



RESIDENTIAL DEVELOPMENT
38 UNDERCLIFF ROAD, FRESHWATER NSW

Prepared for:

MHNDU

Reference: P3371_01 Rev 1

17 October 2024

1 PROJECT BACKGROUND

Morrow Geotechnics Pty Ltd has undertaken a Geotechnical Investigation to provide geotechnical advice and recommendations for the proposed development at 38 Undercliff Road, Freshwater NSW (the site).

1.1 Proposed Development

Architectural drawings for the proposed development have been prepared by MHNDU with drawing number 5.2 to 5.4 Rev B-WIP, 5.5 Rev A-WIP, 5.10 Rev B-WIP, 5.11 Rev B-WIP, 5.13 to 5.16 Rev B-WIP, dated 28 August 2024. The drawings provided show that the proposed development involves the demolition of the existing dwelling and redevelopment of the site with a duplex two-storey residential development and an inground swimming pool at each property.

1.2 Investigation Intent

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

- Expected subsurface conditions;
- Lot classification in accordance with AS2870 and geotechnical parameters for foundation design;
- Excavation support options, including lateral earth pressures and pile design parameters;
- Advice on possible seepage water associated with construction;
- Earthquake site classification in accordance with AS1170.4; and
- Advice on geotechnical construction constraints.

1.3 Published Geological Mapping

Information on regional sub-surface conditions, referenced from the Department of Mineral Resources Geological Map Sydney 1:100,000 (Geological Series Sheet 9130) indicates that the site is underlain by (Rh) Hawkesbury Sandstone, which is typically comprised of medium to coarse-grained quartz sandstone, with very minor shale and laminite lenses.

1.4 Published Soil Landscapes

The Soil Conservation Service of NSW Sydney 1:100,000 Soil Landscapes Series Sheet 9130 (2nd Edition) indicates that the erosional landscape at the site likely comprises the Gynea Landscape. This 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.

2 OBSERVATIONS

2.1 Investigation Methods

Fieldwork was undertaken by Morrow Geotechnics on 23 September 2024. 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 Geotechnical Engineer to assess topographical features, condition of surrounding structures and site conditions;
- Drilling of three boreholes (BH1 to BH3). The Boreholes were drilled using a track mounted drill rig using solid flight augers equipped with a tungsten-carbide bit (TC bit). The boreholes were extended beyond TC bit refusal by NMLC coring techniques to depths of 6.1, 8.1 and 12.1 mBGL. Rock core was boxed and photographed and point load tests were undertaken on selected core sample to assess rock strength;
- Groundwater observations within the borehole during drilling; and
- Installation of three groundwater monitoring wells within the boreholes 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 fill, colluvial soil, residual soil and sandstone bedrock. Observations taken during the investigation have been used to produce a stratigraphic model of the site. The observed stratigraphy has been divided into five geotechnical units.

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 ENCOUNTERED SUBSURFACE CONDITIONS

Unit	Material	Comments
1	Topsoil/Fill	Gravelly sandy clay FILL, firm to stiff, fine to medium grained. Unit 1 is inferred to be uncontrolled and poorly compacted.
2	Colluvial Soil	Sandy CLAY, stiff, medium plasticity, fine to medium grained sand.
3	Residual Soil	Residual SAND, medium dense, fine to medium grained, grading to extremely weathered Sandstone with depth.
4	Class V-IV Sandstone	Extremely to highly weathered SANDSTONE, generally massive, extremely low to very low strength, fine to medium grained and iron stained. Defects within Unit 4 comprise sub-horizontal bed partings and extremely weathered seams.
5	Class III Sandstone	Moderately to slightly weathered SANDSTONE, medium strength, generally massive. Defects within Unit 5 comprise iron stained sub-horizontal bed partings and joints inclined to between 30° and 90°.

