Geotechnical Investigation Report

Lot. 1805, No. 154, Trinity Point Drive, Morisset Park, NSW, 2264

Submitted To

Executive Building Group

No. 331, Windsor Road

Baulkham Hills

Document ID

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Date

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Author
Byron Lee

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Report Prepared By:

Mr Byron Lee

Geotechnical Engineer
B.Eng (Civil) Hons

Report Verified by:

Mr Nigel Wan

Associate Geotechnical Engineer
BEng (Civil) Hons, MIEAust CPEng NER, RPEQ 23378, RBP-EC PE0000420

Direct Contact

Any questions or queries regarding this report should be directed to the report author on 0477 177 562 or byron.lee@intrax.com.au.

Intrax Consulting Engineers Pty Ltd
ABN: 31 106 481 252

Head Office
Level 4, 469 Latrobe Street,
Melbourne, Vic 3000
p: 03 8371 0100 f: 03 8371 0199
w: www.intrax.com.au

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1 Introduction

Executive Building Group has engaged Intrax Consulting Engineers Pty Ltd (Intrax) to conduct a geotechnical investigation for the proposed development of a two-storey dwelling and potential basement at Lot. 1805, No. 154, Trinity Point Drive, Morisset Park, NSW, 2264.

The scope of work and terms and conditions of our engagement are set out in the Intrax-Client service agreement reference number QU1821595. Approval to proceed was given by Nathan Heta via email correspondence on 11/10/2023.

1.1 Project Description

Executive Building Group has not provided Intrax with layout drawings for review at this time. We understand that the development shall comprise of a new double storey dwelling and a potential basement with an approximate depth of 3.0 m.

The proposed foundation types, layouts or design loads have not been provided to Intrax for incorporation into this report. Intrax has assumed that there are no unusually high loads for this type of development.

1.2 Objectives and Scope

The objective of the investigation was to document ground and groundwater conditions in order to assess the founding conditions throughout the footprint of the proposed development.

The scope of work included:

- Preparation of health, safety and environmental documents
- Travel to site
- Drilling of three (3) boreholes to a maximum depth of 4.5 metres below ground level (mbgl)
- In-situ penetration testing
- Analysis and review of field geotechnical test information and the preparation of this report.

The objectives of this report are to:

- Present the findings of the geotechnical site investigation
- Develop a geotechnical ground and groundwater model of the site
- Classify the site reactivity in accordance with AS2870-2011
- Provide recommendations and design parameters for shallow and deep foundation systems
- Provide commentary on construction issues
- List any additional recommended geotechnical investigations or site inspections

1.3 Acknowledgement of Country

Our investigation is being carried out on the lands of the Kuring-gai people and we wish to acknowledge them as Traditional Owners. Intrax would also like to pay our respects to their Elders, past and present, and Aboriginal Elders of other communities.

2 Completed Investigations

2.1 Desktop assessment

A review of geological maps from the Geological Survey of New South Wales, aerial photography and a search of Intrax' internal project records were used to assess the anticipated site conditions prior to attending site and to aid in identification of the geological origin.

2.2 Field Investigations

The fieldwork was conducted on the 18th of October 2023, in accordance with the proposed scope of work.

The boreholes (BH01 – BH03) were drilled using a ute mounted Christie Engineering hydraulic drill rig using 100 mm solid flight auger drilling methods through soil. All boreholes were extended to a depth of 4.5 m. Dynamic Cone Penetrometer (DCP) tests were completed adjacent to BH01 & BH03.

Selected soil samples were retrieved from the substrata for laboratory testing. All test locations were backfilled using the generated spoil.

All materials were described in accordance with the visual and tactile method presented within AS1726 (2017): Geotechnical Site Investigation. Test positions were recorded using a hand-held GPS unit or mobile phone app, which typically report a horizontal accuracy of +/- 5 m. Relative vertical levels from hand-held GPS units are unreliable and are therefore not reported.

The test locations are shown on the site plan provided in Appendix A. Logs from the boreholes and an explanatory sheet outlining the terms and symbols used on the logs is presented in Appendix B.

3 Site Conditions

3.1 Site Description

The site is located at Lot. 1805, No. 154, Trinity Point Drive, Morisset Park, NSW, 2264 (-33.125850, 151.539770).

The site is located within a residentially developed greenfields area approximately 90km north of Sydney. At the time of the investigation, there was no existing building on site and the site is relatively level with no significant slope observed. Vegetation consisted of healthy long grass cover. Several semi-mature trees were noted along the nature strip at front of the lot. A sandstone block retaining wall was observed on the south-eastern boundary and had an approximate maximum height of 1.0 m. Lake Macquarie is situated approximately 40m south of the investigated lot. The site is bounded to the north by a residential dwelling and west by an empty lot. Bathers Way bounds the site from the east and Trinity Point Drive bounds it from the south.

Pertinent site features are visible in the site plan (refer to Appendix A) which is based on aerial imagery. Site conditions on the date of inspection are visible in the attached photographs in Appendix C.

3.2 Regional Geology

The surface geology underlying the site has been mapped by the Geological Survey of New South Wales. The digital seamless geological map for the area indicates that the surface geology is Munmorah Conglomerate. It typically comprises of conglomerate, pebbly sandstone and grey to green shale. An extract of the local geological map is provided below.

