundwater

Project No: 73019.03

BH ID: BH01

Depth: 10.00 - 15.00m

Core Box No.: 3



10.00 - 15.00m

BOREHOLE LOG

CLIENT: Monte Sant' Angelo Mercy College
PROJECT: Monte Scientia Project
LOCATION: 128 Miller Street, North Sydney

SURFACE LEVEL: 75.7 AHD
EASTING: 334113.8
NORTHING: 6254610.1
DIP/AZIMUTH: 90°/--

BORE No: BH02
PROJECT No: 73019.03
DATE: 9/11/2019
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering					Graphic Log	Rock Strength					Water	Fracture Spacing (m)	Discontinuities		Sampling & In Situ Testing			
			EW	HW	MW	SW	FS		FR	Ex Low	Very Low	Low	Medium			High	Very High	Ex High	B - Bedding S - Shear	J - Joint F - Fault	Type
	0.065	BRICK PAVERS																A/E*			PID = 1.1 ppm
	0.4	FILL/Sandy GRAVEL: fine to medium, grey, igneous gravel, fine to medium sand, moist, appears generally well compacted																A/E			PID = 0.5 ppm
	0.8	FILL/Sandy CLAY: low plasticity, orange mottled brown, fine sand, with fine to medium ironstone and sandstone gravel, w<PL, appears generally moderately compacted																A/E			PID = 0.4 ppm
1	1.0																	S			5,6/20,B refusal
	1.28	Sandy CLAY CL: low plasticity, pale grey and slightly pink, fine sand, with fine to medium ironstone gravel, w<PL, hard, residual																			PID = 0.6 ppm
		SANDSTONE: medium to coarse grained, pale grey, some indistinct bedding, low strength, highly weathered then fresh, slightly fractured, Hawkesbury Sandstone																C	83	75	PL(A) = 0.3
2																					PL(A) = 0.2
		SANDSTONE: medium grained, pale grey, cross bedding (20°), medium strength, fresh, slightly fractured and unbroken, Hawkesbury Sandstone																			PL(A) = 0.1
3	3.01																				
		SANDSTONE: medium grained, pale grey, cross bedding (20°), medium strength, fresh, slightly fractured and unbroken, Hawkesbury Sandstone																			PL(A) = 0.5
4																		C	100	96	
																					PL(A) = 0.8
5																					
																					PL(A) = 0.08
	5.3	SANDSTONE: medium grained, red-grey, some cross bedding (20°), medium strength with some very low and low strength bands, moderately then slightly weathered, slightly fractured and unbroken, Hawkesbury Sandstone																			PL(A) = 0.5
6																					PL(A) = 0.9
		6.55-6.95m: high strength																			PL(A) = 0.2
																					PL(A) = 1.2
7																		C	100	97	
																					PL(A) = 0.8
8																					PL(A) = 1
																					PL(A) = 0.1
																					PL(A) = 0.6
9																					

RIG: Hydrapower Scout **DRILLER:** Hagstrom Drilling - MC **LOGGED:** SI/KR **CASING:** HQ to 1.0m
TYPE OF BORING: Diatube to 0.065m, Solid flight augering (TC-bit) 1.00m, NMLC coring to 15.00m
WATER OBSERVATIONS: No free groundwater observed whilst augering
REMARKS: A/E sample at 0.1-0.2m is BD1/9112019

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 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	SP Standard penetration test	
E Environmental sample	≡ Water level	V Shear vane (kPa)	

BOREHOLE LOG

CLIENT: Monte Sant' Angelo Mercy College
PROJECT: Monte Scientia Project
LOCATION: 128 Miller Street, North Sydney