TABLE 2 ENCOUNTERED GEOTECHNICAL CONDITIONS

Unit	Approx. Depth Range of Unit ¹ mBGL (RL mAHD)		
	BH1	BH2	BH3
1 Topsoil/Fill	0.0 to 0.75 (22.3 to 21.55)	0.0 to 0.3 (18.0 to 17.7)	0.0 to 0.25 (18.5 to 18.25)
2 Colluvial Soil	-	0.3 to 0.8 (17.7 to 17.2)	0.25 to 0.6 (18.25 to 17.9)
3 Residual Soil	0.75 to 1.0 (21.55 to 21.3)	0.8 to 1.0 (17.2 to 17.0)	-
4 Class V-IV Sandstone	1.0 to 11.6 (21.3 to 10.7)	1.0 to 3.6 (17.0 to 14.4)	0.6 to 3.3 (17.9 to 15.2)
5 Class III Sandstone	11.6 + (sub 10.7)	3.6 + (sub 14.4)	3.3 + (Sub 15.2)

Notes:

- 1 Depths shown are based on material observed within test locations and will vary across the site.
- 2 Sandstone classed as per Pells (2004)

Sandstone outcrops at a cliff line approximately 1.5 m high near the centre of the site. The cliff line trends roughly east-west and comprises moderately weathered, medium strength Hawkesbury Sandstone.

**Photo 1:** Sandstone outcropping at centre of site.

2.1 Groundwater Observations

Groundwater seepage was not observed during the drilling of any boreholes during the investigation.

3 GEOTECHNICAL RECOMMENDATIONS FOR DESIGN

3.1 Excavation Retention

Where shoring systems are proposed the following Geotechnical parameters should be adopted for shoring design.

TABLE 4 EARTH PRESSURE PARAMETERS

		Unit 1	Unit 2	Unit 3	Unit 4	Unit 5
Material		Fill	Colluvial Soil	Residual Soil	Class V-IV Sandstone	Class III Sandstone
Unit Weight (kN/m ³)		18	18	19	24	24
Earth Pressure Coefficients	At Rest, K_0	0.58	0.50	0.56	0.46	0.36
	Passive, K_p	2.46	3.00	2.56	3.39	4.60
	Active, K_a	0.41	0.33	0.39	0.29	0.22
Drained Cohesion, c' (kPa)		2	0	4	50	250
Friction Angle, ϕ' (°)		25	30	26	33	40
Elastic Modulus (MPa)		5	15	20	100	600
Poisson's Ratio		0.30	0.30	0.30	0.25	0.20

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 considered 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 Unit 5 material to account for a failure wedge forming behind the shoring system.

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 5**. 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 5 SOIL AND ROCK EXCAVATABILITY

Unit	Material	Excavatability
1	Fill	Easy digging by 20t Excavator
2	Colluvial Soil	Easy to moderate digging by 20t Excavator
3	Residual Soil	Moderate to hard digging by 20t Excavator
4	Class V-IV Sandstone	Hard ripping by 20t Excavator with hydraulic hammering required where medium strength sandstone is encountered within Unit 4
5	Class III Sandstone	Hydraulic hammering will be required within Unit 5

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 6**. 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 6 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

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 6** 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 6** 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 or Unit 2 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 'H1.' 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.

Ultimate geotechnical strengths are provided for use in limit state design. Allowable bearing pressures are provided 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.

The parameters given in **Table 7** may be used for the design of pad footings and deep footings (bored pile).

TABLE 7 PAD FOOTING AND PILE DESIGN PARAMETERS

Material		Unit 1 Fill	Unit 2 Colluvial Soil	Unit 3 Residual Soil	Unit 4 Class V-IV Sandstone	Unit 5 Class III Sandstone
Allowable Bearing Pressure (kPa)		N/A	N/A	200	1200	3500
Ultimate Vertical End Bearing Pressure (kPa)		N/A	N/A	600	3600	10500
Elastic Modulus (MPa)		5	15	20	100	600
Ultimate Shaft Adhesion (kPa)	In Compression	0	20	30	250	800
	In Tension	0	10	15	125	400
Susceptibility to Liquefaction		Medium	Low	Low	Low	Low

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.

To adopt these parameters, we have assumed that the bases of all footings 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.

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 be 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 B_e – Rock for the site.