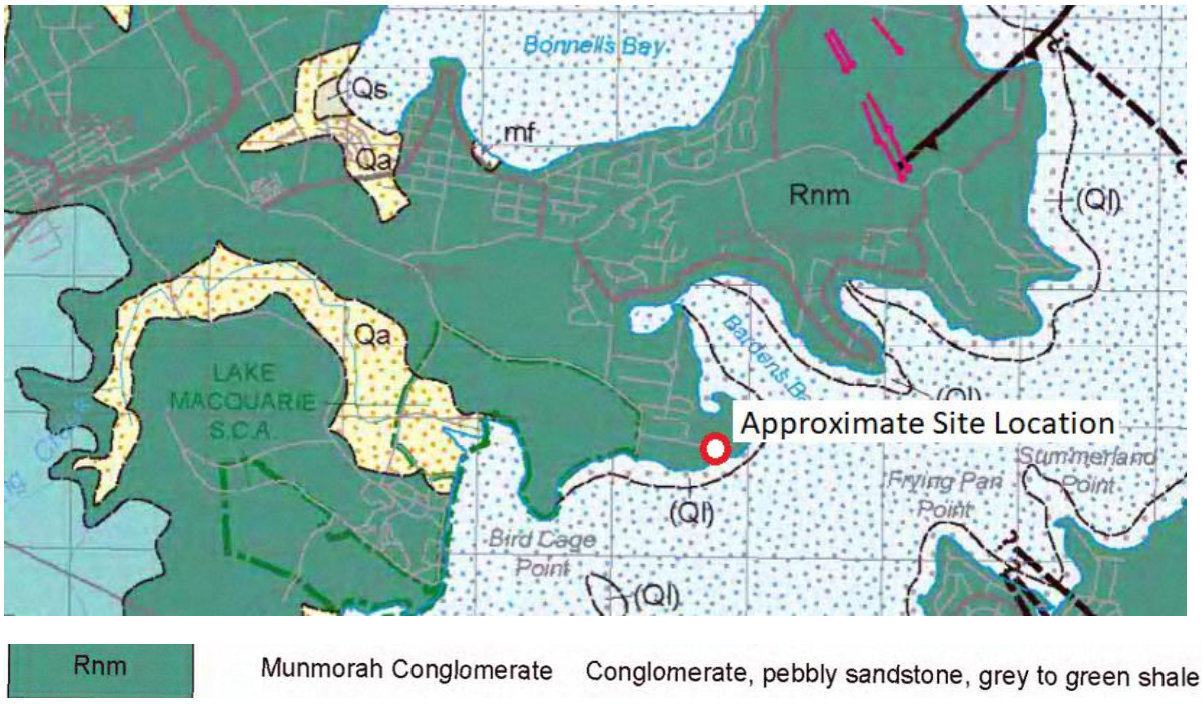


Figure 3-1: Extract of local geology, Geological Survey of New South Wales (Source: https://intrax.maps.arcgis.com/)

3.3 Subsurface Conditions

The geotechnical units encountered within the boreholes consisted of the following generalised materials.

Table 3-1: Geological units

Unit	Description, material, relative consistency. Extent of occurrence
Fill	FILL: TOPSOIL: SILT (ML): low plasticity, grey, trace root material, moist, wet of plastic limit, firm. Encountered in all boreholes from the surface to maximum depths of 0.3 m
	FILL: CLAY (CI): medium plasticity, mottled white grey red brown, with fine to coarse grained sand, moist, near plastic limit, firm. Encountered in BH03 from 0.1 m to 1.0 m.
Residual	CLAY (CI): medium plasticity, mottled grey red brown orange, moist, near plastic limit to wet of plastic limit, very stiff. Encountered in all boreholes at depths ranging from 0.1 m to 4.5 m.

Ground conditions encountered within the completed boreholes are interpreted to be generally consistent with the mapped surface geology and published information.

3.3.1 Ground Water

Groundwater was not encountered during borehole drilling.

It is noted that no groundwater monitoring well was installed during the site investigation program. Slow seepage through low permeability materials would not have been evident during the short period of time the borehole remained open during drilling activities.

Substrata conditions encountered are such that infiltration and occurrence of perched water at the interface between different material layers may occur. The implications of perched groundwater or the potential for perched water infiltration into open excavations should be considered during design and construction.

3.4 In-situ Test Results

Dynamic Cone Penetrometer (DCP) tests were conducted from the surface level, adjacent to BH01 & BH03. DCP test results are summarised in the table below which shows blows per 100 mm of penetration.

Table 3-2: DCP – Blows per 100 mm of penetration

Depth (m)	BH01	BH03
0 to 0.1	25	15
0.1 to 0.2	7	8
0.2 to 0.3	9	6
0.3 to 0.4	8	7
0.4 to 0.5	10	6
0.5 to 0.6	12	3
0.6 to 0.7	13	3
0.7 to 0.8	9	6
0.8 to 0.9	8	7
0.9 to 1.0	13	10
1.0 to 1.1	8	11
1.1 to 1.2	12	9
1.2 to 1.3	9	8
1.3 to 1.4	10	9
1.4 to 1.5	15	9

1.5 to 1.6	24	8
1.6 to 1.7	20/50 REF	9
1.7 to 1.8		7
1.8 to 1.9		8
1.9 to 2.0		8
2.0 to 2.1		13
2.1 to 2.2		18
2.2 to 2.3		18
2.3 to 2.4		20
2.4 to 2.5		21

Legend	
Fill - Topsoil - Silt	Fill - Clay
Clay	

Details of the DCP test results are provided on the borehole logs in Appendix B.

4 Site Classifications

4.1 Residential Slabs and Footings – AS 2870

It is noted that the AS2870 classification is strictly only applicable to Class 1 and 10a structures in accordance with the Building Code of Australia, generally referring to residential dwellings or other lightweight structures. Notwithstanding the above, the classification is a useful measure of site reactivity and can be considered in the design of numerous lightweight structures likely to be influenced by surface movements resulting from soil suction (moisture) changes. Intrax understands proposed development is a two-storey dwelling and potential basement and therefore falls within the scope of AS2870.

