



RESIDENTIAL DEVELOPMENT
4 DELMAR PARADE & 812 PITTWATER ROAD,
DEE WHY NSW

Prepared for:

LANDMARK GROUP AUSTRALIA PTY LTD

Reference: P3018_01 rev3

2 May 2024

1 PROJECT BACKGROUND

Morrow Geotechnics Pty Ltd has undertaken a Geotechnical Investigation to provide geotechnical advice and recommendations for the proposed development at 4 Delmar Parade & 812 Pittwater Road, Macquarie Park NSW (the site). At the time of producing this report DA2022/0145 was active with a modification 2024/0083 being assessed.

The following reports have been previously prepared for the site:

- AssettGeoEnviro, *Proposed Mixed-use Development, 4 Delmar Parade & 812 Pittwater Road, Dee Why, NSW*; ref 6561-G1 and dated 25 November 2021 (AGE 2021);
- Reditus Consulting Pty Ltd, *Preliminary Site Investigation, 4 Delmar Parade & 812 Pittwater Road, Dee Why*; project number 21181, version 2 and dated 1 December 2021 (RC 2021);
- Geosyntec Consultants Pty Ltd, *Detailed Site Investigation, 4 Delmar Parade & 812 Pittwater Road, Dee Why*; project number 21325 and dated 4 May 2022 (GC 2022); and
- Reditus Consulting Pty Ltd, *Dewatering Management Plan, 4 Delmar Parade & 812 Pittwater Road, Dee Why*; report number 21181RP01, version 1 and dated 7 June 2022 (RC 2022).
- Morrow Geotechnics Pty Ltd, *Site Hydrogeology Report, 4 Delmar Parade & 812 Pittwater Road, Dee Why NSW*, referenced P3018_07 rev1, and dated 2 May 2024 (MG 2024-1).
- Morrow Geotechnics Pty Ltd, *Dewatering Management Plan, 4 Delmar Parade & 812 Pittwater Road, Dee Why NSW*, referenced P3018_08 rev1, and dated 2 May 2024 (MG 2024-2).

Architectural drawings for the proposed development have been prepared by Rothe Lowman Property Pty Ltd, Project Number 221054 and dated 16 January 2024. From the drawings provided, Morrow Geotechnics understands that the proposed development involves construction of multi-storey apartment building over a two to three level basement carpark. Morrow understands the development involves excavation to a maximum depth of extends to RL 13.7 to 18.095 mAHD across the eastern half of the site and to RL 21.25 mAHD at the south-western corner of the site.

1.1 Investigation Intent

The purpose of the investigation is to provide geotechnical advice and recommendations for structural design. These recommendations include:

- Building foundation options, including design parameters;
- Excavation support options, including lateral earth pressures and pile design parameters;
- Lot classification in accordance with AS2870;
- Earthquake site classification in accordance with AS1170.4; and
- Advice on geotechnical construction constraints.

1.2 Published Geological Map

The Department of Mineral Resources Geological Map Sydney 1:100,000 Geological Series Sheet 9029-9130 (DMR 1985) indicates the site to be underlain by Hawkesbury Sandstone, which comprises medium to coarse grained quartz sandstone.

1.3 Published Soil Landscapes

The Soil Conservation Service of NSW Sydney 1:100,000 Soil Landscapes Series Sheet 9130 indicates that the residual landscape at the site is located on the boundary of the Gynea and Newport Landscapes.

The Gynea landscape type typically includes undulating to rolling rises and low hills on Hawkesbury Sandstone. Soils are generally shallow to moderately deep (0.3 – 1 m) yellow earths and earthy sands. These soils are noted to present localized steep slopes, high soil erosion hazard, rock outcrop and shallow highly permeable soil.

The Newport landscape type typically includes gently undulating plains of Holocene sands to rolling rises over other soils or bedrock. Soils are generally shallow (< 0.5 m) siliceous sands overlaying moderately deep buried sands (< 1.5m) yellow podzolic soil with sandy topsoil on crests and deep (> 2.0m) podzols in depressions earthy sands. These soils are noted present high soil erosion hazards, localized steep slopes, very low soil fertility and non-cohesive topsoil.

2 OBSERVATIONS

2.1 Investigation Methods

Fieldwork was undertaken by Morrow Geotechnics on 29 & 30 August and 1, 2, 3 & 8 November 2023. Work carried out as part of this investigation includes:

- Review of publicly available information from previous reports in the project area, published geological and soil mapping and government agency websites;
- Site walkover inspection by an experienced Engineering Geologist to assess topographical features, condition of surrounding structures and site conditions;
- Drilling of five boreholes (BH101, BH102, BH103, BH104 and BH105). Boreholes BH101, BH102 and BH105 were drilled using solid flight augers equipped with a tungsten-carbide bit (TC bit), BH103 was drilled using washboring techniques and BH104 was drilled using a tight access man portable rig. The boreholes were extended beyond TC bit refusal by NMLC coring techniques to depths of between 12.99 and 22.22 metres below ground level (mBGL). Rock core was boxed and photographed, and point load tests were undertaken on selected core sample to assess rock strength;
- Groundwater observations within boreholes during drilling; and
- Installation of four groundwater monitoring wells W1, W2, W3 and W4 to the full depth of borehole within BH101, BH102, BH103 and BH104 immediately following drilling.

Borehole locations are shown on **Figure 1** and borehole logs are presented in **Appendix A**.

2.2 Subsurface Conditions

The stratigraphy at the site is characterized by topsoil and fill overlying alluvial sands, residual clay, sandstone and shale bedrock. Observations taken during the investigation have been used to produce a stratigraphic model of the site. The observed stratigraphy has been divided into seven geotechnical units.

An approximately 2 m thick shale band was intersected across the site between approximate RLs 24 and RL 22 in BH102, RLs 18 and 16 mAHD in BH103 and RLs 16 and 18 in BH104. This shale band can be expected to be encountered at bulk excavation level (BEL) in some areas of the site and within the sockets/toe of some piles.

A summary of the subsurface conditions across the site, interpreted from the investigation results, are presented in **Table 1** and **Table 2**. More detailed descriptions of subsurface conditions at the test locations are available in the borehole logs presented in **Appendix A**. The details of the method of soil and rock

classification, explanatory notes and abbreviations adopted in the borehole logs are also presented in Appendix A.

TABLE 1 SUMMARY OF INFERRED SUBSURFACE CONDITIONS

Unit	Material	Comments
1	Fill	Generally a concrete slab overlying gravely SAND, loose and moist.
2	Alluvial Soil	Alluvial SAND and Sandy CLAY, loose to dense and stiff to very stiff, low to medium plasticity, fine to medium grained with medium sized iron stone and quartz gravels.
3	Residual Soil	Residual sandy to gravelly CLAY, stiff to very stiff grading to hard, medium plasticity, fine to medium grained with medium sized iron stone and sandstone gravels and extremely weathered sandstone bands.
4	Class V and IV Sandstone	Extremely to highly weathered SANDSTONE, very low to low strength, medium grained. Defects within unit 4 are generally horizontally orientated bedding partings with infrequent joints inclined at 10 to 60°.
5	Class III Sandstone	Moderate to slightly weathered SANDSTONE, medium to high strength, medium grained. Defects within unit 5 are generally horizontally orientated bedding partings with infrequent joints inclined at 10 to 60°.
6	Class V Shale	SHALE, SILTSTONE and LAMINITE, extremely to moderately weathered, very low to low strength. Defects within Unit 6 are generally horizontally oriented bedding partings, joints inclined to 45° and clay seams.
7	Class III Shale	SHALE, moderately to slightly weathered, medium to high strength. Defects within Unit 7 are generally horizontally oriented bedding partings, joints inclined to 45°. Defect Spacing >200mm.

TABLE 2 ENCOUNTERED GEOTECHNICAL CONDITIONS

	Approx. Depth Range of Unit 1 mBGL (RL mAHD)						
	Unit 1 Fill	Unit 2 Alluvial Soil	Unit 3 Residual Soil	Unit 4 Class V/IV Sandstone	Unit 5 Class III Sandstone	Unit 6 Class V Shale	Unit 7 Class III Shale
BH1/CPT1* (AGE21)	0.0 to 1.0 (28.9 to 27.9)	1.0 to 3.5 (27.9 to 25.4)	3.5 to 6.0 (25.4 to 23.9)	6.0 to 8.93 (23.9 to 20.97)	8.93 to 13.9+ (20.97 to 4.97+)	- -	- -
BH2* (AGE21)	0.0 to 1.6 (29.25 to 27.65)	- -	1.6 to 3.7 (27.65 to 25.55)	3.7 to 5.63 & 6.6 to 8.4 (25.55 to 23.62 & 22.65 to 20.85)	8.4 to 13.95+ (20.85 to 15.3+)	5.63 to 6.6 (23.62 to 22.65)	- -
BH3/CPT4* (AGE21)	0.0 to 0.5 (30.0 to 29.5)	- -	- -	0.5 to 6.36 & 7.09 to 7.7 (29.5 to 23.64 & 22.91 to 22.3)	7.7 to 14.2+ (22.3 to 15.8+)	- -	6.36 to 7.09 (23.64 to 22.91)
BH4* (AGE21)	0.0 to 0.5 (31.92 to 31.42)	- -	- -	0.5 to 6.0 & 9.12 to 14.55+ (31.42 to 25.92 & 22.8 to 17.37+)	6.0 to 7.46 (25.92 to 18.46)	7.46 to 9.12 (18.46 to 22.8)	- -
BH5* (AGE21)	0.0 to 0.2 (32.66 to 32.44)	- -	- -	0.2 to 2.95 (32.44 to 29.71)	2.95 to 8.61 & 9.81 to 15.0+ (29.71 to 24.05 & 22.85 to 17.66+)	8.61 to 9.81 (24.05 to 22.85)	- -