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 (1981) Sydney 1:100,000 Geological Series Sheet 9130 (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,



Jordan Andonoski
Geotechnical Engineer



Alan Morrow
Principal Geotechnical Engineer



02 8599 7579

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P: 02 8599 7579
F:

Borehole Location Plan

Client No:

Job No: P3371

Client: MHNDU

Project: Freshwater

Address: 38 Undercliff Road, Freshwater NSW

Legend:

Borehole Locations

Image Source: NearMap

Viewed: 2024-10-08

Drawn By:
Jordan
Andonoski

Checked By:
Alan Morrow

Date:
2024-10-08

Figure:
1

BOREHOLE LOGS AND EXPLANATORY NOTES



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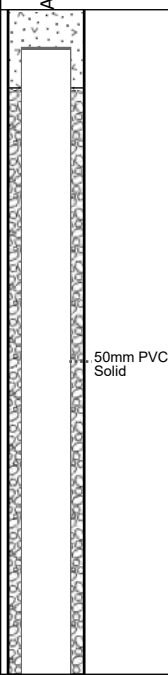
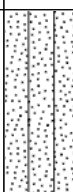



Sydney Gadigal Land: 2/5-7 Malta Steet, Fairfield East NSW 2155

Phone: 02 8599 7579

Geotechnical Log - Borehole

BH1

UTM : 56H Drill Rig : GEO205 - Comacchio Job Number : P3371
Easting (m) : 341,315.28 Driller Supplier : GEONSENSE Client : MHNDU
Northing (m) : 6,260,908.32 Logged By : Jordan Andonoski Project : Freshwater
Ground Elevation : 22.3 (m) Reviewed By : Alan Morrow Location : 38 Undercliff Road, Freshwater NSW
Total Depth : 12.1 m BGL Date : 24/09/2024 Loc Comment :

Drilling Method	Water	Well Diagram	Testing	Soil Origin	Graphic Log	Classification Code	Depth (m)	Material Description	Elevation	Weathering	Consistency	Moisture
			SPT						Depth (m)			
ADT				TOPSOIL		SM		Topsoil Silty SAND SM: loose, brown, fine to medium grained, with fine to coarse sized gravel, dry, with rootlets and sub angular sandstone gravels.			L	D
			5, 5, 10 (N=15)				0.75		21.6			
				Residual		SW		Residual SAND SW: medium dense, orange, fine to medium grained, trace low plasticity clay, dry.	0.75		MD	
							1		21.3			
				Rock		SST		Extremely weathered, rock SAND SST: very dense, orange, fine to medium grained, low resistance.	1	XW	VD	
			6 (N=12)				1.2		21.1			
						SST		Extremely weathered, rock SAND SST: very dense, orange and white, fine to medium grained, medium resistance .	1.2	XW		D
							1.7		20.6			
								For continuation go to next page	1.7			

UTM : 56H	Drill Rig : GEO205 - Comacchio	Job Number : P3371
Easting (m) : 341,315.28	Driller Supplier : GEOSENSE	Client : MHNDU
Northing (m) : 6,260,908.32	Logged By : Jordan Andonoski	Project : Freshwater
Ground Elevation : 22.3 (m)	Reviewed By : Alan Morrow	Location : 38 Undercliff Road, Freshwater NSW
Total Depth : 12.1 m BGL	Date : 24/09/2024	Loc Comment :

Drilling Method	Water	Well Diagram	RQD% and TCR%	Testing	Estimated Strength	Depth (m)	Graphic Log	Classification Code	Material Description	Elevation	Weathering	Defect Spacing (mm)	Defect Description
				Is(50)						Depth (m)			
		A			VLS LS MS HS VHS EHS	1							
									Commenced Coring at 1.7m				
↑ NMLC Coring ↓			RQD = 18% TCR = 45%	d: 0.06, a: 0.08		1.82	SST		As above, but highly weathered, very low to low strength, and white orange, fine to medium grained, high resistance .	20.5	HW		1.75, P, 2°, PL, RO, STN, OP, 1.82, P, 2°, PL, RO, STN, OP, 1.9, P, 2°, PL, RO, CL, OP, 2, P, 2°, PL, RO, CL, OP, 2.05-2.06, P, 10°, PL, RO, CL, OP, 2.15-2.19, J, 45°, PL, RO, CT, OP, rootlets, 2.3, P, 3°, IR, RO, CL, OP, 2.41-2.43, P, 20°, PL, RO, CL, OP, 2.52-2.58, J, 50°, PL, RO, CL, OP, 2.66-2.73, J, 50°, PL, RO, CL, OP, 2.73-2.83, XWS, 2.73, IS, sand,
				d: 0.02, d: 0.07		2	SST		As above, but slightly weathered, very low strength, white and orange, generally massive.	1.82			2.91-2.94, XWS, 2.94-4.62, CORELOSS, Core Loss (notes),
						2.94			Coreloss 1047 mm thk	19.4	SW		
						3	PAV			2.94			