After considering the area geology, the soil profile encountered in the borehole, and the climatic zone of the area, this site has been classified as CLASS P with respect to Australian Standard 2870-2011 "Residential Slabs and Footings". The site is categorised as CLASS P due to the depth of existing uncontrolled fill on the site. It is anticipated that in the absence of the abnormal moisture conditions and fill material the seasonal surface movement would be in the order of 20 mm to 40 mm.

In accordance with Clause 2.5.2 of AS2870 (2011) where the site cut exceeds 500 mm, a second site investigation is recommended. As such;

- Where the cut depth exceeds the lesser of 0.25 x Hs or 0.5 m (but is less than 1 m) the relevant design engineer may choose to design for a reduced crack zone from first principles.
- Where the cut depth is more than 1.0 m, a secondary investigation is encouraged to confirm the effects of the cut on the site classification.

In assessing the classification for this site, unless specifically noted, this report has not considered any future tree(s) to be planted as part of either the site, adjacent sites, or roadside landscaping. If additional information regarding tree or groundwater content is known by the owner, future owner, any stakeholder, or any consultant, this information must be provided to the design engineer to ensure that the footing system is adequate for the conditions which are expected.

Should alternative or additional geotechnical investigation data covering the project site be available, Intrax should be provided with this documentation. It is a condition of this report that any information the client may have with regards to the site and its history be provided to Intrax for review. This may lead to Intrax amending the above classification and recommending additional geotechnical investigation.

5 Foundations

The proposed development is understood to comprise of a new double storey dwelling and a potential basement with an approximate depth of 3.0 m. Structural loading and building tolerance levels have not been provided to Intrax for assessment and incorporation into this report. Based on previous experience, it is anticipated that this development will comprise lightly loaded structures sensitive to ground movements which are typically supported by shallow footings at the basement level.

Based on the findings of the geotechnical investigation and assumed construction type, imposed loads and tolerance to movement, Intrax recommends all foundations extend into the natural very stiff clays.

5.1 Waffle and Raft Footings

It is recommended that the foundation system be designed by engineering principles. (AS 2870 - 2011 Cl 1.4). We recommend that the designing engineer refer to AS2870 - 2011 to ensure design compliance to this document, especially Sections 1.3 "Performance of Footing Systems" and "Design Considerations".

Due to the presence of uncontrolled fill at the surface of the site waffle or raft slabs shall be supported of piles which are founded into stronger underlying units. Refer to piling recommendations are provided in Section 5.3. Alternatively load bearing beams may be deepened where allowable bearing pressures provided in Section 5.2 for strip footings can be adopted for load bearing ribs.

Allowable bearing pressures provided in Section 5.2 for strip footings can be adopted for load bearing ribs beneath waffle/raft foundations.

5.2 Shallow Footings

Subject to design loads and settlement tolerances, pad and strip footings are considered a viable foundation system for the proposed development. It is recommended that any shallow footings are supported a minimum of 100 mm into the natural very stiff clay or underlying material. Allowable bearing capacities for pad and strip footings are presented within Table 5-1. Values presented assume a 300 mm wide strip footing and 600 mm square pad footing. Bearing capacities may be tailored to project specific foundation sizes by the design engineer through adoption of well-established shallow bearing capacity equations, e.g. Meyerhof or Terzaghi.

The founding level of pad footings shall be not less than 0.5 m below adjacent ground level to reduce the influence of shrink-swell movements. All foundations supported at or below zone of influence of adjacent structures (i.e. adjacent footings, service trenches & cuttings). The zone of influence can be determined the area rising upwards from the lowest edge of the structure towards the footing at a gradient of 30 degrees for non-cohesive materials (sands) and 45 degrees cohesive materials (clays).

Table 5-1: Allowable bearing capacities for shallow footings

Unit	Material Strength	Founding Depth[1] (mbgl)	Allowable Bearing Capacity[2] (kPa)	
			Strip	Pad
Fill-Topsoil-Silt	Firm	-	-	-
Fill-Clay	Firm	-	-	-
Clay	Very Stiff[3]	0.5	220	250
		1.0	250	270

[1]Indicative foundation depth, minimum required embedment into unit shall apply to soil profile at location of footing on the site, refer to borehole logs for location specific profiles

[2]Allowable bearing capacities should be reviewed and amended for eccentric loading, inclined loads or foundations supported on sloping ground.

[2]Fill depth extends deeper to 1.0m towards BH03 – south of the site. Over-excavation will be required at this area to ensure footings are founded a minimum 100mm into the natural very stiff clay.

Allowable bearing pressures presented are anticipated to result in settlement of less than 25 mm. Where detailed settlement predictions are required, modelling in appropriate stress-strain software such as PLAXIS should be conducted with the specific project loads and footing dimensions.

5.3 Piled Foundations

Piled foundations are a suitable solution to support the proposed structure. Intrax anticipates that bored piles may be adopted for this structure. Where alternative piling options are considered, Intrax should be contacted for commentary on their suitability and necessary design considerations.

Pile design and installation should be conducted in accordance with AS2159 (2009) Piling – Design and installation. AS2159-2009 requires that a geotechnical strength reduction factor (φ_g) be applied to the design ultimate geotechnical strength ($R_{d,ug}$) of the pile to provide the design geotechnical strength ($R_{d,g}$) of the pile. The $R_{d,g}$ should be less than the design action effect (E_d) on the pile.

Intrax recommend that a geotechnical strength reduction factor (φ_g) of 0.4 is adopted where no further assessments are undertaken. The design engineer may determine an alternative φ_g following the methodology of Section 4.3 of AS2159.