Approx. Depth Range of Unit 1 mBGL (RL mAHD)							
	Unit 1 Fill	Unit 2 Alluvial Soil	Unit 3 Residual Soil	Unit 4 Class V/IV Sandstone	Unit 5 Class III Sandstone	Unit 6 Class V Shale	Unit 7 Class III Shale
BH6/CPT5* (AGE21)	0.0 to 0.2 (32.08 31.88)	0.2 to 3.2 (31.88 to 28.88)	- -	3.2 to 9.15 & 10.1 to 11.06 (28.88 to 22.93 & 21.98 to 21.02)	11.06 to 14.0+ (21.02 to 18.08)+	9.15 to 10.1 (22.93 to 21.98)	- -
BH7/CPT2* (AGE21)	0.0 to 0.9 (31.8 to 29.9)	0.9 to 2.9 (29.9 to 28.9)	2.9 to 9.0 (28.9 to 22.8)	9.0 to 12.78 (22.8 to 19.02)	- -	12.78 to 15.06+ (9.15 to 19.02 to 16.74+)	- -
BH8/CPT3* (AGE21)	0.0 to 2.3 (30.51 to 28.21)	2.3 to 5.2 (28.21 to 25.31)	5.2 to 15.0 (25.31 to 15.51)	15.0 to 16.0+ (15.51 to 14.51+)	- -	- -	- -
BH101	0.0 to 0.3 (28.8 to 28.5)	0.3 to 6.0 (28.5 to 22.8)	- -	- -	6.0 to 13.0+ (22.8 to 15.8)	- -	- -
BH102	0.0 to 1.3 (32.1 to 30.8)	1.3 to 2.21 (30.8 to 29.89)	2.21 to 2.8 (29.89 to 29.3)	2.8 to 4.8 (29.3 to 27.3)	4.8 to 8.06 & 10.0 to 12.99 + (29.3 to 24.04 & 22.1 to 19.11)	8.06 to 9.0 (24.04 to 23.1)	9.0 to 10.0 (23.1 to 22.1)
BH103	0.0 to 0.7 (31.5 to 30.8)	0.7 to 7.1 (30.8 to 24.4)	- -	- -	7.1 to 13.09 (24.4 to 18.41)	13.09 to 14.0 (24.4 to 17.5)	14.0 to 15.0+ (17.5 to 16.5)
BH104	0.0 to 1.4 (31.8 to 30.4)	1.4 to 3.1 (30.4 to 28.7)	- -	3.1 to 3.9 (28.7 to 27.9)	3.9 to 15.95 & 17.7 to 20.91+ (27.9 to 15.85 & 14.1 to 10.89)	15.95 to 17.7 (15.85 to 14.1)	- -
BH105	0.0 to 0.4 (28.5 to 28.1)	0.4 to 5.0 (28.1 to 23.5)	5.0 to 7.6 (23.5 to 20.9)	7.6 to 11.15 (20.9 to 17.35)	11.15 to 22.22+ (17.35 to 6.28)	- -	- -

Notes:

Depths shown are based on material observed within test locations and will vary across the site

2.3 Groundwater Observations

Four monitoring wells were installed within BH101, BH102, BH103 and BH104 as part of the investigation. Further discussion of the geological and hydrogeological conditions at the site is provided in the Site Hydrogeology Report MG2024-1 and in the Dewatering Management Plan MG2024-2.

3 GEOTECHNICAL RECOMMENDATIONS FOR DESIGN

3.1 Excavation Retention

Temporary batters may be considered for retention during basement excavation only where adequate room for full batter construction is available. Temporary batter slopes of 1V:1H will be possible for all units above the water table provided that surface water is diverted away from the batter faces and batter heights are kept to less than 4m. Where batters extend beyond 4 m height benching may be required and further advice should be sought from a qualified geotechnical engineer. Permanent batters of 2H:1V may be employed for excavation design above the water table. Permanent batters will require surface protection or revegetation to prevent erosion and slaking.

For design of flexible shoring systems a triangular pressure distribution may be employed using the parameters provided in **Table 3**. For design of rigid anchored or braced walls, a trapezoidal earth pressure distribution should be used with a maximum pressure of $0.65.K_a.\gamma.H$ (kPa), where 'H' is the effective vertical height of the wall in metres.

TABLE 3 EARTH PRESSURE PARAMETERS

Material	Unit 1 Fill	Unit 2 Alluvial Soil	Unit 3 Residual Soil	Unit 4 Class V/IV Sandstone	Unit 5 Class III Sandstone	Unit 6 Class V Shale	Unit 7 Class III Shale
Unit Weight (kN/m ³)	18	18	20	23	24	22	24
Saturated Unit Weight (kN/m ³)	19	19	21	24	24	23	24
Earth Pressure Coefficients	At Rest, K_o	0.50	0.56	0.56	0.43	0.33	0.53
	Passive, K_p	3.00	2.56	2.56	3.69	5.04	2.77
	Active, K_a	0.33	0.39	0.39	0.27	0.20	0.36
Drained Cohesion, c' (kPa)	0	5	7	40	250	12	36
Friction Angle, ϕ' (°)	30	26	26	35	42	28	34
Elastic Modulus (MPa)	5	15	25	120	600	75	200
Poisson's Ratio	0.30	0.30	0.30	0.22	0.20	0.25	0.25

Table 3 Notes

- 1 Unit Weight is based on visual assessment only and may vary by $\pm 10\%$.
- 2 Earth pressures are provided on the assumption that the ground behind the retaining wall is flat and drained.

In addition, design of retaining walls should consider the following:

- Appropriate surcharge loading from construction equipment, vehicular traffic and neighbouring structures at finished surface level should be taken into account in the retention design. Surcharge loads on retention structures may be calculated using a rectangular stress block with an earth pressure coefficient of 0.5 applied to surcharge loads at ground surface level.
- Anchor design should ignore the contribution of any bonded length within a wedge which extends upwards at 45° from the base of the excavation to account for a failure wedge forming behind the shoring system.

Earth pressure coefficients with **Table 3** are provided on the assumption that the ground behind the retaining wall is flat and drained. For cases where the ground profile rises at more than 5° behind the retaining system detailed design input should be sought from a geotechnical engineer.

Surcharge loads on retention structures may either be modelled directly through finite element inputs in programs such as Plaxis or Wallap, or they may be calculated using a rectangular stress block with an earth pressure coefficient of 0.5 applied to surcharge loads at ground surface level. The retaining walls should be designed to withstand hydrostatic pressure from 3 mBGL unless permanent drainage is incorporated in the wall design.

3.2 Soil and Rock Excavatability

The expected ability of equipment to excavate the soil and rock encountered at the site is summarised in **Table 4**. This assessment is based on available site investigation data and guidance on the assessment of excavatability of rock by Pettifer and Fookes (1994). The presence of medium to high strength bands in lower strength rock and the discontinuity spacing may influence the excavatability of the rock mass.

TABLE 4 SOIL AND ROCK EXCAVATABILITY

Unit	Material	Excavatability
1	Fill	
2	Alluvial Soil	Easy digging by 20t Excavator
3	Residual Soil	
4	Class V/IV Sandstone	Hard ripping by 20t Excavator
5	Class III Sandstone	Hydraulic hammering will be required within Unit 5
6	Class V Shale	Moderate to hard ripping by 20t Excavator
7	Class III Shale	Hydraulic hammering will be required in medium to high strength shale within Unit 7

The excavation methodology may also be affected by the following factors:

- Scale and geometry of the excavation;
- Availability of suitable construction equipment;
- Potential reuse of material on site; and
- Acceptable excavation methods, noise, ground vibration and other environmental criteria.

3.3 Excavation Vibration Considerations

As a guide, safe working distances for typical items of vibration intensive plant are listed in **Table 5**. The safe working distances are quoted for both “cosmetic” damage (refer British Standard BS 7385:1993) and human comfort (refer NSW Environmental Protection Agency Vibration Guideline). The safe working distances should be complied with at all times, unless otherwise mitigated to the satisfaction of the relevant stakeholders.

TABLE 5 RECOMMENDED SAFE WORKING DISTANCES FOR VIBRATION INTENSIVE PLANT

Plant Item	Rating/Description	Safe Working Distance	
		Cosmetic Damage (BS 7385:1993) ¹	Human Response (EPA Vibration Guideline)
Vibratory Roller	< 50 kN (typically 1-2 tonnes)	5 m	15 m to 20 m
	< 100 kN (typically 2-4 tonnes)	6 m	20 m
	< 200 kN (typically 4-6 tonnes)	12 m	40 m
	< 300 kN (typically 7-13 tonnes)	15 m	100 m
	< 300 kN (typically 13-18 tonnes)	20 m	100 m
	< 300 kN (typically >18 tonnes)	25 m	100 m
Small Hydraulic Hammer	300 kg – 5 to 12 t excavator	2 m	7 m
Med Hydraulic Hammer	900 kg – 12 to 18 t excavator	7 m	23 m
Large Hydraulic Hammer	1600 kg – 18 to 34 t excavator	22 m	73 m
Vibratory Pile Driver	Sheet Piles	2 m to 20 m	20 m
Pile Boring	≤ 800 mm	2m (nominal)	N/A
Jackhammer	Hand held	1 m (nominal)	Avoid contact with structure

Table 5 Notes:

¹ More stringent conditions may apply to heritage buildings or other sensitive structures.

In relation to human comfort (response), the safe working distances in **Table 5** relate to continuous vibration and apply to residential receivers. For most construction activities, vibration emissions are intermittent in nature and for this reason, higher vibration levels, occurring over shorter periods are permitted, as discussed in British Standard BS 6472-1:2008.

The safe working distances provided in **Table 5** are given for guidance only. Monitoring of vibration levels may be required to ensure vibrations levels remain below threshold values during the construction period.

3.4 Foundation Design

It is not recommended that shallow footings or slabs found within Unit 1 material due to the potential for differential settlement caused by footings bridging between materials of varying stiffness. Shallow footings and slabs at the site should be designed in accordance with AS2870:2011 based on a Site Classification of 'A.' The site classification has been provided on the basis that the performance expectations set out in Appendix B of AS2870–2011 are acceptable and that future site maintenance will be undertaken in accordance with CSIRO BTF 18.

The parameters given in **Table 6** may be used for the design of pad footings and bored piles. Morrow Geotechnics recommends that a Preliminary Geotechnical Strength Reduction Factor (GSRF) of 0.4 is used for the design of piles in accordance with AS 2159:2009 if no allowance is made for pile testing during construction. Should pile testing be nominated, the GSRF may be reviewed and a value of 0.55 to 0.65 may be expected.

Ultimate geotechnical strengths are provided for use in limit state design. Allowable bearing pressures are provide for serviceability checks. These values have been determined to limit settlements to an acceptable level for conventional building structures, typically less than 1% of the minimum footing dimension.

TABLE 6 PAD FOOTING AND PILE DESIGN PARAMETERS

Material	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	
	Fill	Alluvial Soil	Residual Soil	Class V/IV Sandstone	Class III Sandstone	Class V Shale	Class III Shale	
Allowable Bearing Pressure (kPa)	N/A	N/A	150	1000	3500	700	2000	
Ultimate Vertical End Bearing Pressure (kPa)	N/A	N/A	450	3000	10500	2100	6000	
Elastic Modulus (MPa)	5	15	25	120	600	75	200	
Ultimate Shaft Adhesion (kPa)	In Compression	0	0	25	150	800	75	200
	In Tension	0	0	12.5	75	400	37.5	100
Susceptibility to Liquefaction	Med	Med	Low	Low	Low	Low	Low	

Table 6 Notes:

- Side adhesion values given assume there is intimate contact between the pile and foundation material. Design engineer to check both ‘piston’ pull-out and ‘cone’ pull-out mechanics in accordance with AS4678-2002 Earth Retaining Structures.
- Susceptibility to liquefaction during an earthquake is based on the following definition:
 Low - Medium to very dense sands, stiff to hard clays, and rock
 Medium - Loose to medium dense sands, soft to firm clays, or uncontrolled fill below the water table
 High - Very loose sands or very soft clays below the water table
- Allowable Bearing Pressure provided for Unit 5 Class II/I Sandstone will require on site verification of rock quality by spoon testing of a minimum of 50% of the pad footings to 2 times the minimum pad footing width.