SURFACE LEVEL: 75.7 AHD
EASTING: 334113.8
NORTHING: 6254610.1
DIP/AZIMUTH: 90°/-

BORE No: BH02
PROJECT No: 73019.03
DATE: 9/11/2019
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering						Graphic Log	Rock Strength					Water	Fracture Spacing (m)	Discontinuities		Sampling & In Situ Testing			
			EW	HW	MW	SW	FS	FR		Ex Low	Very Low	Low	Medium	High			Very High	Ex High	B - Bedding S - Shear	J - Joint F - Fault	Type	Core Rec. %
	11	SANDSTONE: medium grained, red-grey, some cross bedding (20°), medium strength with some very low and low strength bands, moderately then slightly weathered, slightly fractured and unbroken, Hawkesbury Sandstone <i>(continued)</i>																C	100	96	PL(A) = 0.4	
	11.5	SANDSTONE: medium to coarse grained, pale grey then red-brown, some cross bedding (20°), high strength,slightly weathered, slightly fractured and unbroken, Hawkesbury Sandstone																			PL(A) = 1.1	
	12																					PL(A) = 1.7
	13																		C	100	99	PL(A) = 1.3
	13.62	SANDSTONE: medium to coarse grained, pale grey, some cross bedding (20°) then massive, low then medium strength, slightly weathered then fresh, slightly fractured and unbroken, Hawkesbury Sandstone																			PL(A) = 0.2 PL(A) = 0.5	
	14																		C	100	100	PL(A) = 0.7
	15	Bore discontinued at 15.0m - Target Depth Reached																				
	16																					
	17																					
	18																					
	19																					

RIG: Hydrapower Scout **DRILLER:** Hagstrom Drilling - MC **LOGGED:** SI/KR **CASING:** HQ to 1.0m
TYPE OF BORING: Diatube to 0.065m, Solid flight augering (TC-bit) 1.00m, NMLC coring to 15.00m
WATER OBSERVATIONS: No free groundwater observed whilst augering
REMARKS: A/E sample at 0.1-0.2m is BD1/9112019

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 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)	

BORE: 02

PROJECT: NORTH SYDNEY

NOVEMBER 2019



Project No: 73019-03
BH ID: BH02
Depth: 1.00 - 5.00 m
Core Box No.: 1



73019-03 NORTH SYDNEY 9/11/09 BH02 START 1.00m



1.00 - 5.00m

BORE: 02

PROJECT: NORTH SYDNEY

NOVEMBER 2019



Project No: 73019-03
BH ID: BH02
Depth: 5.00 - 10.00 m
Core Box No.: 2



5.00 - 10.00m

BORE: 02

PROJECT: NORTH SYDNEY

NOVEMBER 2019



Douglas Partners
Geotechnics | Environment | Groundwater

Project No: 73019-03

BH ID: BH 02

Depth: 10.00 - 15.00 m

Core Box No.: 3



10.00 - 15.00m

BOREHOLE LOG

CLIENT: Monte Sant' Angelo Mercy College
PROJECT: Monte Scientia Project
LOCATION: 128 Miller Street, North Sydney

SURFACE LEVEL: 73.0 AHD
EASTING: 334109.2
NORTHING: 6254576.2
DIP/AZIMUTH: 90°/--

BORE No: BH03
PROJECT No: 73019.03
DATE: 9/11/2019
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering					Graphic Log	Rock Strength					Water	Fracture Spacing (m)	Discontinuities		Sampling & In Situ Testing			
			EW	HW	MW	SW	FS		FR	Ex Low	Very Low	Low	Medium			High	Very High	Ex High	B - Bedding S - Shear	J - Joint F - Fault	Type
	0.055	ASPHALTIC CONCRETE																			
	0.3	FILL/Clayey SAND: fine to medium, orange mottled brown, with fine to medium igneous gravel, moist, appears generally moderately compacted																A/E			PID = 0.4 ppm
	1.0	SANDSTONE: fine to medium grained, red-brown then pale grey, apparently very low and low to medium strength																A/E			PID = 0.3 ppm
	1.2	SANDSTONE: fine to medium grained, pale grey brown then red brown, thinly bedded with 20% clay seams, very low, low and medium strength, highly to moderately weathered, fractured, Hawkesbury Sandstone																			
	2																	C	85	35	PL(A) = 0.7
	3																				PL(A) = 0.2
	4																	C	100	98	PL(A) = 0.2
	4.3	SANDSTONE: fine to medium grained, brown then pale grey, thinly bedded with some cross bedding (5°-10°), medium strength, moderately weathered then fresh, slightly fractured and unbroken, Hawkesbury Sandstone																			PL(A) = 0.7
	5																				
	6																				PL(A) = 0.5
	7																	C	93	93	PL(A) = 0.5
	8																				PL(A) = 0.9
	8.47																				
	9																	C	97	94	PL(A) = 0.6