For estimation of the design ultimate geotechnical strength, the ultimate shaft resistance (Fs) and ultimate base resistance (Fb) are provided in the table below.

Table 5-2: Recommended ultimate pile resistance values (axial compression)

Unit	Material Strength	Ultimate Shaft Resistance (kPa)[1]	Ultimate Base Resistance (kPa)[2]
Fill-Topsoil-Silt	Firm	-	-
Fill-Clay	Firm	-	-
Clay	Very Stiff	45	1000

[1]Shaft resistance is an average over the layer

[2]Base resistance taken at the bottom of layer depth

In addition to the above, the following recommendations are made:

- The contribution of the uppermost soil profile shall be considered ineffective in providing geotechnical shaft resistance. The recommended ineffective depth is the larger of 1.125 m or 1.5D, where D is the pile diameter.
- Ultimate shaft friction values provided in the table above shall be reduced by a factor of 0.8 for determination of tensile capacity. The pile self-weight may be included in tension capacities. The tension capacity shall also be limited by the self-weight of cone pull-out. A pull-out angle of 30 degrees from vertical commencing at the base of the pile may be adopted for initial estimation.
- Engagement of shaft resistance requires mobilisation of the pile. It is anticipated that settlement shall be in the order of 1% of the pile diameter to mobilise full shaft friction.
- Ultimate base resistance values provided in the table above assume a minimum embedment of 3D in soil. It is recommended that the pile designer adopt these minimum embedment lengths.
- The values in the table above assume that pile shafts are clean (free from remoulded material) and that the pile base is clean (free of water, loose or softened material).

5.4 General Footing Considerations

Note that it is our preference for the design engineer to adopt the same founding material throughout the entire foundation. Where footings are founded in different materials, especially reactive soils and non-reactive materials

(sand/gravel/rock), the designer should provide articulation for the structure to avoid potential damages which could be caused by differential movements due to seasonal moisture variations in the reactive soils.

If there is any doubt as to the identification of materials and determination of the bearing capacity of the founding materials during footing excavation, Intrax should be contacted and an inspection of the founding conditions carried out.

5.5 Suitability for Potential Basement Construction

Based on the data from the geotechnical site investigation, we can conclude that the subject site is suitable for a basement to be constructed. This is due to the very stiff clay soil profile that extends to a depth of at least 4.5 m, which is suitably below the expected 3.0m basement excavation depth and no groundwater being encountered during the investigation. Depending on the extent of the basement to adjacent structures and critical infrastructures, appropriate retention system should be considered as part of the assessment.

Intrax should be contacted for information on suitable excavation and retention parameters if a basement is confirmed to be constructed on the investigated site.

6 Construction Considerations

6.1.1 Trafficability

Trafficability is anticipated to be sufficient while soil conditions remain dry, however following significant or sustained rainfall periods, trafficability may be restricted to tracked machinery only. To improve trafficability during wet periods, access roads can be created by stripping unsuitable materials (where present) and replacing with a coarse aggregate (non-descript crushed rock) or similar. If adverse weather precedes construction, a geotextile may be required prior to placement of the crushed rock to prevent soft spot development.

6.1.2 Inspections (Hold Points)

Intrax **must** be engaged in the following events for further clarification and advice:

1. Where soil conditions encountered differ significantly from those described within this report.
2. If project design is altered significantly from drawings reviewed and outlined or project described within this report

Intrax or a suitably experienced geotechnical consultant **should** be engaged at the following stages:

1. To confirm safe batter angles and excavation geometry during construction.
2. To confirm founding materials and allowable bearing pressures.

7 References

AS 1726. (2017). Geotechnical site investigations. Sydney: Standards Australia, Retrieved from SAI Global.

AS 2159. (2009). Piling-Design and Installation. Sydney: Standards Australia, Retrieved from SAI Global.

AS 2870. (2011). Residential slabs and footings. Sydney: Standards Australia, Retrieved from SAI Global.

AS 3600. (2009). Concrete structures. Sydney: Standards Australia, Retrieved from SAI Global.

AS 3798. (2007). Guidelines on earthworks for commercial and residential developments. Sydney: Standards Australia, Retrieved from SAI Global.

AS 4678. (2002). Earth retaining structures. Sydney: Standards Australia, Retrieved from SAI Global.

Bowles, J. (1997). *Foundation Analysis and Design* (Fifth Edition ed.). McGraw-Hill.