To adopt these parameters we have assumed that the bases of all pile excavations are cleaned of loose debris and water and inspected by a suitably qualified Geotechnical Engineer prior to pile construction to verify that ground conditions meet design assumptions. Where groundwater ingress is encountered during pile excavation, concrete is to be placed as soon as possible upon completion of pile excavation. Pile excavations should be pumped dry of water prior to pouring concrete, or alternatively a tremmie system could be used.

Selection of footing types and founding depth will need to consider the risk of adverse differential ground movements within the foundation footprint and between high level and deeper footings. Unless an allowance for such movement is included in the design of the proposed development we recommend that all new structures found on natural materials with comparable end bearing capacities and elastic moduli.

3.5 AS1170 Earthquake Site Risk Classification

Assessment of the material encountered during the investigation in accordance with the guidelines provided in AS1170.4-2007 indicates an earthquake subsoil class of Class C_e – Shallow Soil for the site.

3.6 Site Filling and Earthworks

All earthworks should be carried out in accordance with AS3798-2007 Guidelines on Earthworks for Commercial and Residential Developments. We recommend the following earthworks for excavation, fill placement and subgrade preparation for working platforms, footings and basement slab construction, if required:

- Strip any existing fill material from the development footprint to a depth of 2 m. Segregate unsuitable material (e.g. deleterious material) and remove from site in accordance with NSW DECCW Waste Classification Guidelines Part 1: Classify Waste. All material to be placed as fill at the site should comply with the requirements of AS3798 2007 Guidelines on Earthworks for Commercial and Residential Developments and be free of unsuitable material, including:
 - Particle dimensions not exceeding two thirds (2/3) of the loose layer thickness;
 - Organic soils, root affected soil, decaying vegetation or other deleterious substances;
 - Materials contaminated through past site history;
 - Silts or materials subject to volume change; and
 - Material that contains wood, metal, plastic, boulders, soluble or perishable material.
- A suitably qualified Geotechnical Engineer is to assess the condition of the exposed material at design level to assess the suitability of the prepared surface to act as foundation or subgrade.

Suitable fill material should be recompacted to design subgrade levels in no greater than 200 mm lifts in accordance with AS3798-2007.

4 STATEMENT OF LIMITATIONS

The adopted investigation scope was limited by site access restrictions due to presence of structures at the site at the time of our investigation and by the investigation intent. Further geotechnical inspections should be carried out during construction to confirm both the geotechnical model and the design parameters provided in this report.

Your attention is drawn to the document “Important Information”, which is included in **Appendix B** of this report. The statements presented in this document are intended to advise you of what your realistic expectations of this report should be. The document is not intended to reduce the level of responsibility accepted by Morrow Geotechnics, but rather to ensure that all parties who may rely on this report are aware of the responsibilities each assumes in so doing.

5 REFERENCES

AS1726:1993, *Geotechnical Site Investigations*, Standards Australia.

AS2159:2009, *Piling – Design and Installation*, Standards Australia.

AS2870:2011, *Residential Slabs and Footings*, Standards Australia.

AS3798:2007, *Guidelines on Earthworks for Commercial and Residential Developments*, Standards Australia.

Chapman, G.A. and Murphy, C.L. (1989), *Soil Landscapes of the Sydney 1:100000 sheet*. Soil Conservation Services of NSW, Sydney.

NSW Department of Finance and Service, Spatial Information Viewer, maps.six.nsw.gov.au.

NSW Department of Mineral Resources (1985) *Wollongong-Port Hacking 1:100,000 Geological Series Sheet 9029-9129 (Edition 1)*. Geological Survey of New South Wales, Department of Mineral Resources.

Pells (2004) *Substance and Mass Properties for the Design of Engineering Structures in the Hawkesbury Sandstone*, Australian Geomechanics Journal, Vol 39 No 3

6 CLOSURE

Please do not hesitate to contact Morrow Geotechnics if you have any questions about the contents of this report.

For and on behalf of Morrow Geotechnics Pty Ltd,



Andrew Butel
Engineering Geologist



Alan Morrow
Principal Geotechnical Engineer



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Map description	P3018 - Borehole Location Plan rev1		
Site location	4 Delmar Parade, Dee Why NSW		
Client	Landmark Group Construction Australia Pty Ltd		
Project name	Dee Why		
Project No	P3018	Scale	Not to scale

BOREHOLE LOGS AND EXPLANATORY NOTES






Morrow Geotechnics


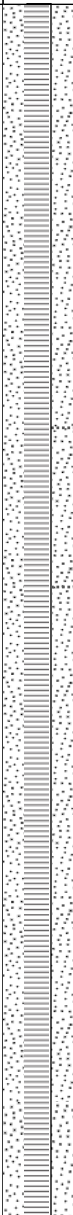
Bellambi, NSW
Phone: 0405 843 933

Boring No.: BH101

Easting : 341051.1	Drill Supplier : MATRIX DRILLING	Job Number : P3018	Sheet : 1 OF 2
Northing : 6263534.7	Driller Company : MATRIX DRILLING	Client : Landmark Group Construction Australia Pty Ltd	
Elevation : 28.8(m)	Logged By : Mark Peach	Project : Dee Why	
Total Depth : 13 m	Date : 30/08/2023	Location : 4 Delmar Parade, Dee Why NSW	

Drilling Method	Water	Well Diagram	Testing		Soil Origin	Graphic Log	Classification Code	Depth (m)	Elevation (m)	Material Description	Consistency/Density	Moisture	Observations	
			SPT											
ADT		A			Fill-on-Soil		CCT	0.15	28.0	Concrete				
					Residual		SC	0.3		Fill Clayey to gravelly SAND (SC) : low plasticity clay, loose, brown grey, fine to medium grained, medium to coarse sized gravel, moist, (low resistance).	L	M		
					Residual		SW				Residual Gravelly SAND (SW) : loose, orange, fine to medium grained, medium to coarse sized gravel, trace low plasticity clay, moist, (low resistance, sandstone gravels).			
			6, 8, 12, (N = 20)		Residual		SC	1.4			Residual Clayey to gravelly SAND (SC) : medium dense, low plasticity clay, low plasticity, orange, fine to medium grained, medium sized gravel, moist, (low resistance, sandstone and quartz gravels).	MD		
			8, 12, 11, (N = 23)		Residual		SC	2						
			7, 6, 9, (N = 15)		Residual		SC	4						
					Residual		SC	4.9	23.8	As above, but red orange.				
					Residual		CI	5.5		Residual Sandy CLAY (CI) : very stiff, medium plasticity, grey red, medium grained sand, with fine sized gravel, w ≈ pl, (low resistance, sandstone gravels).	VSt	w = PL		

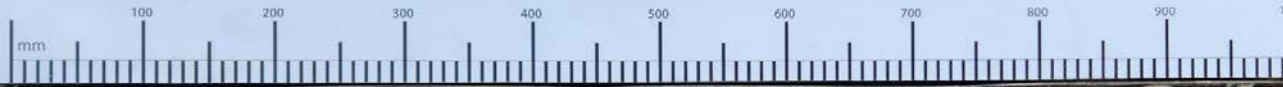
<div style="display: flex; justify-content: space-between; align-items: center;"> <div style="text-align: left;">  <p>Morrow Geotechnics Bellambi, NSW Phone: 0405 843 933</p> </div> <div style="text-align: right;"> <p>Boring No.: BH101</p> </div> </div>													
Easting : 341051.1		Drill Supplier : MATRIX DRILLING		Job Number : P3018		Sheet : 2 OF 2							
Northing : 6263534.7		Driller Company : MATRIX DRILLING		Client : Landmark Group Construction Australia Pty Ltd									
Elevation : 28.8(m)		Logged By : Mark Peach		Project : Dee Why									
Total Depth : 13 m		Date : 30/08/2023		Location : 4 Delmar Parade, Dee Why NSW									
Drilling Method	Water	Well Diagram	Testing		Soil Origin	Graphic Log	Classification Code	Depth (m)	Elevation (m)	Material Description	Consistency/Density	Moisture	Observations
			SPT										
ADT			22, (N = 44)		Rock		SST	6	22.0	Extremely weathered, rock Sandy CLAY (SST) : hard, low plasticity, light grey, medium grained sand, trace fine to medium sized gravel, w = pl, (low to medium resistance).	H		
								7	21.8	<p>6.17m : Commenced NMLC Coring;</p>			
								8	20.8				
								9	19.8				
								10	18.8				
								11	17.8				

<div style="display: flex; justify-content: space-between; align-items: center;"> <div style="text-align: left;">  <p>Morrow Geotechnics Bellambi, NSW Phone: 0405 843 933</p> </div> <div style="text-align: right;"> <p>Boring No.: BH101</p> </div> </div>																	
Easting : 341051.1			Drill Supplier : MATRIX DRILLING			Job Number : P3018			Sheet : 2 OF 3								
Northing : 6263534.7			Driller Company : MATRIX DRILLING			Client : Landmark Group Construction Australia Pty Ltd											
Elevation : 28.8(m)			Logged By : Mark Peach			Project : Dee Why											
Total Depth : 13 m			Date : 30/08/2023			Location : 4 Delmar Parade, Dee Why NSW											
Drilling Method	Water	Well Diagram	RQD% and TCR%	Testing					Weathering	Depth (m)	Elevation (m)	Graphic Log	Classification Code	Material Description	Defect Spacing (mm)	Defect Depth	Defect Description <small>type, inclination, planarity, roughness, coating, thickness</small>
				Is(50)	MLS	LS	MS	HS									
										23.0							
										22.8							
NMLC Coring			RQD = 26% TCR = 100%						SW			SST	rock SANDSTONE: slightly weathered, medium strength, grey, fine to medium grained, (massive, subvertical joints).				6.24, J, defect bounds 6.20m to 6.28m, 80°, , STP, CL, C 6.35, J, defect bounds 6.34m to 6.37m, 80°, , STP, CL, C 6.8, J, defect bounds 6.65m to 6.93m, 80°, RO, STP, CL, OP 7-7.1, , IR, CL, OP 7.34, P, clay coating, 6°, RO, CV, CT, OP 7.38, P, clay coating, , PL, CT, OP 7.46, P, clay coating, 6°, RO, PL, CT, OP 7.64, J, defect bounds 7.59m to 7.68m, 70°, , IR, CL, C 7.87, P, 5°, RO, PL, CL, OP 8-19-8.39, XWS, infill clay and extremely weathered sandstone 3°, , IR, CT, 9.33, P, clay coating, 4°, , PL, CT, OP 9.42, P, 5°, , STP, CL, OP 9.5-9.51, IS, infilled clay, 3°, RO, UN, CL, 9.66, P, 4°, RO, PL, CL, C 9.76, P, 3°, , PL, CL, C 9.89, P, 4°, , IR, CL, C 9.92, P, 3°, , PL, CL, C 9.99, P, 3°, RO, PL, CL, C
			d: 0.34, a: 0.38							21.8							
			RQD = 52% TCR = 100%							20.8							
			d: 0.51, a: 0.44							19.8							
			RQD = 43% TCR = 87%														
			d: 0.51, a: 0.55														
			d: 0.46, a: 0.76														