RIG: Hanjin DB8 **DRILLER:** BG Drilling - MW **LOGGED:** SI/KR **CASING:** HQ to 3.5m

TYPE OF BORING: Diatube to 0.055m, Solid flight augering (TC-bit) to 1.00m, NMLC coring to 16.50m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Well construction details: Blank pipe from 0.00-10.50m, Slotted pipe from 10.50-16.50m, Bentonite from 0.00-9.50m, Gravel from 9.50-16.50m, Gatic at surface

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

BOREHOLE LOG

CLIENT: Monte Sant' Angelo Mercy College
PROJECT: Monte Scientia Project
LOCATION: 128 Miller Street, North Sydney

SURFACE LEVEL: 73.0 AHD
EASTING: 334109.2
NORTHING: 6254576.2
DIP/AZIMUTH: 90°/-

BORE No: BH03
PROJECT No: 73019.03
DATE: 9/11/2019
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering					Graphic Log	Rock Strength					Water	Fracture Spacing (m)	Discontinuities		Sampling & In Situ Testing				
			EW	HW	MW	SW	FS		FR	Ex Low	Very Low	Low	Medium			High	Very High	Ex High	B - Bedding S - Shear	J - Joint F - Fault	Type	Core Rec. %
		SANDSTONE: as above																				
11	11.0	SANDSTONE: medium grained, brown grey then pale grey, massive then thinly bedded, medium to high then high strength, fresh, slightly fractured and unbroken, Hawkesbury Sandstone																C	97	94	PL(A) = 0.6	
	11.16																					PL(A) = 0.9
12																						PL(A) = 1
13																		C	100	99		
14																					PL(A) = 1.6	
14.3		SILTSTONE: pale grey and dark grey, with 20% fine grained sandstone laminations, 10% clay with quartz gravel, very low and low strength, slightly and highly weathered, slightly fractured, Hawkesbury Sandstone																				
14.55																		C	77	54	PL(A) = 0.2	
15	15.05	SANDSTONE: fine then medium grained, pale grey and grey, thinly laminated with 10% carbonaceous laminations, high strength, fresh, unbroken, Hawkesbury Sandstone																				
16																		C	100	100	PL(A) = 1.6	
16.5																					PL(A) = 1.3	
	16.5	Bore discontinued at 16.5m - Target Depth Reached																				
17																						
18																						
19																						

RIG: Hanjin DB8

DRILLER: BG Drilling - MW

LOGGED: SI/KR

CASING: HQ to 3.5m

TYPE OF BORING: Diatube to 0.055m, Solid flight augering (TC-bit) to 1.00m, NMLC coring to 16.50m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Well construction details: Blank pipe from 0.00-10.50m, Slotted pipe from 10.50-16.50m, Bentonite from 0.00-9.50m, Gravel from 9.50-16.50m, Gatic at surface

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	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)