Nearmap. (n.d.). *Nearmap*. Retrieved 2023, from nearmap.com/au

8 Limitations of Report

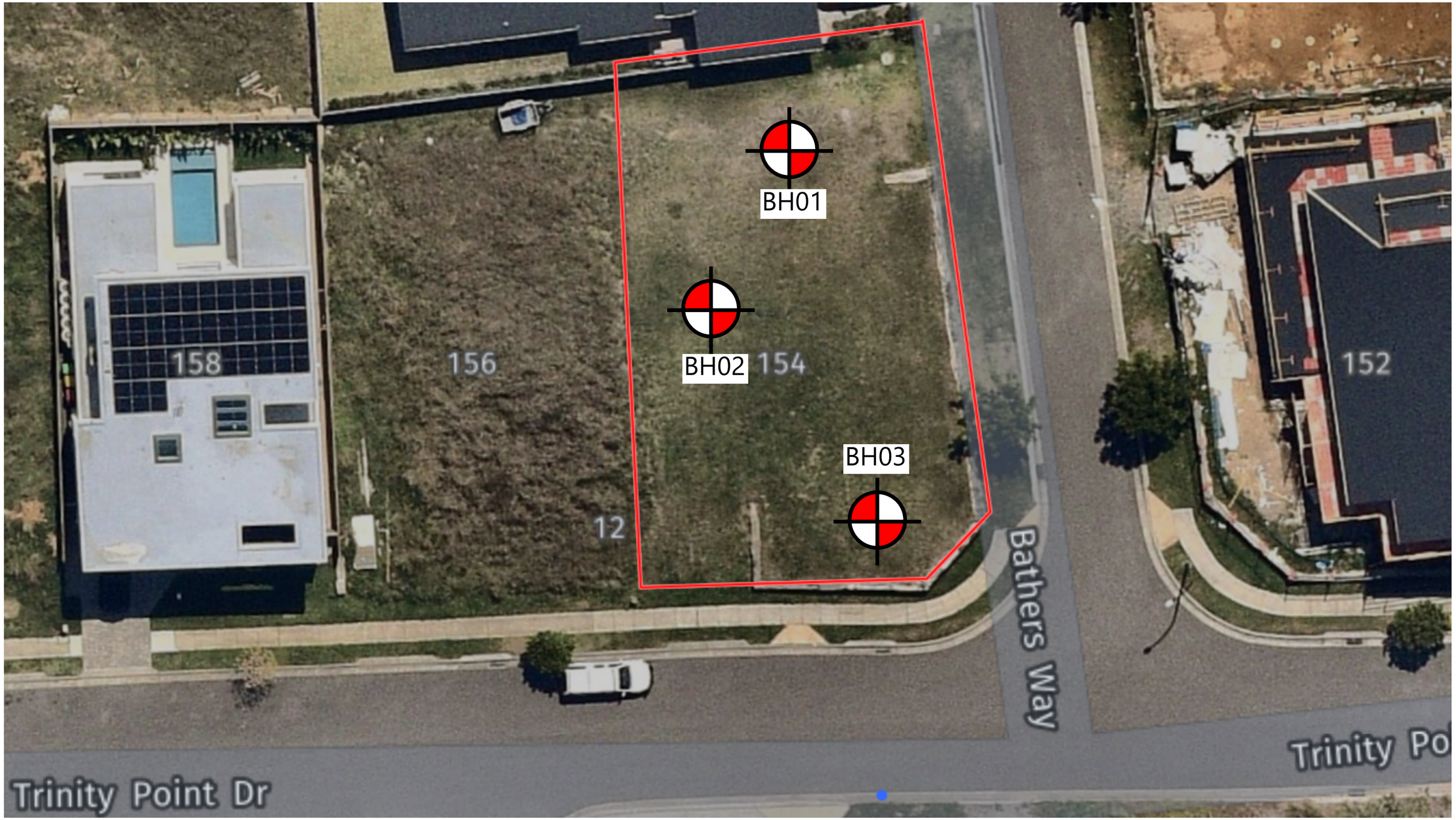
1. The recommendations in this report are based on the following:
    a. Information about the site & its history, proposed site treatment and building type conveyed to us by the client and or their agent.
    b. Professional judgements and opinions using the most recent information in soil testing practice that is available to us.
    c. The location of our test sites and the information gained from this and other investigations.

    Should the client or their agent neglect to supply us with correct or relevant information, including information about previous buildings, trees or past activities on the site, or should changes be made to the building type, size and or/position, this report may be made obsolete, irrelevant or unsuitable. In such cases, Intrax will not accept any liability for the consequences and Intrax reserves the right to make an additional charge if more testing or a change to the report is necessary.
2. The recommendations made in this report may need to be reviewed should any site works disturb any soil below the proposed founding depth.
3. The descriptions of the soils encountered in the boreholes follow those outlined in AS1726-2017; Geotechnical Site Investigations. Colour descriptions can vary with soil moisture content and individual interpretation.
4. If the site conditions at the time of construction differ from those described in this report, then Intrax must be contacted so a site inspection can be carried out prior to any footing being poured. The owner/builder will be responsible for any fees associated with this additional work.
5. This report assumes that the soil profile(s) observed in the boreholes are representative of the entire site. If the soil profile and site conditions appear to differ substantially from those reported herein, then Intrax should be contacted immediately and this report may need to be reviewed and amended where appropriate. The owner/builder will be responsible for any fees associated with this additional work.
6. The user of this report must consider the following limitations. Soil and drilling depths are given to a tolerance reflective of the drilling methodology. Lower levels of accuracy are possible from wash boring or solid flight auger then is achievable from geoprobe sampling or diamond coring.

    It must be understood and a condition of acceptance of this report is that whilst every effort is made to identify fill material across the site, difficulties exist in determining fill material for example, well compacted site won or area derived fill, especially when utilising a small diameter auger. Consequently, Intrax emphasises that we will not be responsible for any financial losses, consequential or otherwise, that may occur as a result of not accurately determining the fill profile across the site.
7. Finally, no responsibility will be taken for this report if it is altered in any way or is not reproduced in full.

Appendix A

Site Plan



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Intrax LAND
E: info@intrax.com.au
P: 1300 INTRAX
ABN 31 106 481 252
www.intrax.com.au

TITLE: Site Plan	DRAWN: BL	PAGE SIZE: A3
	CHECKED: NW	SITE NO.: 213821
CLIENT: Executive Building Group	SCALE: N.T.S	DOC ID: 213821-PRJ1064548-GEO-DWG-01
	DATE: 27/10/2023	VERSION: 0

Appendix B

Borehole Log(s) and Explanatory Notes

Intrax Consulting
Level 4, 469 La Trobe Street, Melbourne 3000
Phone: 61 3 8371 0100