morrow

CLIENT NAME: LANDMARK GROUP
PROJECT: Dee Why
LOCATION: 4 Delmar Parade
JOB NUMBER: P3018
LOGGED BY: MP

BOREHOLE ID: BH101
DEPTH: 6.17M to 13.0m
CORE TRAY NO: Box 1+2 of 2
DATE: 30.08.23



0405 843 933



Bellambi, NSW



info@morrowgeo.com.au

Photo description

BH101 - Tray 1 and 2 of 2

Client

Landmark Group Construction Australia Pty Ltd

Location

4 Delmar Parade, Dee Why NSW

Project name

Dee Why

Project No

P3018

Scale




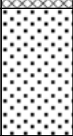

Not to Scale

BH No

BH101

BH Depth

6.17 to 13.00m

<div style="display: flex; justify-content: space-between; align-items: center;">  <div style="text-align: center;"> Morrow Geotechnics Bellambi, NSW Phone: 0405 843 933 </div> <div style="text-align: right;"> Boring No.: BH102 </div> </div>												
Easting : 341016.1		Drill Supplier : MATRIX DRILLING		Job Number : P3018		Sheet : 1 OF 1						
Northing : 6263445.7		Driller Company : MATRIX DRILLING		Client : Landmark Group Construction Australia Pty Ltd								
Elevation : 32.1(m)		Logged By : Mark Peach		Project : Dee Why								
Total Depth : 12.99 m		Date : 30/08/2023		Location : 4 Delmar Parade, Dee Why NSW								
Drilling Method	Water	Testing		Soil Origin	Graphic Log	Classification Code	Depth (m)	Elevation (m)	Material Description	Consistency/Density	Moisture	Observations
		Non-Seal	Fill									
ADT				Non-Seal		CCT	0.2	32.1	Concrete			
				Fill		SM	0.9		Fill Silty to gravelly SAND (SM) : loose, grey dark grey, fine to medium grained, fine to medium sized gravel, trace low plasticity clay, moist, (low resistance).	L	M	
				Rock		SST	1.3	31.1	Rock SANDSTONE: distinctly weathered, very low strength, grey orange, medium grained, (sandstone floater).	VLS	D	
				Residual		SC	2.0	30.1	Residual Clayey to gravelly SAND (SC) : loose to medium dense, low plasticity clay, orange grey, medium grained, medium to coarse sized gravel, moist, (low resistance, sandstone floaters).	L-MD	M	
									2.21m : Commenced NMLC Coring;			
							3	29.1				
							4	28.1				



Morrow Geotechnics

Bellambi, NSW

Phone: 0405 843 933

Boring No.: BH102

Easting : 341016.1	Drill Supplier : MATRIX DRILLING	Job Number : P3018	Sheet : 2 OF 3
Northing : 6263445.7	Driller Company : MATRIX DRILLING	Client : Landmark Group Construction Australia Pty Ltd	
Elevation : 32.1(m)	Logged By : Mark Peach	Project : Dee Why	
Total Depth : 12.99 m	Date : 30/08/2023	Location : 4 Delmar Parade, Dee Why NSW	

Drilling Method	Water	Well Diagram	Testing		Estimated Strength	Weathering	Depth (m)	Elevation (m)	Graphic Log	Classification Code	Material Description	Defect Spacing (mm)	Defect Depth	Defect Description
			RQD% and TCR%	Is(50)										
NMLC Coring			RQD = 81% TCR = 96%	d: 0.48, a: 0.60	SW		27.1		SST	rock SANDSTONE: slightly weathered, medium strength, grey, fine grained, (massive, infilled sandy clay seams).				
			RQD = 68% TCR = 86%	d: 1.34, a: 1.12			26.1							5.53. IS, clay infilled, 3°, RO, UN, CL, C
							6.6		SST	As above, but highly, grey red orange, (generally massive, iron stained with sub horizontal laminations and subvertical joints).				5.72-5.78. IS, sandy clay infilled, 3°, RO, PL, CT.
						HW	7	25.1						6.61. P, iron stained, 10°, RO, PL, STN, OP
							8.0	24.1						6.66. J, iron stained, defect bounds 6.64m to 6.68m, 75°, UN, STN, OP
							8.4							7.37. iron stained, defect bounds 7.19m to 7.48m, 85°, IR, STN, OP
							8.5							7.42. J, iron stained, infilled extremely weathered sandstone, defect bounds 7.31m to 7.52m, 85°, IR, STN, C
														7.52. P, clay coating, 3°, PL, CT, OP
														8.06-8.46. CORELOSS (notes)
				RQD = 52% TCR = 97%	d: 0.13, a: 0.11			8.4		CI	residual Silty CLAY (CI) : very stiff to hard, medium plasticity, grey, with fine sized gravel, trace fine grained sand, w ≈ pl, (shale fragments and thin shale bands).			
					MW		8.5		PAV					8.65. P, clay veneer, 3°, RO, UN, VN, OP
									LAM	rock LAMINITE: moderately weathered, low strength, grey light grey, fine grained, (massive in parts, interbedded with sub-horizontal shale laminations and infilled clay seams).				8.7. P, clay coating, 3° RO, PL, CT, OP
														8.72-8.75. IS, clay infilled with extremely weathered shale laminations, 4°, UN, CL,
					MW-S		9	23.1	SHA	rock SHALE: moderately to slightly weathered, low to medium strength, grey, fine grained, (minor sandstone bands).				8.8-8.83. XWS, infilled extremely weathered shale, 4°, RO, IR, CL
														8.87-8.89. IS, infilled clay, 3°, RO, IR, CL, OP
														8.91-9. IS, infilled clay seam with 1mm to 2mm shale laminations, 3°, RO, PL, CL,
														9.06. P, 2°, RO, PL, CT, OP
														9.25. P, 3°, RO, PL, CT, OP



Morrow Geotechnics

Bellambi, NSW
Phone: 0405 843 933

Boring No.: BH102

Easting : 341016.1	Drill Supplier : MATRIX DRILLING	Job Number : P3018	Sheet : 3 OF 3
Northing : 6263445.7	Driller Company : MATRIX DRILLING	Client : Landmark Group Construction Australia Pty Ltd	
Elevation : 32.1(m)	Logged By : Mark Peach	Project : Dee Why	
Total Depth : 12.99 m	Date : 30/08/2023	Location : 4 Delmar Parade, Dee Why NSW	

Drilling Method	Water	Well Diagram	Testing		Estimated Strength	Weathering	Depth (m)	Elevation (m)	Graphic Log	Classification Code	Material Description	Defect Spacing (mm)	Defect Depth	Defect Description			
			RQD% and TCR%	Is(50)													
NMLC Coring			RQD = 52% TCR = 97%		MLS LS MS HS VHS EHS	MW-S	10	22.1		SHA	rock SHALE: moderately to slightly weathered, low to medium strength, grey, fine grained, (minor sandstone bands).	30 100 300 1000 3000		10. P, 2°, SO, PL, CL, OP 10.08, P, 2°, RO, PL, CL, OP 10.21-10.22, IS, infilled extremely weathered shale, 3°, RO, PL, CL			
				d: 0.72, a: 1.07			F				SST	rock SANDSTONE: fresh weathered, medium to high strength, light grey, fine grained, (generally massive, minor carbonaceous laminations).					
				d: 0.72, a: 0.91					11	21.1							
				d: 0.62, a: 1.36					12	20.1							
			RQD = 99% TCR = 100%				13	19.1			BH102 Terminated at 12.99 m (Target Depth Reached)			12.52, P, 8°, RO, CL, OP			
							14	18.1									

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CLIENT NAME: LANDMARK GROUP
PROJECT: Dee Why
LOCATION: 4 Delmar Parade
JOB NUMBER: P3018
LOGGED BY: MP

BOREHOLE ID: BH102
DEPTH: 2.21m to 7.0m
CORE TRAY NO.: Box 1 of 3
DATE: 30.08.23



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Photo description

BH102 - Tray 1 of 3

Client

Landmark Group Construction Australia Pty Ltd

Location

4 Delmar Parade, Dee Why NSW

Project name

Dee Why

Project No

P3018

Scale

Not to Scale

BH No

BH102

BH Depth

2.21 to 7.00m

morrow

CLIENT NAME: LANDMARK GROUP
PROJECT: Dee Why
LOCATION: 4 Delmar Parade
JOB NUMBER: P3018
LOGGED BY: MP

BOREHOLE ID: BH102
DEPTH: 7.0m to 12.99m
CORE TRAY NO.: Box 2+3 of 3
DATE: 30-08-23



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
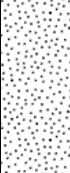
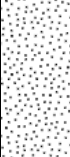


 Bellambi, NSW


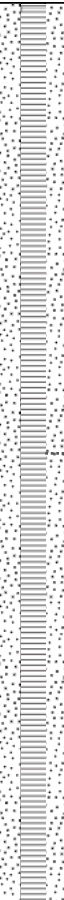
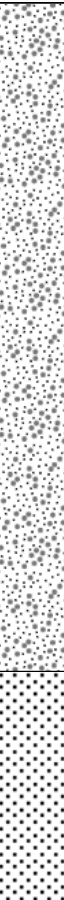
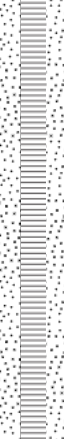

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Photo description	BH102 - Tray 2 and 3 of 3		
Client	Landmark Group Construction Australia Pty Ltd		
Location	4 Delmar Parade, Dee Why NSW		
Project name	Dee Why		
Project No	P3018	Scale	Not to Scale
BH No	BH102	BH Depth	7.00 to 12.99m

 <p>Morrow Geotechnics Bellambi, NSW Phone: 0405 843 933</p>	<p>Boring No.: BH103</p>
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Easting : 340947.7	Drill Supplier : MATRIX DRILLING	Job Number : P3018	Sheet : 1 OF 2
Northing : 6263458.9	Driller Company : MATRIX DRILLING	Client : Landmark Group Construction Australia Pty Ltd	
Elevation : 31.5(m)	Logged By : Andrew Butel	Project : Dee Why	
Total Depth : 15 m	Date : 03/09/2023	Location : 4 Delmar Parade, Dee Why NSW	

Drilling Method	Water	Well Diagram	Testing		Soil Origin	Graphic Log	Classification Code	Depth (m)	Elevation (m)	Material Description	Consistency/Density	Moisture	Observations
			SPT										
ADT	Diabase	C			Non-Seal		CCT	0.22	31.5	Concrete			
					Fill		SW	0.7	30.8	Fill Gravelly SAND (SW) : loose, orange grey, fine to medium grained, medium sized gravel, moist, (poorly graded).	L	M	
			4, 5, 4, (N = 9)		Alluvial		SW	1	30.5	Alluvial Gravelly SAND (SW) : loose, orange grey, fine to medium grained, medium sized gravel, moist, (poorly graded).			
					Alluvial		SW	2	29.5				
			2, 4, 7, (N = 11)		Alluvial		CI	2	29.5	Alluvial Sandy CLAY (CI) : stiff, medium plasticity, orange light grey, medium grained sand, with medium to coarse sized gravel, inorganic, w ≈ pl, (quartz gravels).	St	w = PL	
					Alluvial		CI	3	28.5	As above, but red orange.			
				Alluvial		SP	4	27.5	Alluvial Gravelly SAND (SP) : medium dense to dense, grey orange, medium grained, medium sized gravel, wet, (quartz gravels).	MD-D	W		
			6, 7, 5, (N = 12)										