BORE: 03

PROJECT: NORTH SYDNEY

NOVEMBER 2019



Douglas Partners
Geotechnics | Environment | Groundwater

Project No: 73019-03
BH ID: BH03
Depth: 1.00 - 5.00 m
Core Box No.: 1



73019-03 NORTH SYDNEY 9.11.19 BH03 START 1.00m



1.00 - 5.00m

BORE: 03

PROJECT: NORTH SYDNEY

NOVEMBER 2019



Douglas Partners
Geotechnics | Environment | Groundwater

Project No: 73019-03
BH ID: BH03
Depth: 5.00 - 10.00 m
Core Box No.: 2



5.00 - 10.00m

BORE: 03

PROJECT: NORTH SYDNEY

NOVEMBER 2019



Douglas Partners
Geotechnics | Environment | Groundwater

Project No: 73019-03

BH ID: BH03

Depth: 10.00 - 15.00 m

Core Box No.: 3



10.00 - 15.00m

BORE: 03

PROJECT: NORTH SYDNEY

NOVEMBER 2019



Douglas Partners
Geotechnics | Environment | Groundwater

Project No: 73019-03

BH ID: BH03

Depth: 15.00 - 16.45 m

Core Box No.: 4



15.00 - 16.45m

Appendix D

Laboratory Test Results

Material Test Report

Report Number: 73019.03-1
Issue Number: 1
Date Issued: 20/11/2019
Client: Bloompark Consulting Pty Ltd
Suite 2.04, North Sydney NSW 2060
Contact: Peter Brogan
Project Number: 73019.03
Project Name: Science and Sports Building Project
Project Location: 128 Miller Street, NORTH SYDNEY
Work Request: 5189
Sample Number: SY-5189A
Date Sampled: 09/11/2019
Dates Tested: 12/11/2019 - 14/11/2019
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Sample Location: BH2 (0.9-1.0m)
Material: Sandy CLAY: pale grey and slightly pink, fine grained sand



Lujia Wu

Approved Signatory: Lujia Wu
soil technician

NATA Accredited Laboratory Number: 828

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	33		
Plastic Limit (%)	15		
Plasticity Index (%)	18		
Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)	8.0		
Cracking Crumbling Curling	None		
Moisture Content (AS 1289 2.1.1)			
Moisture Content (%)		15.0	

CERTIFICATE OF ANALYSIS 230507

Client Details

Client	Douglas Partners Pty Ltd
Attention	Matthew Bennett
Address	96 Hermitage Rd, West Ryde, NSW, 2114

Sample Details

Your Reference	<u>73019.03, North Sydney</u>
Number of Samples	9 soil
Date samples received	11/11/2019
Date completed instructions received	11/11/2019

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	18/11/2019
Date of Issue	18/11/2019
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 *	

Asbestos Approved By

Analysed by Asbestos Approved Identifier: Aida Marner
 Authorised by Asbestos Approved Signatory: Lucy Zhu

Results Approved By

Diego Bigolin, Team Leader, Inorganics
 Josh Williams, Senior Chemist
 Loren Bardwell, Senior Chemist
 Lucy Zhu, Senior Asbestos Analyst
 Nick Sarlamis, Inorganics Supervisor
 Steven Luong, Organics Supervisor

Authorised By



Nancy Zhang, Laboratory Manager

Misc Inorg - Soil				
Our Reference		230507-2	230507-4	230507-9
Your Reference	UNITS	BH1/0.9-1.0	BH2/0.9-1.0	BH3/0.9-1.0
Depth		0.9-1.0	0.9-1.0	0.9-1.0
Date Sampled		09/11/2019	09/11/2019	09/11/2019
Type of sample		soil	soil	soil
Date prepared	-	13/11/2019	13/11/2019	13/11/2019
Date analysed	-	13/11/2019	13/11/2019	13/11/2019
pH 1:5 soil:water	pH Units	5.4	5.6	5.7
Electrical Conductivity 1:5 soil:water	µS/cm	79	28	31
Chloride, Cl 1:5 soil:water	mg/kg	<10	<10	10
Sulphate, SO4 1:5 soil:water	mg/kg	120	36	22