Geotechnical Log - Borehole

BH01

UTM	: 56H	Drill Rig	: SC Ute rig	Job Number	: 213821-PRJ1064548
Easting (m)	: 363780.63	Driller Supplier	: Intrax Consulting Engineers Pty Ltd	Client	: Executive Building Group
Northing (m)	: 6333824.77	Logged By	: MI	Project	: Feasibility Investigation
Ground Elevation	: Not Surveyed	Reviewed By	: BL	Location	: Lot. 1805, No. 154, Trinity Point Drive, Morisset Park, NSW, 2264
Total Depth	: 4.5 m BGL	Date	: 18/10/2023	Loc Comment	:

Drilling Method	Penetration Resistance	Water	Depth (m)	Samples	Testing	DCP graph	Graphic Log	Classification Code	Material Description	Moisture	Consistency/Density	Soil Origin	Remarks
AD/T			0.2			25 7		ML	FILL- SILT (ML) : low plasticity, grey.	w > PL	F	Fill	
			1			9 8 10 12 13 9 8 13 8 12 9 10 15		CI	CLAY (CI) : medium plasticity, mottled grey red brown orange.	w ≈ PL	VSt	Residual	
			1.5			24 20/50m		CI	CLAY (CI) : medium plasticity, mottled grey red brown.	w > PL			
			2										
			3										
			3.8					CI	CLAY (CI) : medium plasticity, mottled grey red brown.	w ≈ PL			
			4						**BH01 Terminated at 4.5 m (Target Depth)**				

Intrax Consulting
Level 4, 469 La Trobe Street, Melbourne 3000
Phone: 61 3 8371 0100

Geotechnical Log - Borehole

BH02

UTM	: 56H	**Drill Rig**	: SC Ute rig	**Job Number**	: 213821-PRJ1064548
Easting (m)	: 363775.66	**Driller Supplier**	: Intrax Consulting Engineers Pty Ltd	**Client**	: Executive Building Group
Northing (m)	: 6333811.72	**Logged By**	: MI	**Project**	: Feasibility Investigation
Ground Elevation	: Not Surveyed	**Reviewed By**	: BL	**Location**	: Lot. 1805, No. 154, Trinity Point Drive, Morisset Park, NSW, 2264
Total Depth	: 4.5 m BGL	**Date**	: 18/10/2023	**Loc Comment**	:

Drilling Method	Penetration Resistance	Water	Depth (m)	Samples	Testing	DCP graph	Graphic Log	Classification Code	Material Description	Moisture	Consistency/Density	Soil Origin	Remarks
AD/T			0.3					ML	FILL- SILT (ML) : low plasticity, grey.	w > PL	F	Fill	
			1					CI	CLAY (CI) : medium plasticity, grey red brown orange.	w < PL	VSt	Residual	
			2					CI	CLAY (CI) : medium plasticity, mottled grey red brown orange.	w ≈ PL			
			2.5					CI	CLAY (CI) : medium plasticity, mottled grey red brown.	w > PL			
			3										
			3.5					CI	CLAY (CI) : medium plasticity, mottled grey red brown.	w ≈ PL			
			4						**BH02 Terminated at 4.5 m (Target Depth)**				

This report must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

Intrax Consulting
Level 4, 469 La Trobe Street, Melbourne 3000
Phone: 61 3 8371 0100

Geotechnical Log - Borehole

BH03

UTM	: 56H	**Drill Rig**	: SC Ute rig	**Job Number**	: 213821-PRJ1064548
Easting (m)	: 363785.69	**Driller Supplier**	: Intrax Consulting Engineers Pty Ltd	**Client**	: Executive Building Group
Northing (m)	: 6333802.99	**Logged By**	: MI	**Project**	: Feasibility Investigation
Ground Elevation	: Not Surveyed	**Reviewed By**	: BL	**Location**	: Lot. 1805, No. 154, Trinity Point Drive, Morisset Park, NSW, 2264
Total Depth	: 4.5 m BGL	**Date**	: 18/10/2023	**Loc Comment**	:

Drilling Method	Penetration Resistance	Water	Depth (m)	Samples	Testing	DCP graph	Graphic Log	Classification Code	Material Description	Moisture	Consistency/Density	Soil Origin	Remarks
AD/T			0.1			15		ML	FILL- SILT (ML) : low plasticity, grey.	w > PL	F	Fill	
						8		CI	FILL- CLAY (CI) : medium plasticity, mottled white grey red brown, with fine to coarse grained sand.	w ≈ PL			
						6							
						7							
						6							
						3							
						3							
						6							
						7							
			1			10							
			1			11		CI	CLAY (CI) : medium plasticity, mottled grey red brown orange.		VSt	Residual	
						9							
						8							
						9							
			1.5			9							
						8		CI	CLAY (CI) : medium plasticity, mottled grey red brown.	w > PL			
						9							
						7							
						8							
			2			8							
						13							
						18							
						18							
						20							
			2.5			21							
								CI	CLAY (CI) : medium plasticity, mottled grey red brown.	w ≈ PL			
			3										
			4						**BH03 Terminated at 4.5 m (Target Depth)**				

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EXPLANATORY NOTES AND ABBREVIATIONS

The following presents a depiction and explanation of terms adopted by Intrax Land in geotechnical borehole logs, test pits and other soil and rock descriptions. Soil and rock descriptions are in accordance with Australian Standard 1726-2017, Geotechnical Site Investigations.