<div style="display: flex; justify-content: space-between; align-items: center;"> <div style="text-align: left;">  <p>Morrow Geotechnics Bellambi, NSW Phone: 0405 843 933</p> </div> <div style="text-align: right;"> <p>Boring No.: BH103</p> </div> </div>													
Easting : 340947.7 Northing : 6263458.9 Elevation : 31.5(m) Total Depth : 15 m			Drill Supplier : MATRIX DRILLING Driller Company : MATRIX DRILLING Logged By : Andrew Butel Date : 03/09/2023			Job Number : P3018 Client : Landmark Group Construction Australia Pty Ltd Project : Dee Why Location : 4 Delmar Parade, Dee Why NSW			Sheet : 2 OF 2				
Drilling Method	Water	Well Diagram	Testing		Soil Origin	Graphic Log	Classification Code	Depth (m)	Elevation (m)	Material Description	Consistency/Density	Moisture	Observations
			SPT										
ADT					Alluvial		SP		26.5	Alluvial Gravelly SAND (SP) : medium dense to dense, grey orange, medium grained, medium sized gravel, wet, (quartz gravels).	MD-D	W	
			4, 10, 11, (N = 21)	6				25.5					
150mm Washbore					Rock		SST		24.5	Rock SANDSTONE: distinctly weathered, very low strength, very light grey, medium grained, (generally massive with minor carbaceous lamintions).	VLS	D	
			12, (N = 24) , Hard Bounce	7				7.1					
								8	23.5	7.83m : Commenced NMLC Coring;			
								9	22.5				



Morrow Geotechnics

Bellambi, NSW
Phone: 0405 843 933

Boring No.: BH103

Easting : 340947.7	Drill Supplier : MATRIX DRILLING	Job Number : P3018	Sheet : 2 OF 3
Northing : 6263458.9	Driller Company : MATRIX DRILLING	Client : Landmark Group Construction Australia Pty Ltd	
Elevation : 31.5(m)	Logged By : Andrew Butel	Project : Dee Why	
Total Depth : 15 m	Date : 03/09/2023	Location : 4 Delmar Parade, Dee Why NSW	

Drilling Method	Water	Well Diagram	RQD% and TCR%	Testing						Weathering	Depth (m)	Elevation (m)	Graphic Log	Classification Code	Material Description	Defect Spacing (mm)	Defect Depth	Defect Description <small>type, inclination, planarity, roughness, coating, thickness</small>
				Is(50)	MLS	LS	MS	HS	VHS									
										26.5								
										6	25.5							
										7	24.5							
NMLC Coring			RQD = 84% TCR = 100%						SW	8	23.5		SST	rock SANDSTONE: slightly weathered, medium strength, very light grey, medium grained, (generally massive with minor carbeaceous lamintions).				
				d: 0.70, a: 0.40					MW	8.2			SST	rock SANDSTONE: moderately weathered, medium strength, orange red, medium grained, (20° to 40° bedding).			8.05, P, 3°, RO, UN, C OP	
				d: 0.58, a: 0.48					MW	9			SST	rock SANDSTONE: moderately weathered, medium strength, red orange mottled, medium grained, (generally massive).			8.17, P, 6°, VR, UN, C OP	
			RQD = 100% TCR = 100%						MW	9.2			SST	rock SANDSTONE: moderately weathered, medium strength, orange red, medium grained, (10° to 20° bedding).			8.21, P, 1°, VR, UN, C OP	
				d: 0.77, a: 1.11					SW	9.5			SST	rock SANDSTONE: slightly weathered, medium to high strength, very light grey pink, medium grained, (generally massive).			8.26, P, 1°, VR, UN, C OP 8.29, P, 1°, VR, UN, C OP 8.31-8.37, J, 40°, VR, UN, CL, OP	



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Bellambi, NSW

Phone: 0405 843 933

Boring No.: BH103

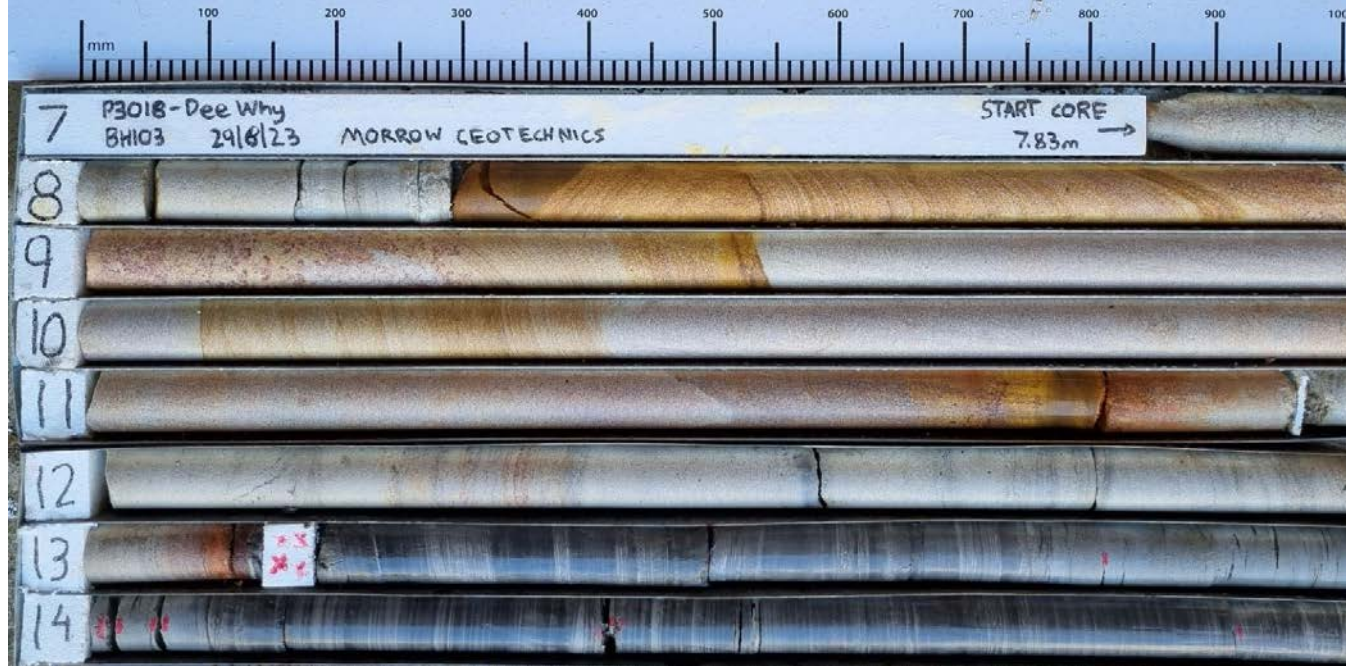
Easting : 340947.7	Drill Supplier : MATRIX DRILLING	Job Number : P3018	Sheet : 3 OF 3
Northing : 6263458.9	Driller Company : MATRIX DRILLING	Client : Landmark Group Construction Australia Pty Ltd	
Elevation : 31.5(m)	Logged By : Andrew Butel	Project : Dee Why	
Total Depth : 15 m	Date : 03/09/2023	Location : 4 Delmar Parade, Dee Why NSW	

Drilling Method	Water	Well Diagram	RQD% and TCR%	Testing						Weathering	Depth (m)	Elevation (m)	Graphic Log	Classification Code	Material Description	Defect Spacing (mm)	Defect Depth	Defect Description <small>type, inclination, planarity, roughness, coating, thickness</small>
				Is(50)	MLS	LS	MS	HS	VHS									
NMLC Coring			RQD = 100% TCR = 100%							10.0	21.5		SST	rock SANDSTONE: slightly weathered, medium to high strength, very light grey pink, medium grained, (generally massive).				
										10.0			SST	rock SANDSTONE: moderately weathered, medium to high strength, light orange very light grey, medium grained, (2° to 8° bedding).				
				d: 1.08, a: 1.28							11.0			SST	rock SANDSTONE: slightly weathered, medium to high strength, very light grey pink, medium grained, (generally massive).			
											11.4			HW-M	rock SANDSTONE: highly to moderately weathered, medium to high strength, red-purple, medium grained, (generally massive).			
											11.8			SST	rock SANDSTONE: slightly weathered, medium to high strength, very light grey, medium grained, (generally massive).			
				RQD = 98% TCR = 100%							12.0	19.5		SST	rock SANDSTONE: slightly weathered, medium to high strength, very light grey, medium grained, (generally massive).			
											13.0							
											13.4							
											13.7			SHA	residual Sandy CLAY (CL) : soft, low plasticity, very light grey, medium grained sand, inorganic, w = pl.			
											13.7			SHA	rock SHALE: slightly weathered, very low to low strength, very light grey, fine grained, (5° laminations at 1-5mm spacing).			
											14.0	17.5		SST	rock SANDSTONE: moderately weathered, low strength, very light grey, medium grained, (generally massive with some carbonaceous layers).			
											14.6			SHA	rock SHALE: slightly weathered, medium strength, grey very dark grey, fine grained, (sub-horizontal laminations at 1-2mm spacing).			

morrow

CLIENT NAME: LANDMARK GROUP
PROJECT: 4 Delmar Parade
LOCATION: Dee Why
JOB NUMBER: P3018
LOGGED BY: A.B.

