GEOTECHNICAL INVESTIGATION – WALLGROVE BUSINESS HUB, 97-123 & 125-151 WALLGROVE ROAD, CECIL PARK NSW 2178

Prepared for Western Sydney Parklands Trust

Construction Sciences

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1. Introduction

1.1 Project Background and Objectives

Construction Sciences Pty Ltd (CS) was engaged by Western Sydney Parklands Trust ('the client') to carry out a Geotechnical Investigation for the proposed development of a Business Hub at 97-123 & 125-151 Wallgrove Road, Cecil Park, NSW, 2178 ('the site').

The purpose of this assessment was to investigate the existing geotechnical conditions across the site and provide interpretation of findings to aid design and construction of the proposed development as outlined in Section 1.3. The investigation and associated geotechnical interpretation has been carried out in line with CS' proposal referenced 10791E-Q-1057-P1 Rev 1, dated 31st of May, 2023.

The objectives were to provide:

- Description of geological site conditions;
- Information on surface and subsurface profile and develop geotechnical model;
- Depth to bedrock, and strength of rock profile;
- Depth of any seepage and/or groundwater;
- Commentary on excavatability for the proposed development;
- Provide geotechnical design parameters to aid retaining wall and bearing capacity design including estimation of anticipated soil modulus;
- Provide assessment for the suitability of site won materials for earthworks including recommended soil moisture control and compaction requirements;
- Recommendations on soil management due to site erodibility characteristics;
- Advice on anticipated earthworks including site topsoil and the potential suitability for the adoption of limited top soil blending into suitable fill;
- Design parameters for footings including options for shallow and pile footings, if suitable;
- Recommendations for further investigation, if required;
- Other geotechnical risks to the development.

1.2 Proposed Development and Project Understanding

Based on the information provided by the client, it is understood that the proposed development is a business hub, and comprises the following:

- Two industrial/warehouses to accommodate a range of land uses including light industrial, warehouse and ancillary office spaces;
- Loading docks, truck hardstand areas and car parking spaces;
- Access road to the proposed business hub off Wallgrove Road; and
- Stormwater management works.

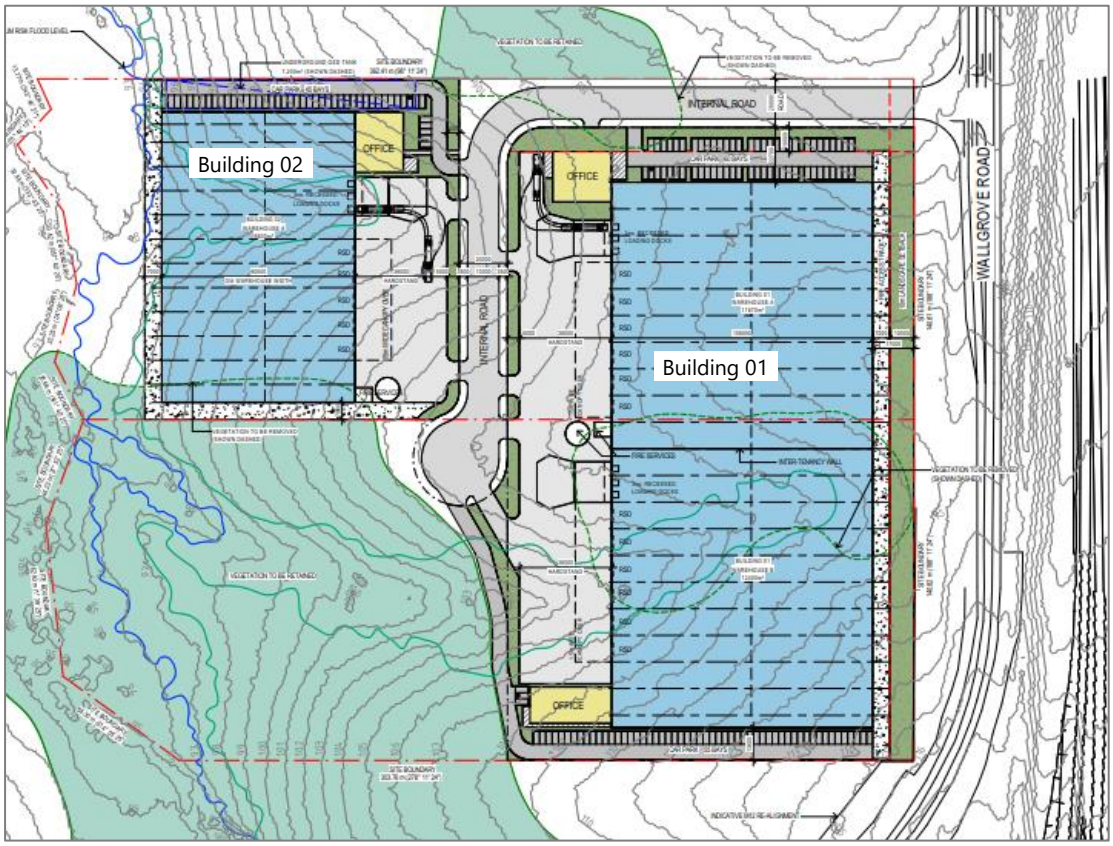
CS has drawn on information provided in the following documentation to understand geotechnical aspects relating to design and required earthworks.