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Phone: 02 8599 7579

Geotechnical Log - Borehole

BH1

UTM	: 56H	Drill Rig	: GEO205 - Comacchio	Job Number	: P3371
Easting (m)	: 341,315.28	Driller Supplier	: GEOSENSE	Client	: MHNDU
Northing (m)	: 6,260,908.32	Logged By	: Jordan Andonoski	Project	: Freshwater
Ground Elevation	: 22.3 (m)	Reviewed By	: Alan Morrow	Location	: 38 Undercliff Road, Freshwater NSW
Total Depth	: 12.1 m BGL	Date	: 24/09/2024	Loc Comment	:

Drilling Method	Water	Well Diagram	RQD% and TCR%	Testing	Estimated Strength	Depth (m)	Graphic Log	Classification Code	Material Description	Elevation	Weathering	Defect Spacing (mm)	Defect Description
				Is(50)						Depth (m)			
			RQD = 18% TCR = 45%		VLS LS MS HS VHS EHS				Coreloss 1047 mm thk				
						4.63		PAV					
				d:0.23, a:0.28		5		SST	Rock SANDSTONE: slightly weathered, low strength, white and orange, coarse grained, generally massive .	17.7 4.63	SW		4.96, P, 5°, PL, RO, STN, OP, 5, P, 2°, PL, RO, CL, OP, 5.1, P, 2°, PL, RO, CL, OP, 5.15-5.16, P, 5°, PL, Very Rough, CL, OP, 5.28-5.45, J, 80°, PL, RO, STN, OP, 5.51, P, 2°, PL, RO, CL, OP, 5.6, P, 2°, UN, RO, CL, OP, 5.65-5.7, J, 45°, PL, RO, CL, OP, 5.7-7.75, CORELOSS, Core Loss (notes),
						5.71			Coreloss	16.6 5.71			
			RQD = 21% TCR = 36%			6		PAV					
						7							
			RQD = 20% TCR = 86%			7.75		SST	Rock SANDSTONE: highly weathered, very low strength, white and orange, coarse grained, generally massive .	14.6 7.75	HW		

UTM : 56H	Drill Rig : GEO205 - Comacchio	Job Number : P3371
Easting (m) : 341,315.28	Driller Supplier : GEOSENSE	Client : MHNDU
Northing (m) : 6,260,908.32	Logged By : Jordan Andonoski	Project : Freshwater
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Total Depth : 12.1 m BGL	Date : 24/09/2024	Loc Comment :

Drilling Method	Water	Well Diagram	RQD% and TCR%	Testing	Estimated Strength	Depth (m)	Graphic Log	Classification Code	Material Description	Elevation	Weathering	Defect Spacing (mm)	Defect Description
				Is(50)						Depth (m)			
			RQD = 20% TCR = 86%	d:0.26, a:10	VLS LS MS HS VHS EHS	8			As above, but slightly weathered, very low to low strength, white and orange, generally massive .	14.3 8			8.11, P, 2°, PL, RO, CL, OP, 8.16-8.88, J, 90°, CV, RO, STN, OP,
						9		SST			SW		8.97-8.98, P, 10°, PL, RO, CL, OP, 9.02, P, 2°, UN, RO, CL, OP, 9.08-9.13, J, 40°, PL, RO, STN, OP,
				d:0.07, a:0.07									9.32-9.35, XWS,
													9.55-9.6, J, 45°, PL, RO, STN, OP, 9.61-9.68, J, 70°, PL, Very Rough, STN, OP, 9.68-9.73, J, 45°, CV, RO, STN, OP,
													9.81-9.85, J, 40°, PL, RO, CL, OP,
						10			Coreloss	12.3 10			10-10.66, CORELOSS, Core Loss (notes),
						10.66		PAV					
						11		SST	Rock SANDSTONE: highly weathered, very low strength, white and pale grey, fine to medium grained, generally massive .	11.6 10.66		HW	11.1, P, 2°, PL, RO, CL, OP, 11.18-11.23, J, 45°, PL, RO, CL, OP,
						11.25		SST	As above, but moderately weathered, low strength.	11.1 11.25		MW	11.28-11.35, J, 50°, CV, RO, CL, OP, 11.35-11.44, IS,
				d:0.29, a:0.65		11.45		SST	As above, but slightly to fresh weathered, medium strength, and white grey, generally massive with some carbonaceous layers.	10.9 11.45		SW-F	11.64, P, 5°, PL, RO, CL, OP,
			RQD = 28% TCR = 69%										