BOREHOLE ID: BH103
DEPTH: 7.83 → 15.00m
CORE TRAY NO.: 1+2 of 2
DATE: 29/8/23



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 Bellambi, NSW

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Photo description

BH103 - Tray 1 and 2 of 2

Client

Landmark Group Construction Australia Pty Ltd

Location

4 Delmar Parade, Dee Why NSW

Project name

Dee Why

Project No

P3018

Scale

Not to Scale

BH No

BH103

BH Depth

7.83 to 15.00m



Morrow Geotechnics

Bellambi, NSW
Phone: 0405 843 933

Geotechnical Log - Borehole

BH104

UTM : 56H	Drill Rig : Hand Auger	Job Number : P3018
Easting (m) : 340914.1	Driller Supplier : MG	Client : Landmark Group Construction Australia Pty Ltd
Northing (m) : 6263462.4	Logged By : Mark Peach	Project : Dee Why
Ground Elevation : 31.8 (m)	Reviewed By : Rhiannon McKeon	Location : 4 Delmar Parade, Dee Why NSW
Total Depth : 20.91 m BGL	Date : 30/08/2023	Loc Comment :

Drilling Method	Water	Well Diagram	Soil Origin	Graphic Log	Classification Code	Depth (m)	Material Description	Elevation (m)	Consistency/Density	Moisture
Hand Auger	GWN		Natural Soil		PAR	0.1	Pavers	31.8		
					SW		Fill Gravelly SAND (SW) : very loose to loose, grey, fine to medium grained, fine to medium sized gravel, moist, low resistance, concrete gravels .		VL-L	M
					SW	1.4	Alluvial SAND (SW) : loose, grey, fine to medium grained, trace fine sized gravel, moist, low resistance .		L	
					SC	1.8	Alluvial Clayey SAND (SC) : loose to medium dense, low plasticity clay, orange light grey grey, medium grained, trace medium sized gravel, moist, low resistance .		L-MD	
					CL-CI	2.7	Alluvial Sandy CLAY (CL-CI) : firm, low to medium plasticity, grey orange light grey, fine to medium grained sand, with fine to medium sized gravel, w ≈ pl, low to medium resistance, ironstone and extremely weathered sandstone gravels .		F	w ≈ PL
					SST	3.1	Extremely weathered, rock Sandy CLAY (SST) : very stiff to hard, low to medium plasticity, light grey red orange, medium grained sand, with fine sized gravel, w < pl, high resistance, with sandy clay bands.		VSt-H	w < PL
						3.3m : Commenced NMLC Coring;				
						4		27.8		



Morrow Geotechnics

Bellambi, NSW
Phone: 0405 843 933

Geotechnical Log - Borehole

BH104

UTM : 56H	Drill Rig : Hand Auger	Job Number : P3018
Easting (m) : 340914.1	Driller Supplier : MG	Client : Landmark Group Construction Australia Pty Ltd
Northing (m) : 6263462.4	Logged By : Mark Peach	Project : Dee Why
Ground Elevation : 31.8 (m)	Reviewed By : Rhiannon McKeon	Location : 4 Delmar Parade, Dee Why NSW
Total Depth : 20.91 m BGL	Date : 30/08/2023	Loc Comment :

Drilling Method	Water	Well Diagram	RQD% and TCR%	Testing				Weathering	Depth (m)	Graphic Log	Classification Code	Material Description	Elevation (m)	Defect Spacing (mm)	Defect Depth	Defect Description
				Is (50)	M.S	LS	HS									
		Backfill										31.8				
		50mm PVC Solid										30.8				
												29.8				
												28.8				
NMLC Coring	0% Water Loss	Bentonite	RQD = 92% TCR = 100%					HW	3.9	SST	Rock SANDSTONE: highly weathered, low strength, light grey red orange, fine grained, massive, iron stained .					
				d: 0.65, a: 0.53				F	4	SST	Rock SANDSTONE: fresh weathered, medium strength, grey, fine grained, massive, minor carbonaceous laminations .	27.8			4.16, P, 5°, RO, PL, CL, OP	
				d: 0.27, a: 0.30											4.35, P, 3°, RO, PL, CL, OP	
		5mm Graded Sand	RQD = 99% TCR = 100%												4.81, P, 5°, PL, CL, OP	



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Geotechnical Log - Borehole

BH104

UTM : 56H	Drill Rig : Hand Auger	Job Number : P3018
Easting (m) : 340914.1	Driller Supplier : MG	Client : Landmark Group Construction Australia Pty Ltd
Northing (m) : 6263462.4	Logged By : Mark Peach	Project : Dee Why
Ground Elevation : 31.8 (m)	Reviewed By : Rhiannon McKeon	Location : 4 Delmar Parade, Dee Why NSW
Total Depth : 20.91 m BGL	Date : 30/08/2023	Loc Comment :

Drilling Method	Water	Well Diagram	RQD% and TCR%	Testing				Weathering	Depth (m)	Graphic Log	Classification Code	Material Description	Elevation (m)	Defect Spacing (mm)	Defect Depth	Defect Description
				Is(50)	M.S	LS	HS									
NMLC Coring	0% Water Loss	50mm PVC Solid	RQD = 99% TCR = 100%	d: 0.79, a: 0.83						SST	Rock SANDSTONE: fresh weathered, medium strength, grey, fine grained, massive, minor carbonaceous laminations .	26.8			5.07, P, 5°, RO, PL, CL, OP	
		5mm Graded Sand	RQD = 100% TCR = 100%	d: 0.79, a: 1.32					6	6	SST	Rock SANDSTONE: fresh weathered, medium to high strength, grey, fine grained, massive, minor carbonaceous laminations .	25.8			5.59, P, 3°, RO, PL, CL, OP
		50mm PVC Slotted	RQD = 100% TCR = 100%	d: 1.07, a: 1.25					7	7			24.8			
		50mm PVC Slotted	RQD = 100% TCR = 100%	d: 1.17, a: 0.78					8	8			23.8			8.14, P, 5°, PL, CL, OP
			RQD = 100% TCR = 100%					9	9			22.8			9.71, P, 5°, PL, CL, OP	



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Geotechnical Log - Borehole

BH104


UTM : 56H	Drill Rig : Hand Auger	Job Number : P3018
Easting (m) : 340914.1	Driller Supplier : MG	Client : Landmark Group Construction Australia Pty Ltd
Northing (m) : 6263462.4	Logged By : Mark Peach	Project : Dee Why
Ground Elevation : 31.8 (m)	Reviewed By : Rhiannon McKeon	Location : 4 Delmar Parade, Dee Why NSW
Total Depth : 20.91 m BGL	Date : 30/08/2023	Loc Comment :

Drilling Method	Water	Well Diagram	RQD% and TCR%	Testing				Weathering	Depth (m)	Graphic Log	Classification Code	Material Description	Elevation (m)	Defect Spacing (mm)	Defect Depth	Defect Description <small>type, inclination, planarity, roughness, coating, thickness</small>
				Is(50)	Estimated Strength	MS	LS									
NMLC Coring	0% Water Loss	<p>5mm Graded Sand 50mm PVC Slotted</p>	ROD = 100% TCR = 100%							SST	Rock SANDSTONE: fresh weathered, high strength, light grey, fine to medium grained, massive.	11.8				
								21			BH104 Terminated at 20.91m (Target Depth Reached)	10.8		21		
								22				9.8		22		
								23				8.8		23		
								24				7.8		24		

morrow

CLIENT NAME: LANDMARK GROUP PTY LTD BOREHOLE ID: BH 104
PROJECT: DEE WHY DEPTH: 3.3m to 8.0m
LOCATION: 4 DELMAR PARADE CORR: Box 1 of 4
JOB NUMBER: P3018 DATE: 01.11.23
LOGGED BY: MP



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Photo description	Box 1 of 4		
Client	Landmark Group Construction Australia Pty Ltd		
Location	4 Delmar Parade, Dee Why NSW		
Project name	Dee Why		
Project No	P3018	Scale	Not to Scale
BH No	BH104	BH Depth	3.3m to 8.0m

morrow

CLIENT NAME: LANDMARK GROUP PTY LTD BOREHOLE ID: BH104
PROJECT: DEE WHY DEPTH: 8.0 m to 13.0 m
LOCATION: 4 DELMAR PARADE CORR: Box 2 of 4
JOB NUMBER: P3018 DATE: 02.11.23
LOGGED BY: MP



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Photo description

Box 2 of 4

Client

Landmark Group Construction Australia Pty Ltd

Location

4 Delmar Parade, Dee Why NSW

Project name

Dee Why

Project No

P3018

Scale

Not to Scale

BH No

BH104

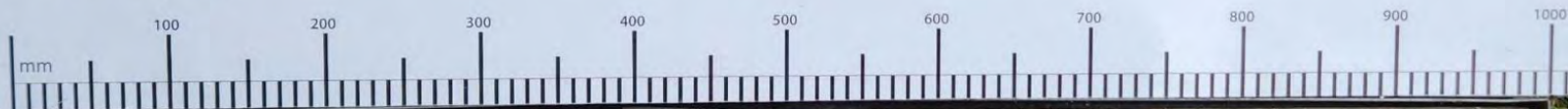
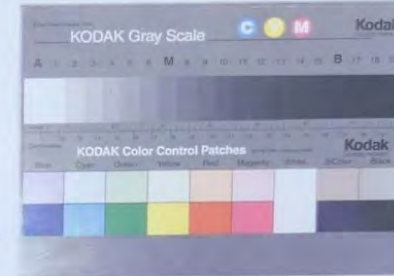
BH Depth

8.0m to 13.0m

morrow

CLIENT NAME: LANDMARK GROUP PTY LTD
 PROJECT: DEE WHY
 LOCATION: 4 DELMAR PARADE
 JOB NUMBER: P3018
 LOGGED BY: MP

BOREHOLE ID: BH104
 DEPTH: 13.0m to 18.0m
 CORE: Box 3 of 4
 DATE: 03.11.23



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Photo description

Box 3 of 4

Client

Landmark Group Construction Australia Pty Ltd

Location

4 Delmar Parade, Dee Why NSW

Project name

Dee Why

Project No

P3018

Scale

Not to Scale

BH No

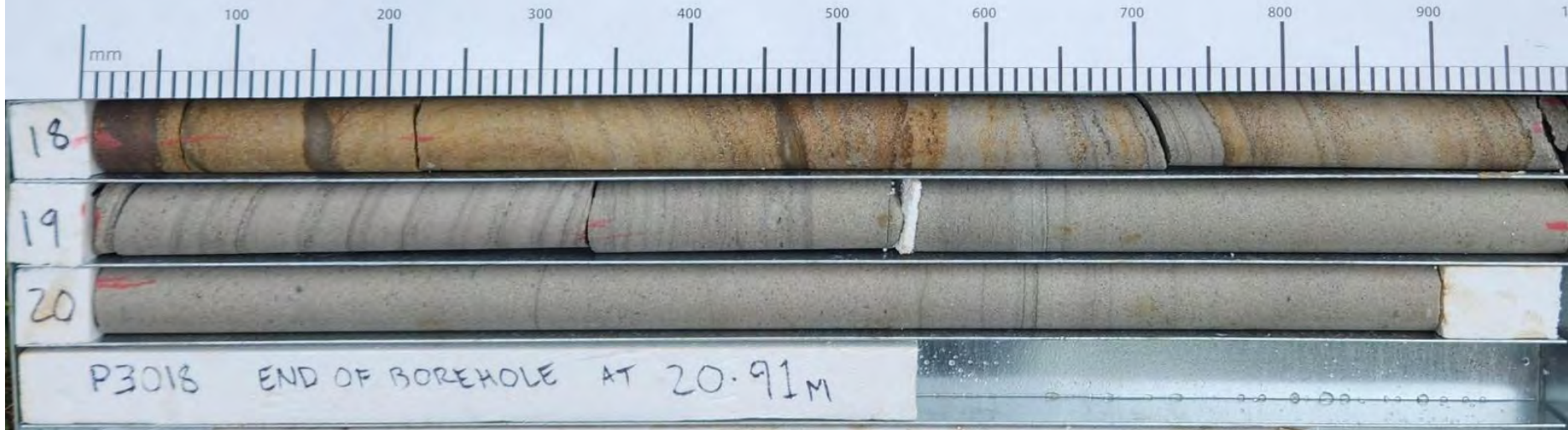
BH104

BH Depth

13.0m to 18.0m

morrow

CLIENT NAME: LANDMARK GROUP PTY LTD BOREHOLE ID: BH104
PROJECT: DEE WHY DEPTH: 18.0m to 20.91m
LOCATION: 4 DELMAR PARADE CORN: Box 4 of 4
JOB NUMBER: P3018 DATE: 03.11.23
LOGGED BY: MP