- Architectural drawings provided by Watson Young referenced 20306-MP01-P1 and 20306-MP01-P2 dated 27/01/2021 and 27/01/2021, respectively.

- Survey drawing 11550-001 dated 16/03/2023.
- Preliminary bulk earthworks plan based on Lidar survey data, by Sparks and Partners

CS understands that the Building 01/ Warehouse A & B will be situated along the length of the eastern half of the site, whilst Building 02/ Warehouse A is proposed for the north west quadrant as shown in Figure 1. The proposed footprints of Building 01 combined and Building 02 are understood to be 24,270m^2 and 9,600m^2, respectively. Both buildings are expected to have ancillary offices, each with footprints of 500m^2. The two buildings are understood to be connected by hardstand pavement and an access road. The internal roadways/ hardstands will make up 7,441 m^2 of the development and the buildings will be serviced by 155 parking spaces.

Figure 1: Site Layout



Based on the survey drawing, the site topography generally falls from east to west with exception to fall occurring in the north-east corner of the site in the same direction.

Building 01 Topographic Data:

- The preliminary cut and fill plan indicates a bulk excavation level of 106mRL (inferred mAHD).
- Existing ground surface levels range from about 115mRL at the south-eastern corner to 106mRL at the north-western corner, including the office.
- The eastern portion of the site overlain by Building 01 is to be in a cut zone, with a maximum estimated cut depth at the south-western corner expected to be about 9m. This would be a significant change in level to be accommodated by a retaining structure or long term embankment.
- Existing ground surface level reduce towards the north of the site and Building, the proposed depth of excavation at the northern end of Building 01 to reach BEL, is anticipated to range from about 1m to 3m.

Building 02 Topographic Data

- The preliminary cut and fill plan indicates a bulk excavation level of 105.5mRL.
- Existing ground surface levels in the vicinity of Building 02 range from about 105mRL at the north-eastern corner (inclusive of the proposed driveway) to 94.5mRL at the north-western corner.
- The elevation change across the width is about 6-8m from existing site surface levels.
- The Western portion of the site overlain by Building 02 is to be in a filled zone, the maximum height of fill at is anticipated to be about 10m. This is represents a significant height of fill, to be bounded by either a retaining wall or long term embankment.