morrow

CLIENT NAME: Edward

PROJECT: Freshwater

LOCATION: 38 Undercliffe Road, Freshwater NSW

JOB NUMBER: P3371

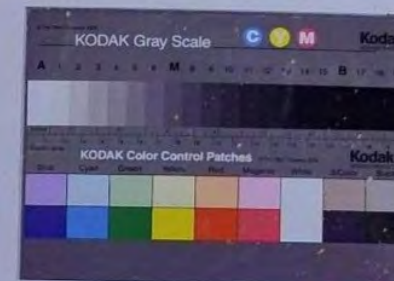
LOGGED BY: JA

BOREHOLE ID: BH1

DEPTH: 1.7 - 6.0m

CORE TRAY NO.: 1

DATE: 24/09/24



morrow



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Sydney Gadigal Land,
2/5-7 Malta Street, Fairfield
East NSW 2155



info@morrowgeo.com.au

Photo description

BH1 Box 1

Client

Edward Eve

Location

38 Undercliff Road, Freshwater NSW

Project name

Freshwater

Project No

P3371

Scale

Not to Scale

BH No

BH1

BH Depth

1.7m - 6.0m

morrow

CLIENT NAME: Edward

PROJECT: Freshwater

LOCATION: 38 Undercliffe Road, Freshwater NSW

JOB NUMBER: P3371

LOGGED BY: JA

BOREHOLE ID: BH1

DEPTH: 6.0 - 12.1m

CORE TRAY NO.: 2-3

DATE: 24/09/24



morrow



02 8599 7579



Sydney Gadigal Land,
2/5-7 Malta Street, Fairfield
East NSW 2155



info@morrowgeo.com.au

Photo description

BH1 Box 2 and 3

Client

MHNDU

Location

38 Undercliff Road, Freshwater NSW

Project name

Freshwater

Project No

P3371

Scale

Not to Scale

BH No

BH1

BH Depth

6.0m - 12.1m



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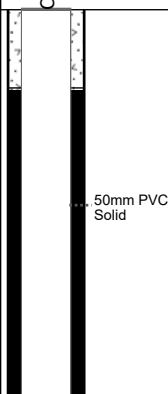
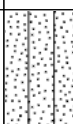


Sydney Gadigal Land: 2/5-7 Malta Steet, Fairfield East NSW 2155

Phone: 02 8599 7579

Geotechnical Log - Borehole

BH2

UTM	: 56H	Drill Rig	: GEO205 - Comacchio	Job Number	: P3371
Easting (m)	: 341,332.29	Driller Supplier	: GEONSENSE	Client	: Edward Eve
Northing (m)	: 6,260,926.77	Logged By	: Jordan Andonoski	Project	: Freshwater
Ground Elevation	: 18.5 (m)	Reviewed By	: Alan Morrow	Location	: 38 Undercliff Road, Freshwater NSW
Total Depth	: 8.1 m BGL	Date	: 23/09/2024	Loc Comment	:

Drilling Method	Water	Well Diagram	Testing	Soil Origin	Graphic Log	Classification Code	Depth (m)	Material Description	Elevation	Weathering	Consistency	Moisture
			SPT						Depth (m)			
ADT			2,3,7 (N=10)	TOPSOIL		SM	0.3	Topsoil Silty SAND SM: loose, brown, fine to medium grained, dry, no resistance .	18.2		L	D
				Colluvial		CI	0.3	Colluvial Sandy CLAY CI: stiff, medium plasticity, yellow pale brown, fine to medium grained sand, w ≈ pl.	0.3		St	w ≈ PL
				Residual		SW	0.8	Residual SAND SW: medium dense, white and orange, medium to coarse grained, dry, low resistance .	17.7		MD	D
							1	For continuation go to next page	17.5			
									1			

UTM : 56H	Drill Rig : GEO205 - Comacchio	Job Number : P3371
Easting (m) : 341,332.29	Driller Supplier : GEOSENSE	Client : MHNDU
Northing (m) : 6,260,926.77	Logged By : Jordan Andonoski	Project : Freshwater
Ground Elevation : 18.5 (m)	Reviewed By : Alan Morrow	Location : 38 Undercliff Road, Freshwater NSW
Total Depth : 8.1 m BGL	Date : 23/09/2024	Loc Comment :

Drilling Method	Water	Well Diagram	RQD% and TCR%	Testing	Estimated Strength	Depth (m)	Graphic Log	Classification Code	Material Description	Elevation	Weathering	Defect Spacing (mm)	Defect Description
				Is(50)						Depth (m)			
		C			VLS LS MS HS VHS EHS							30 100 300 1000 3000	
						1.61			Commenced Coring at 1m	17.5			
		50mm PVC Solid					SST PAV		Rock SANDSTONE: highly weathered, very low to low strength, and white orange, medium to coarse grained, 10° bedding at 20mm spacing . Core Loss 700mm	1.01	HW		1-1.7, CORELOSS,
						1.7			As above, but rock SANDSTONE: moderately weathered, medium strength, white and orange, medium to coarse grained, generally massive.	16.8 1.7			1.7-1.73, CRF, 1.76, P, 2°, PL, RO, CL, OP, 1.8, P, 2°, PL, RO, CL, OP, 1.87, P, 5°, PL, RO, STN, OP, 2, P, 10°, CV, RO, STN, OP, 2.03, P, 10°, PL, RO, STN, OP,
				d:0.37, a:0.19		2	SST				MW		
		50mm PVC Slotted	RQD = 34% TCR = 47%			2.65			Coreloss 0.87	15.8 2.65			2.37-2.57, J, 75°, UN, RO, STN, OP,
				d:0.31, a:0.38		3	PAV						2.65-3.52, CORELOSS, 75°, UN, RO, STN, OP,
						3.52			Rock SANDSTONE: slightly weathered, medium strength, white and pale orange, medium to coarse grained, 10° bedding at 20mm spacing.	15.0 3.52	SW		
				d:0.21, a:0.62			SST						

UTM : 56H	Drill Rig : GEO205 - Comacchio	Job Number : P3371
Easting (m) : 341,332.29	Driller Supplier : GEOSENSE	Client : MHNDU
Northing (m) : 6,260,926.77	Logged By : Jordan Andonoski	Project : Freshwater
Ground Elevation : 18.5 (m)	Reviewed By : Alan Morrow	Location : 38 Undercliff Road, Freshwater NSW
Total Depth : 8.1 m BGL	Date : 23/09/2024	Loc Comment :