Investigation methods, sampling, testing & groundwater

Drilling Method	
AD/V	Auger drilling with V bit
AD/T	Auger drilling with TC-Bit
DPT	Direct push tube
HA	Hand auger
WB	Wash boring
HOA	Hollow auger
AH	Air Hammer
SPT	Standard Penetration Test
NQ	Diamond Core – 47mm
NMLC	Diamond Core – 52mm
HQ	Diamond Core – 63mm
PQ	Diamond Core – 81mm
SO	Sonic drilling
NDD	Non-destructive digging
EX	Excavator bucket
BH	Backhoe bucket
EE	Existing Excavation

Groundwater & Support	
▼	Standing water level at date shown
►	Water inflow
◄	Water loss
GROUNDWATER NOT OBSERVED	Observation of groundwater, whether present or not, was not possible due to drilling water, seepage or cave in
GROUNDWATER NOT ENCOUNTERED	Borehole was dry soon after excavation, however, no well was installed to monitor seepage from low permeability materials
C	Casing
M	Mud

Field Sampling & Testing	
W	Water Sample
D	Disturbed Sample
B	Bulk Disturbed Sample
U50 / U63	Undisturbed Tube Sample (50/63mm diameter tube)
E	Environmental Sample
PP	Pocket Penetrometer Test (kPa)
FV	Field Shear Vane (kPa)
CPT	Static cone penetration test
CPTu	Static cone penetration test with pore pressure measurement
DCP	**Dynamic Cone Penetrometer (blows / 100mm)**
R	DCP refusal condition 20 blows with less than 100mm penetration
SPT	**Standard penetration Test**
5, 8, 22	SPT blow counts (150mm increments)
N = 30	SPT N count (blows for final 300mm)
30/100mm	Refused test with partial penetration
R	SPT refusal conditions. 30 blows with less than 100mm penetration or 5 blows with hammer bounce or no measurable movement
RW	Rod Weight only causing penetration (SPT N < I)
HW	Hammer and rod weight only causing full penetration (N < I)
HB	Hammer Bouncing

Core Recovery Measurements		Definition
TCR	Total Core Recovery (%)	$\frac{Lenth\ of\ core\ recovered}{Length\ of\ core\ run} \times 100$
SCR	Solid Core Recovery* (%)	$\frac{\sum Lenth\ of\ cylindrical\ core\ recovered}{Length\ of\ core\ run} \times 100$
RQD	Rock Quality Designation* (%)	$\frac{\sum Length\ of\ sound\ core\ pieces > 100\ mm\ length}{Length\ of\ core\ run} \times 100$

*Only natural breaks considered, mechanical breaks shall be ignored, and core shall be marked with chalk

Penetration / Excavation Resistance

Symbol	Term	Description
L	Low resistance	Rapid penetration with little effort from equipment used
M	Medium resistance	Penetration progresses at normally accepted rate with moderate effort from equipment
H	High resistance	Penetration rate is slow and requires significant effort from equipment
R	Practical Refusal	Further progress is not practical without damage or unacceptable wear to the equipment

SOIL DESCIPTION

Soil classification symbols

Classification Symbol	Typical Soil Name
GW	Well graded gravels, sand-gravel mixtures – little or no fines
GP	Poorly graded gravels, sand-gravel mixtures – little or no fines, uniform gravels
GM	Silty gravels, gravel-sand-silt mixtures
GC	Clayey gravels, gravel-sand-clay mixtures
ML	Inorganic silts of low plasticity
MH	Inorganic silts of high plasticity
OL	Organic silts of low plasticity
OH	Organic clay of medium to high plasticity

Classification Symbol	Typical Soil Name
SW	Well graded sands, gravel-sand mixtures – little or no fines
SP	Poorly graded sands, gravel-sand mixtures – little or no fines, uniform sands
SM	Silty sands, sand-silt mixtures
SC	Clayey sands, sand-clay mixtures
CL	Inorganic clay of low plasticity
CI	Inorganic clay of medium plasticity
CH	Inorganic clay of high plasticity
Pt	Peat – highly organic material

Dual classification (SP-SM, GP-GC) may be adopted for coarse grained soils with fines contents between 5% and 12%

Particle size distributions and material components

Particle Size Divisions			
Group	**Name**	**Division**	**Size (mm)**
Coarse	BOULDERS		> 200
	COBBLES		63 to 200
	GRAVEL	coarse	19 to 63
		medium	6.7 to 19
		fine	2.36 to 6.7
	SAND	coarse	0.6 to 2.36
		medium	0.21 to 0.6
		fine	0.075 to 0.21
Fine	SILT		0.002 to 0.075
	CLAY		< 0.002

Minor and Secondary Components			
Fine Grained Minor Component		**Coarse Grained Minor Component**	
≤5%	Trace clay/silt	≤15%	Trace sand/gravel
>5%, ≤12%	With clay/silt	>15%, ≤30%	With sand/gravel
>12%	Prefix 'Silty' or 'Clayey'	>30%	Prefix 'Sandy' or 'Gravelly'

Plasticity

Descriptive Term	Range of liquid limit or silt	Range of liquid limit for clay
Low	≤50	≤35
Medium	Not Applicable	>35 and ≤50
High	>50	>50

Moisture Condition

Fine grain soils		Coarse grain soils	
w < PL	Moist, dry of plastic limit	D	Dry, non-cohesive and free running
w ≈ PL	Moist, near plastic limit	M	Moist, soil feels cool tends to stick together
w > PL	Moist, wet of plastic limit	W	Wet, soil feel cool, free water forms when handling
w ≈ LL	Wet, near liquid limit		
w > LL	Wet, wet of liquid limit		

Consistency of cohesive soils

Abbreviation	Term	Undrained Shear Strength (kPa)	Indicative SPT N*	Indicative DCP per 100mm*	Pocket Penetrometer	Visual Assessment
VS	Very Soft	≤ 12	0 to 2	0 to 1	25	Exudes between the fingers when squeezed in hand
S	Soft	>12 to ≤25	2 to 4	1 to 2	25 to 50	Can be moulded by light finger pressure
F	Firm	>25 to ≤50	4 to 8	2 to 3	50 to 100	Can be moulded by strong finger pressure
St	Stiff	>50 to ≤100	8 to 15	3 to 5	100 to 200	Cannot be moulded by fingers
VSt	Very Stiff	>100 to ≤200	15 to 30	5 to 10	200 to 400	Can be indented by thumb nail
H	Hard	> 200	> 30	> 10	> 400	Can be indented with difficulty with thumb nail
Fr	Friable	-	-	-	-	Can be easily crumbled or broken into small pieces by hand

*Indicative correlations, accuracy will vary with soil type, testing equipment and groundwater conditions. Site specific correlations developed with more accurate testing methods would take precedence over the above relationships.