CS anticipate that significant earthworks will be required to create level pads to facilitate warehouse and associated pavement footprints. Earthworks are expected to consist of fill embankments and retaining structures/ batters. Due to site constraints, it is anticipated that retaining walls will be required to form the boundaries of the proposed building pads at some parts of the site. Cut and fill requirements will be subject to finalised design finished levels. This geotechnical investigation aims to serve as a preliminary assessment to inform designers of current geotechnical conditions. Detailed investigation will be required following finalisation of structural loads for foundations, cut/fill heights indicating extent and position of retaining walls, batters and embankments and pavement subgrade levels for collections of confirmatory CBR testing.

2. Site Geology

The MINVIEW online geological mapping database indicates that the investigation area is underlain primarily by Bringelly Shale, a subgroup of the Wianamatta Group. Bringelly Shale was deposited in the Middle Triassic era and comprises shale, claystone, laminate, sandstone and rare coal. Site locality overlain on geological mapping (Minview, 2023) is shown below in Figure 2. No other geological formation is known to be within an applicable distance to the site.

Figure 2 Surface Geology. Source: MINVIEW

3. Site Description

The subject site includes both Lots 24 and 25, covering a total area of about 98,700m^2 constituting a minor portion of the total parkland within the vicinity. Located to the west of Wallgrove Road which runs parallel to the West Link M7 and south of Kosovich Place/ Ropes Creek, the site appears to be mostly undeveloped agricultural land with grass coverings and scattered trees. Based on aerial imagery sourced from Nearmap, it appears that a small ephemeral watercourse runs north-west intersecting two man-made dams, one to the south-west of the site at distance and the other in the north-western corner outside the site boundary. The watercourse then joins into Ropes Creek to the north. A second inferred ephemeral water course runs east to west in the southern portion of the site intersecting a pond, described as zone 1 and zone 5 below. The eastern portion of the site, where majority of the proposed development is understood to be carried out, historically has been used for low-density residential and agricultural purposes. At the time of investigation, the site appeared to be mostly undeveloped with grass coverings and scattered trees. Dense vegetation consisting of medium sized trees was situated to the south west of the site, outside the development envelope. A dam and residential building were observed to be located in the southwestern extent of the site.

The surrounding area outside of the development envelope appears to be predominantly used for agricultural or residential purposes with some commercial facilities along Wallgrove to the north. Significant vegetation is noted to the south and south-east with some intermitted cleared areas.

3.1 Descriptive Geotechnical Zones

In order to distinguish geotechnical characteristics, the site has been divided into zones for reference purposes, which are outlined on a site plan in Figure A2, Appendix A. The site contained the following zones:

- Zone 1: An ephemeral creek zone underlain by residual soils then bedrock. Boreholes BH09 and BH10 were drilled in the vicinity of the upper portion of the creek zone and encountered residual clay soils or bedrock at shallow depth. Further to the west and in lower parts of the site, shallow thickness of alluvium or topsoil is anticipated.
- Zone 2: Local Alluvial soils deposited by erosion of the surrounding hills, underlain by residual soils or bedrock. This zone is generally located at the western and north-eastern part of the site. Minor alluvium was logged in BH01 as a silty topsoil to a depth of 0.25m. BH03 and BH05 were drilled within the vicinity of Zone 2 but did not encounter alluvium. It is anticipated that alluvium in the lower parts of the site, represented by shallow marshy or boggy surface conditions which were not accessible by the drilling rigs. Refer figure 3.
- Zone 3: Hillside or undulating slopes underlain by residual soils and extremely weathered to highly weathered siltstone. The ground profile within this zone is represented by BH02, BH03, BH04, BH05 BH06, BH07, BH08, BH11 and BH12. Most of these boreholes encountered bedrock or extremely weathered bedrock material within about 1m depth.
- Zone 4: Adjacent to the residential building located at the southern extent. Minor filling or disturbed soils may be associated with the house. BH04 was drilled in this zone and encountered natural residual soil at shallow (0.1m) depth.
- Zone 5: A semi-circular pond/dam located at the south-western portion of the proposed development, about 20m in diameter. Surface conditions were not accessible for drilling in this zone, however fill, local silty alluvium and topsoil are expected in this zone. Refer figure 4.
- Zone 6: Densely vegetated bushland located southwest of the proposed development, understood to be outside of the building envelope.