Drilling Method	Water	Well Diagram	RQD% and TCR%	Testing	Estimated Strength	Depth (m)	Graphic Log	Classification Code	Material Description	Elevation	Weathering	Defect Spacing (mm)	Defect Description
				Is(50)						Depth (m)			
			RQD = 95% TCR = 100%			5		SST	Rock SANDSTONE: slightly weathered, medium strength, white and pale orange, medium to coarse grained, 10° bedding at 20mm spacing.		SW		
				d:0.45, a:0.57									
				d:0.31, a:0.49									
				d:0.95, a:1.28									
				d:0.80, a:0.59									
			RQD = 32% TCR = 78%			6		SST	As above, but slightly to fresh weathered, medium to high strength, white and pale grey, medium grained.	12.5 6	SW-F		5.21, P, 2°, PL, RO, CL, OP, 5.49, P, 10°, PL, RO, CL, C, 5.53, P, 10°, PL, RO, CL, OP,
			RQD = 32% TCR = 78%			6.56		PAV	Coreloss 440mm thk	11.9 6.56			6.56-7, CORELOSS, 10°, PL, RO, CL, OP,
			RQD = 32% TCR = 78%			7.2		SST	Rock SANDSTONE: fresh weathered, medium strength, white and pale grey, fine to medium grained, 10° bedding at 20 mm spacing.	11.5 7	F		7.55, P, 10°, PL, RO, CL, OP, 7.57, P, 10°, PL, RO, CL, OP, 7.7, P, 10°, PL, RO, CL, OP,






Morrow Geotechnics

Sydney Gadigal Land: 2/5-7 Malta Steet, Fairfield East NSW 2155
Phone: 02 8599 7579

Geotechnical Log - Borehole

BH2

UTM	: 56H	Drill Rig	: GEO205 - Comacchio	Job Number	: P3371
Easting (m)	: 341,332.29	Driller Supplier	: GEOSENSE	Client	: MHNDU
Northing (m)	: 6,260,926.77	Logged By	: Jordan Andonoski	Project	: Freshwater
Ground Elevation	: 18.5 (m)	Reviewed By	: Alan Morrow	Location	: 38 Undercliff Road, Freshwater NSW
Total Depth	: 8.1 m BGL	Date	: 23/09/2024	Loc Comment	:

Drilling Method	Water	Well Diagram	RQD% and TCR%	Testing		Estimated Strength	Depth (m)	Graphic Log	Classification Code	Material Description	Elevation		Weathering	Defect Spacing (mm)	Defect Description
				Is(50)	Is(50)						Depth (m)	Depth (m)			
NML	C		RQD = 32% TCR = 78%	d:0.81, a:1.14	VLS LS MS HS VHS EHS		9		SST	Rock SANDSTONE: fresh weathered, medium strength, white and pale grey, fine to medium grained, 10° bedding at 20 mm spacing. BH2 Terminated at 8.1m (Target Depth Reached)			F		

morrow

CLIENT NAME: Edward

PROJECT: Freshwater

LOCATION: 38 Undercliffe Road, Freshwater NSW

JOB NUMBER: P3371

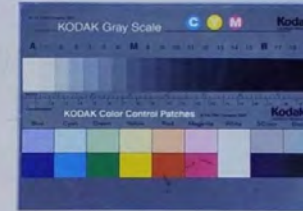
LOGGED BY: JA

BOREHOLE ID: BH2

DEPTH: 1.0 - 8.1 m

CORE TRAY NO.: 1-2

DATE: 23/09/24



morrow



02 8599 7579



Sydney Gadigal Land,
2/5-7 Malta Street, Fairfield
East NSW 2155



info@morrowgeo.com.au

Photo description

BH2 Box 1 and 2

Client

MHNDU

Location

38 Undercliff Road, Freshwater NSW

Project name

Freshwater

Project No

P3371

Scale

Not to Scale

BH No

BH2

BH Depth

1.0m - 8.1m

UTM : 56H	Drill Rig : GEO205 - Comacchio	Job Number : P3371
Easting (m) : 341,322.99	Driller Supplier : GEOSENSE	Client : MHNDU
Northing (m) : 6,260,930.42	Logged By : Jordan Andonoski	Project : Freshwater
Ground Elevation : 18.0 (m)	Reviewed By : Alan Morrow	Location : 38 Undercliff Road, Freshwater NSW
Total Depth : 6.1 m BGL	Date : 23/09/2024	Loc Comment :