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Photo description	Box 4 of 4		
Client	Landmark Group Construction Australia Pty Ltd		
Location	4 Delmar Parade, Dee Why NSW		
Project name	Dee Why		
Project No	P3018	Scale	Not to Scale
BH No	BH104	BH Depth	18.0m to 20.91m



Morrow Geotechnics

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Geotechnical Log - Borehole

BH105

UTM : 56H	Drill Rig : Christie Rig	Job Number : P3018
Easting (m) : 341010.2	Driller Supplier : Tracess	Client : Landmark Group Construction Australia Pty Ltd
Northing (m) : 6263530.0	Logged By : Mahmoud Jangidaryan	Project : Dee Why
Ground Elevation : 28.5 (m)	Reviewed By : Mark Peach	Location : 4 Delmar Parade, Dee Why NSW
Total Depth : 22.22 m BGL	Date : 08/11/2023	Loc Comment :

Drilling Method	Water	DCP graph	Soil Origin	Graphic Log	Classification Code	Depth (m)	Material Description	Elevation (m)	Consistency/Density	Moisture
Diatube			Non-Soil		CCT	0.15	Concrete	28.5		
			Fill		SC	0.4	Fill Clayey to gravelly SAND (SC) : low plasticity clay, medium dense, brown, fine grained, fine sized gravel, moist.		MD	M
			Alluvial		SC	1	Alluvial Clayey SAND (SC) : medium dense, low plasticity clay, brown, fine grained, trace fine sized gravel, moist.	27.5		
			Alluvial		CI	1.5	Alluvial Sandy CLAY (CI) : stiff to very stiff, medium plasticity, brown yellow, fine grained sand, w < pl.	26.5	St-VSt	w < PL
			Alluvial		CL	3	Alluvial Sandy CLAY (CL) : very stiff, low plasticity, yellow brown orange brown yellow, fine grained sand, w < pl.	25.5	VSt	
						4		24.5		



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Geotechnical Log - Borehole

BH105

UTM : 56H	Drill Rig : Christie Rig	Job Number : P3018
Easting (m) : 341010.2	Driller Supplier : Tracess	Client : Landmark Group Construction Australia Pty Ltd
Northing (m) : 6263530.0	Logged By : Mahmoud Jangidaryan	Project : Dee Why
Ground Elevation : 28.5 (m)	Reviewed By : Mark Peach	Location : 4 Delmar Parade, Dee Why NSW
Total Depth : 22.22 m BGL	Date : 08/11/2023	Loc Comment :

Drilling Method	Water	DCP graph	Soil Origin	Graphic Log	Classification Code	Depth (m)	Material Description	Elevation (m)	Consistency/Density	Moisture
ADT			Residual		CL	5	Residual Sandy CLAY (CL) : very stiff, low plasticity, grey light grey orange, fine to medium grained sand, w ≈ pl.	23.5		w ≈ PL
			Residual		CL	6	As above, but grey orange brown yellow, fine grained sand, trace fine sized gravel, w ≈ ll.	22.5		w ≈ LL
			Rock		SST	7.6	Extremely weathered, rock Clayey SAND (SST) : very dense, low plasticity clay, brown brown yellow, fine grained, trace fine sized gravel, wet.	20.5	VD	W
						8.72m : Commenced NMLC Coring;				
						9		19.5		



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Bellambi, NSW
Phone: 0405 843 933

Geotechnical Log - Borehole

BH105

UTM : 56H	Drill Rig : Christie Rig	Job Number : P3018
Easting (m) : 341010.2	Driller Supplier : Tracess	Client : Landmark Group Construction Australia Pty Ltd
Northing (m) : 6263530.0	Logged By : Mahmoud Jangidaryan	Project : Dee Why
Ground Elevation : 28.5 (m)	Reviewed By : Mark Peach	Location : 4 Delmar Parade, Dee Why NSW
Total Depth : 22.22 m BGL	Date : 08/11/2023	Loc Comment :

Drilling Method	Water	RQD% and TCR%	Testing		Estimated Strength	Weathering	Depth (m)	Graphic Log	Classification Code	Material Description	Elevation (m)	Defect Spacing (mm)	Defect Depth	Defect Description <small>type, inclination, planarity, roughness, coating, thickness</small>
			Is(50)											
							6							
							7							
							8							
NMLC Coring	0% Water Loss	RQD = 100% TCR = 100%				HW	9		SST	Rock SANDSTONE: highly weathered, very low strength, orange, fine grained, generally massive, with minor xw and dw sandstone bands, iron stained.	19.5			



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Geotechnical Log - Borehole

BH105

UTM : 56H	Drill Rig : Christie Rig	Job Number : P3018
Easting (m) : 341010.2	Driller Supplier : Tracess	Client : Landmark Group Construction Australia Pty Ltd
Northing (m) : 6263530.0	Logged By : Mahmoud Jangidaryan	Project : Dee Why
Ground Elevation : 28.5 (m)	Reviewed By : Mark Peach	Location : 4 Delmar Parade, Dee Why NSW
Total Depth : 22.22 m BGL	Date : 08/11/2023	Loc Comment :

Drilling Method	Water	RQD% and TCR%	Testing		Estimated Strength	Weathering	Depth (m)	Graphic Log	Classification Code	Material Description	Elevation (m)	100% Defect Spacing (mm)	Defect Depth	Defect Description		
			Is(50)	Is(100)												
NMLC Coring	0% Water Loss	RQD = 100% TCR = 100%	d: 0.07, a: 0.01		VLS LS MS HS EHS	HW	10.3	[Dotted Pattern]	SST	Rock SANDSTONE: highly weathered, very low strength, orange, fine grained, generally massive, with minor xw and dw sandstone bands, iron stained.	18.5	30				
						HW-M			SST	Rock SANDSTONE: highly to moderately weathered, low strength, grey light grey, fine to medium grained, medium grained.						
		RQD = 90% TCR = 100%	d: 0.20, a: 0.21					11				17.5		11.06, P, RO, PL, CL, OP 11.14, P, RO, PL, CL, OP		
							SW-F	11.15		SST	Rock SANDSTONE: slightly to fresh weathered, medium strength, light grey mottled yellow white, fine grained, 10-15 degree 2mm beddings at 10-20mm spacing.					
								12				16.5				
								13								
								13.32		SST	Rock SANDSTONE: slightly to fresh weathered, medium to high strength, very light grey with grey, medium to coarse grained, generally massive, medium to coarse grained with sub rounded gravels.					
								14					14.5			
								14.45		SST	Rock SANDSTONE: fresh weathered, medium to high strength, light grey, fine grained, generally massive, 10° laminations at 1-5mm spacing.					



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Geotechnical Log - Borehole

BH105

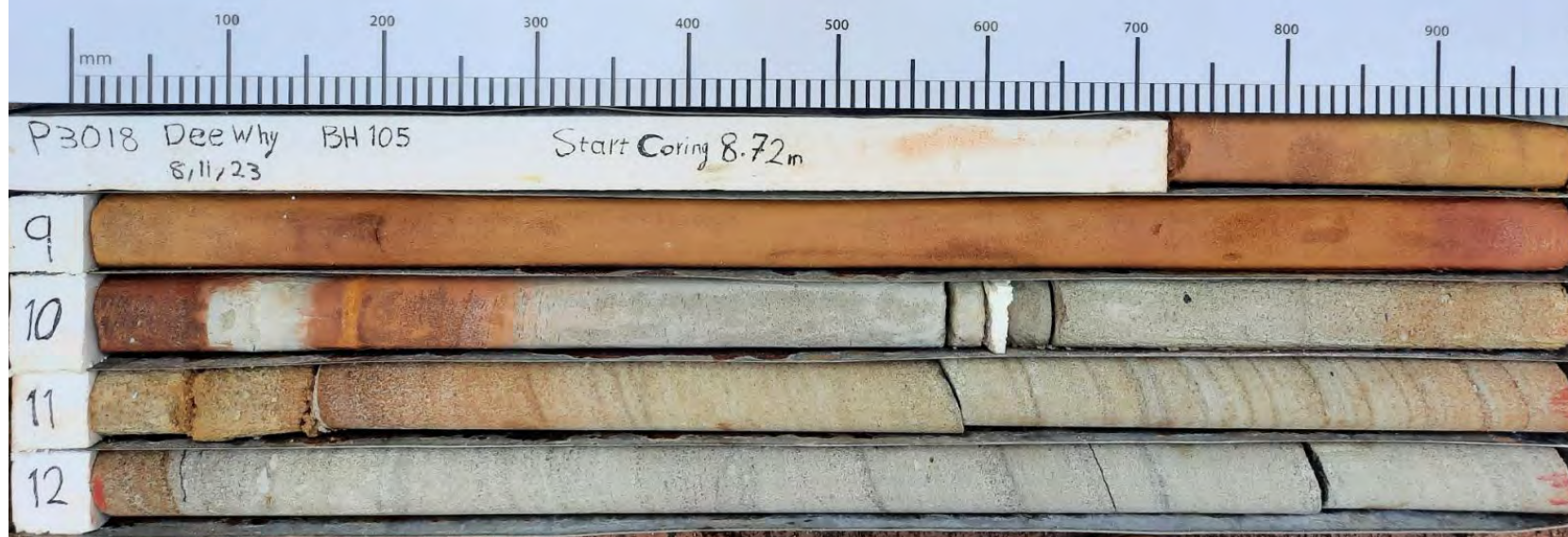
UTM : 56H	Drill Rig : Christie Rig	Job Number : P3018
Easting (m) : 341010.2	Driller Supplier : Tracess	Client : Landmark Group Construction Australia Pty Ltd
Northing (m) : 6263530.0	Logged By : Mahmoud Jangidaryan	Project : Dee Why
Ground Elevation : 28.5 (m)	Reviewed By : Mark Peach	Location : 4 Delmar Parade, Dee Why NSW
Total Depth : 22.22 m BGL	Date : 08/11/2023	Loc Comment :