Relative density of non-cohesive soils

Abbreviation	Term	Density Index (%)	Indicative SPT (N) blows per 300mm	Approximate DCP per 100mm	Approximate PSP per 100mm
VL	Very Loose	0 to ≤15	0 to 4	0 to 1	0 to 2
L	Loose	>15 to ≤35	4 to 10	1 to 3	2 to 6
MD	Medium Dense	>35 to ≤65	10 to 30	3 to 8	6 to 8
D	Dense	>65 to ≤85	30 to 50	8 to 15	8 to 15
VD	Very Dense	> 85	> 50	> 15	> 15

Relative density is typically only provided where testing is conducted, where testing is not conducted the relative density shall be noted as inferred by use of an asterisk (*) symbol

ROCK DESCIPTION

Rock weathering

Abbreviation		Term		Definition
RS		Residual Soil		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.
XW		Extremely Weathered		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.
HW	DW	Highly Weathered	Distinctly Weathered	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 recognizable. 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.
MW		Moderately Weathered		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.
SW		Slightly Weathered		Rock is partially discoloured with staining or bleaching along joints but shows little or no change of strength from fresh rock.
FR		Fresh		Rock shows no sign of decomposition of individual minerals or colour changes.

Residual soil and extremely weathered materials are to be described using soil descriptions

Rock strength

Symbol	Term	UCS* (MPa)	Is50* (MPa)	Field Assessment
VL	Very Low Strength	0.6 to 2	0.03 to 0.1	Material crumbles under firm blows with sharp end of pick; can be peeled with knife; too hard to cut a triaxial sample by hand. Pieces up to 30 mm thick can be broken by finger pressure.
L	Low Strength	2 to 6	0.1 to 0.3	Easily scored with a knife; indentations 1 mm to 3 mm show in the specimen with firm blows of the pick point; has dull sound under hammer. A piece of core 150 mm long by 50 mm diameter may be broken by hand. Sharp edges of core may be friable and break during handling.
M	Medium Strength	6 to 20	0.3 to 1	Readily scored with a knife; a piece of core 150 mm long by 50 mm diameter can be broken by hand with difficulty.
H	High Strength	20 to 60	1 to 3	A piece of core 150 mm long by 50 mm diameter cannot be broken by hand but can be broken by a pick with a single firm blow; rock rings under hammer.
VH	Very High Strength	60 to 200	3 to 10	Hand specimen breaks with pick after more than one blow; rock rings under hammer.
EH	Extremely High Strength	> 200	> 10	Specimen requires many blows with geological pick to break through intact material; rock rings under hammer.

Material with strength less than 'Very Low' shall be described using soil characteristics.

*Point load test values are provided a guide, however UCS strengths take precedence, and no correlation between the two measurements should be interpreted from the above

Defect type

Abbr.	Type	Definition	Diagram
P	Parting	A surface or crack across which the rock has little or no tensile strength. Parallel or sub-parallel to layering (e.g. bedding) or a planar anisotropy in the rock material (e.g. cleavage). May be open or closed.	
JT	Joint	A surface or crack with no apparent shear displacement and across which the rock has little or no tensile strength, but which is not parallel or sub-parallel to layering or to planar anisotropy in the rock material. May be open or closed.	
SF	Sheared Surface (fault)	A near planar, curved or undulating surface which is usually smooth, polished or slickensided and which shows evidence of shear displacement.	
SZ	Sheared Zone (fault)	Zone of rock material with roughly parallel near planar, curved or undulating boundaries cut by closely spaced joints, sheared surfaces or other defects. Some of the defects are usually curved and intersect to divide the mass into lenticular or wedge-shaped blocks.	
SS	Sheared Seam (fault)	Seam of soil material with roughly parallel almost planar boundaries, composed of soil materials with roughly parallel near planar, curved or undulating boundaries cut by closely spaced joints, sheared surfaces or other defects. Some of the defects are usually curved and intersect to divide the mass into lenticular or wedge-shaped blocks.	
CS	Crushed Seam (fault)	Seam of soil material with roughly parallel almost planar boundaries, composed of disoriented, usually angular fragments of the host rock material which may be more weathered than the host rock. The seam has soil properties.	
IS	Infilled Seam	Seam of soil material usually with distinct roughly parallel boundaries formed by the migration of soil into an open cavity or joint, infilled seams less than 1 mm thick may be described as a veneer or coating on a joint surface.	
XS	Extremely Weathered Seam	Seam of soil material, often with gradational boundaries. Formed by weathering of the rock material in place.	
FZ	Fractured Zone	Heavily fractured section of containing large number of defects	

Defect type

Surface Roughness		Surface Shape		Coating / Infill	
VR	Very Rough	ST	Stepped	CN	Clean
RO	Rough	CU	Curved	SN	Stained
SM	Smooth	UN	Undulating	VN	Veneer
PO	Polished	IR	Irregular	CT	Coating
SL	Slickensided	PL	Planar	Infill described separately	

Appendix C

Site Photography

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