Drilling Method	Water	Well Diagram	RQD% and TCR%	Testing	Estimated Strength	Depth (m)	Graphic Log	Classification Code	Material Description	Elevation	Weathering	Defect Spacing (mm)	Defect Description
				Is(50)						Depth (m)			
		B			VLS LS MS HS VHS EHS							30 100 300 1000 3000	
									Commenced Coring at 0.7m				
↑ NMLC Coring ↓		50mm PVC Solid		d:0.23, a:0.12		1			Coreloss 910mm thick				—0.74, P, 3°, PL, RO, STN, OP, —0.8-0.81, P, 5°, PL, RO, STN, OP, —1.11-2.02, CORELOSS, Core Loss (notes),
			RQD = 30% TCR = 58%				PAV						
				d:0.11, a:0.14		2.02			Rock SANDSTONE: moderately weathered, low strength, orange and white, medium to coarse grained, 10° bedding at 20mm spacing .	16.0 2.02			—2.02-2.06, XWS, —2.14-2.15, P, 10°, PL, RO, STN, OP, —2.33-2.36, J, 30°, PL, RO, STN, OP,
		50mm PVC Slotted					SST				MW		—2.56-2.57, P, 10°, PL, RO, STN, OP, —2.65, P, 10°, PL, RO, STN, OP, —2.71-2.74, XWS, —2.84, P, 10°, PL, RO, CL, OP, —2.87, P, 2°, PL, RO, CL, OP,
			RQD = 97% TCR = 100%	d:0.39, a:0.33		3			As above, but medium strength.	15.0 3			—3, P, 10°, PL, RO, STN, OP, —3.04, P, 10°, PL, RO, STN, OP, —3.12, P, 10°, PL, RO, STN, OP, —3.3, P, 10°, PL, RO, STN, OP,
							SST				MW		—3.92, P, 10°, PL, RO, STN, OP,

UTM : 56H Easting (m) : 341,322.99 Northing (m) : 6,260,930.42 Ground Elevation : 18.0 (m) Total Depth : 6.1 m BGL	Drill Rig : GEO205 - Comacchio Driller Supplier : GEONSENSE Logged By : Jordan Andonoski Reviewed By : Alan Morrow Date : 23/09/2024	Job Number : P3371 Client : MHNDU Project : Freshwater Location : 38 Undercliff Road, Freshwater NSW Loc Comment :
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Drilling Method	Water	Well Diagram	RQD% and TCR%	Testing	Estimated Strength	Depth (m)	Graphic Log	Classification Code	Material Description	Elevation	Weathering	Defect Spacing (mm)	Defect Description
				Is(50)						Depth (m)			
			RQD = 97% TCR = 100%	d:0.33, a:0.37		4		SST	As above, but slightly weathered, white and pale orange.	14.0	SW		4.15, P, 10°, PL, RO, STN, OP, 4.17, P, 10°, PL, RO, CT, OP, clay, 4.23, P, 10°, PL, RO, STN, OP, 4.38-4.41, XWS, 4.72, P, 10°, PL, RO, CL, OP, 5.15, P, 10°, PL, RO, CL, OP, 5.27, P, 10°, PL, RO, CL, OP, 5.93, P, 10°, PL, RO, CL, OP, 6, P, 10°, PL, RO, CL, OP,
				d:0.37, a:0.55		5				4			
				d:0.43, a:0.56		6				4			
						7							
									BH3 Terminated at 6.1m (Target Depth Reached)				

morrow

CLIENT NAME: Edward Eve

PROJECT: Freshwater

LOCATION: 38 Undercliff Road, Freshwater NSW

JOB NUMBER: P3371

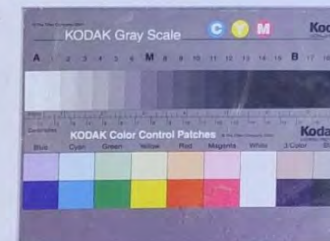
LOGGED BY: JA

BOREHOLE ID: BH3

DEPTH: 0.7m - 6.1m

CORE TRAY NO.: 1-2

DATE: 23/09/24



morrow



02 8599 7579



Sydney Gadigal Land,
2/5-7 Malta Street, Fairfield
East NSW 2155



info@morrowgeo.com.au

Photo description

BH3 Box 1 and 2

Client

MHNDU

Location

38 Undercliff Road, Freshwater NSW

Project name

Freshwater

Project No

P3371

Scale

Not to Scale

BH No

BH3

BH Depth

0.7m - 6.1m

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, $I_s(50)$ (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
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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 Slickensided 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

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