Drilling Method	Water	RQD% and TCR%	Testing		Estimated Strength	Weathering	Depth (m)	Graphic Log	Classification Code	Material Description	Elevation (m)	100% Defect Spacing (mm)	Defect Depth	Defect Description <small>type, inclination, planarity, roughness, coating, thickness</small>		
			Is(50)	Is(100)												
NMLC Coring	70% Water Loss	RQD = 88% TCR = 100%			[Shaded Bar]	T	[Dotted Pattern]	SST	Rock SANDSTONE: fresh weathered, medium to high strength, light grey, fine grained, generally massive, 10° laminations at 1-5mm spacing.	13.5	[Line Graph]	[Line Graph]	15.34, J, 75°, RO, PL, CL, OP	15.37, P, 10°, RO, PL, CL, OP		
		d: 1.58, a: 1.52	16	16.3, P, 5°, SO, PL, CL, OP												
		d: 0.87, a: 0.90	17	16.59, P, 5°, SO, PL, CL, OP									16.73, J, 60°, RO, PL, CL, OP	16.77, P, RO, PL, CL, OP		
		RQD = 91% TCR = 100%	18	17.09, P, RO, PL, CL, OP												
		d: 0.89, a: 1.08	19	17.6, P, 5°, SO, PL, CL, OP									17.7, P, 5°, RO, PL, CL, OP			
		RQD = 71% TCR = 100%											18.3, P, 5°, SO, PL, CL, OP	18.37, P, 10°, RO, PL, CL, OP	18.46, P, 10°, RO, PL, CL, OP	18.57, P, 15°, RO, PL, CL, OP
														19.32, P, 5°, RO, PL, CL, OP	19.66, J, 80°, RO, PL, CL, OP	19.9, J, 75°, RO, PL, CL, OP

morrow

CLIENT NAME: Landmark Group Construction Australia
PROJECT: Dee Why
LOCATION: 4 Delmar Parade
JOB NUMBER: P3018
LOGGED BY: MJ

BOREHOLE ID: BH105
DEPTH: 8.72 to 13
CORE TRAY NO: Tray 1 of 3
DATE: 8, 11, 23



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Photo description

Box 1 of 3

Client

Landmark Group Construction Australia Pty Ltd

Location

4 Delmar Parade, Dee Why NSW

Project name

Dee Why

Project No

P3018

Scale

Not to Scale

BH No

BH105

BH Depth

8.72m to 13.0m

morrow

CLIENT NAME: Landmark Group Construction Australia
PROJECT: Dee Why
LOCATION: 4 Delmar Parade
JOB NUMBER: P3018
LOGGED BY: MJ

BOREHOLE #: BH105
DEPTH: 13 to 18
CORE TRAY NO: 2 of 3
DATE: 8/11/23



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Photo description

Box 2 of 3

Client

Landmark Group Construction Australia Pty Ltd

Location

4 Delmar Parade, Dee Why NSW

Project name

Dee Why

Project No

P3018

Scale

Not to Scale

BH No

BH105

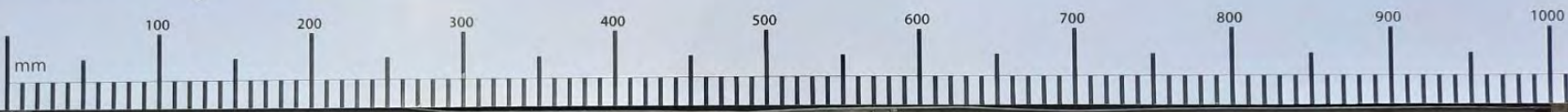
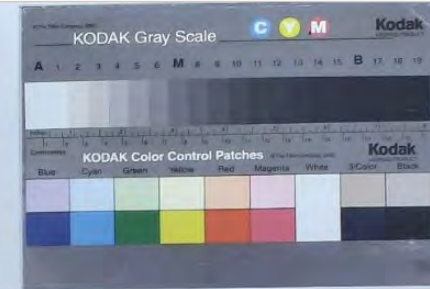
BH Depth

13.0m to 18.0m

morrow

CLIENT NAME Landmark Group Construction Australia
 PROJECT: Dee Why
 LOCATION: 4 Delmar Parade
 JOB NUMBER: P3018
 LOGGED BY: MJ

BOREHOLE ID: BH105
 DEPTH: 18 to 22.22
 CORE TRAY NO: 3 of 3
 DATE: 8/11/23



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Photo description

Box 3 of 3

Client

Landmark Group Construction Australia Pty Ltd

Location

4 Delmar Parade, Dee Why NSW

Project name

Dee Why

Project No

P3018

Scale

Not to Scale

BH No

BH105

BH Depth

18.0m to 22.22m

GENERAL

Information obtained from site investigations is recorded on log sheets. The "Cored Drill Hole Log" presents data from an operation where a core barrel has been used to recover material - commonly rock. The "Non-Core Drill Hole - Geological Log" presents data from an operation where coring has not been used and information is based on a combination of regular sampling and insitu testing. The material penetrated in non-core drilling is commonly soil but may include rock. The "Excavation - Geological Log" presents data and drawings from exposures of soil and rock resulting from excavation of pits, trenches, etc.

The heading of the log sheets contains information on Project Identification, Hole or Pit Identification, Location and Elevation. The main section of the logs contains information on methods and conditions, material substance description and structure presented as a series of columns in relation to depth below the ground surface which is plotted on the left side of the log sheet. The common depth scale is 8m per drill log sheet and about 3-5m for excavation logs sheets.

As far as is practicable the data contained on the log sheets is factual. Some interpretation is inevitable in the identification of material boundaries in areas of partial sampling, the location of areas of core loss, description and classification of material, estimation of strength and identification of drilling induced fractures. Material description and classifications are based on SAA Site Investigation Code AS 1726 - 1993 with some modifications as defined below.

These notes contain an explanation of the terms and abbreviations commonly used on the log sheets.

DRILLING

Drilling & Casing

ADV	Auger Drilling with V-Bit
ADT	Auger Drilling with TC Bit
WB	Wash-bore drilling
RR	Rock Roller
NMLC	NMLC core barrel
NQ	NQ core barrel
HMLC	HMLC core barrel
HQ	HQ core barrel

Drilling Fluid/Water

The drilling fluid used is identified and loss of return to the surface estimated as a percentage.

Drilling Penetration/Drill Depth

Core lifts are identified by a line and depth with core loss per run as a percentage. Ease of penetration in non-core drilling is abbreviated as follows:

VE	Very Easy
E	Easy
M	Medium
H	High
VH	Very High

Groundwater Levels

Date of measurement is shown.

Standing water level measured in completed borehole

Level taken during or immediately after drilling

D	Disturbed
B	Bulk
U	Undisturbed
SPT	Standard Penetration Test
N	Result of SPT (sample taken)
PBT	Plate Bearing Test
PZ	Piezometer Installation
HP	Hand Penetrometer Test

EXCAVATION LOGS

Explanatory notes are provided at the bottom of drill log sheets. Information about the origin, geology and pedology may be entered in the "Structure and other Observations" column. The depth of the base of excavation (for the logged section) at the appropriate depth in the "Material Description" column. Refusal of excavation plant is noted should it occur. A sketch of the exposure may be added.

MATERIAL DESCRIPTION - SOIL

Classification Symbol - In accordance with the Unified Classification System (AS 1726-1993, Appendix A, Table A1)

Material Description - In accordance with AS 1726-1993, Appendix A2.3

Moisture Condition

D	Dry, looks and feels dry
M	Moist, No free water on remoulding
W	Wet, free water on remoulding

Consistency - In accordance with AS 1726-1993, Appendix A2.5

VS	Very Soft	< 12.5 kPa
S	Soft	12.5 – 25 kPa
F	Firm	25 – 50 kPa
St	Stiff	50 – 100 kPa
VSt	Very Stiff	100 – 200 kPa
H	Hard	> 200 kPa

Strength figures quoted are the approximate range of undrained shear strength for each class.

Density Index. (%) is estimated or is based on SPT results.

VL	Very Loose	< 15 %
L	Loose	15 – 35 %
MD	Medium Dense	35 – 65 %
D	Dense	65 – 85 %
VD	Very Dense	> 85 %

MATERIAL DESCRIPTION -ROCK

Material Description

Identification of rock type, composition and texture based on visual features in accordance with AS 1726-1993, Appendix A3.1-A3.3 and Tables A6a, A6b and A7.

Core Loss

Is shown at the bottom of the run unless otherwise indicated.

Bedding

Thinly Laminated	< 6 mm
Laminated	6 - 20
Very Thinly Bedded	20 - 60
Thinly Bedded	60 - 200
Medium Bedded	200 – 600
Thickly Bedded	600 – 2000
Very Thickly Bedded	> 2000

Weathering - No distinction is made between weathering and alteration. Weathering classification assists in identification but does not imply engineering properties.

Fresh (F)	Rock substance unaffected by weathering
Slightly Weathered (SW)	Rock substance partly stained or discoloured. Colour and texture of fresh rock recognisable.
Moderately Weathered (MW)	Staining or discolouration extends throughout rock substance. Fresh rock colour not recognisable.
Highly Weathered (HW)	Stained or discoloured throughout. Signs of chemical or physical alteration. Rock texture retained.
Extremely Weathered (EW)	Rock texture evident but material has soil properties and can be remoulded.

Strength - The following terms are used to described rock strength:

Rock Strength Class	Abbreviation	Point Load Strength Index, Is(50) (MPa)
Extremely Low	EL	< 0.03
Very Low	VL	0.03 to 0.1
Low	L	0.1 to 0.3
Medium	M	0.3 to 1
High	H	1 to 3
Very High	VH	3 to 10
Extremely High	EH	≥ 10

Strengths are estimated and where possible supported by Point Load Index Testing of representative samples. Test results are plotted on the graphical estimated strength by using:

° Diametral Point Load Test

Axial Point Load Test

Where the estimated strength log covers more than one range it indicates the rock strength varies between the limits shown.

MATERIALS STRUCTURE/FRACTURES

ROCK

Natural Fracture Spacing - A plot of average fracture spacing excluding defects known or suspected to be due to drilling, core boxing or testing. Closed or cemented joints, drilling breaks and handling breaks are not included in the Natural Fracture Spacing.

Visual Log - A diagrammatic plot of defects showing type, spacing and orientation in relation to core axis.

Defects		Defects open in-situ or clay sealed Defects closed in-situ Breaks through rock substance
---------	--	--

Additional Data - Description of individual defects by type, orientation, in-filling, shape and roughness in accordance with AS 1726-1993, Appendix A Table A10, notes and Figure A2.

Orientation - angle relative to the plane normal to the core axis.

Type	BP JT SM FZ SZ VN FL CL DL HB DB	Bedding Parting Joint Seam Fracture Zone Shear Zone Vein Foliation Cleavage Drill Lift Handling Break Drilling Break
Infilling	CN X Clay KT CA Fe Qz MS MU	Clean Carbonaceous Clay Chlorite Calcite Iron Oxide Quartz Secondary Mineral Unidentified Mineral
Shape	PR CU UN ST IR DIS	Planar Curved Undulose Stepped Irregular Discontinuous
Roughness	POL SL S RF VR	Polished Slicksided Smooth Rough Very Rough

SOIL

Structures - Fissuring and other defects are described in accordance with AS 1726-1993, Appendix A2.6, using the terminology for rock defects.

Origin - Where practicable an assessment is provided of the probable origin of the soil, eg fill, topsoil, alluvium, colluvium, residual soil.

IMPORTANT INFORMATION

This Document has been provided by Morrow Geotechnics Pty Ltd subject to the following limitations:

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