Combinations of the above zones are also present, with some boreholes positioned to intersect more than one zone.

Figure 3: Zone 2, far north-western and western portion of the site, low level alluvial soils. Image looking north.

Figure 4: Zone 5, farm pond / dam

4. Geotechnical Investigation

Field investigation was undertaken on 15th, 28th to 30th of June and 6th July 2023 and comprised the following sequence of activities:

- Dial Before You Dig (DBYD) service searches and onsite underground service locating carried out by an accredited service locator to identify the presence of buried services;
- Preparation of a safe-work method statement (SWMS);
- Drilling of nine (9) boreholes, using a 4WD truck mounted drilling rig with solid flight augers, fitted with a tungsten carbide (TC) bit. Four (4) of the bores were drilled to a maximum target depth of 3m below ground level (BGL) or prior refusal, with balance having a target depth of 5m.
- Dynamic Cone Penetrometer (DCP) testing was carried out adjacent to the locations to aid assessment of in-situ soil strength;
- An additional two (2) borehole (BH05 and BH10) were augured to refusal, then continued using NMLC coring to reach target depths of 8.72m and 8.80m BGL, respectively;
- Standard Penetration Testing (SPT) at nominal 1.5m depth intervals within the soil profile to aid assessment of in-situ strength/ consistency;
- Installation of three (3) ground water monitoring wells fitted with a PVC cap.
- Disturbed soil sampling and rock core recovery for laboratory testing and future reference;
- Development and monitoring of the groundwater monitoring wells which occurred on additional dates.

All fieldwork, including logging of the subsurface profiles, in-situ testing and sampling was undertaken by or in the presence of a Geotechnical Engineer from CS. The approximate locations of the boreholes are presented in the site plan in **Appendix A**. Borehole logs and photographs with explanatory notes are presented in **Appendix B**. Borehole locations were recorded using a handheld GPS, with an approximate accuracy of +/- 5 to 15m. Surface levels indicated in the borehole logs have been interpolated approximately from Lidar based surface level data provided.

Fieldwork was carried out in accordance with Australian Standard, 'AS1726-2017 Geotechnical Investigations'.

4.1 Encountered Subsurface Conditions

Subsurface soil profiles encountered in the boreholes are generalised in **Table 1** below. Reference should be made to the boreholes logs presented in **Appendix B** for a more detailed description of soils encountered at a particular location. Encountered subsurface materials generally include a thin layer of topsoil underlain by residual silty clay / clay that generally varies in consistency between firm and hard underlain by shallow extremely weathered rock tending to better quality rock at depth. The head of extremely weathered material or weathered rock was encountered between 0.4m and 3.0m bgl. The reader is referred to Table 1 for generalised material unit descriptions and depth ranges. **Table 3** shows the depths ranges from the existing surface level at the time of investigation. Geotechnical recommendations are discussed in detail in terms of the Geotechnical units defined in **Table 2**.

Table 1 Generalised Summary of Subsurface Geotechnical Units

Unit No.	Material	Description
1	Topsoil	Clayey SILT / Silty CLAY, low to medium plasticity, colour variations observed were brown, grey and dark grey. Material assessed to range from less than Plastic Limit (<PL) to greater than Plastic Limit (>PL), with grass rootlets.
2A 2B 2C 2D	Residual Soils	CLAY / Silty CLAY, medium to high plasticity, colour variations included brown, orange brown and red brown. Material moisture condition was assessed to be generally <PL with the exception of BH06 where >PL material was encountered. Material consistency was assessed to range between firm to very stiff with a soft layer encountered in BH11.
3	Extremely Weathered Material	SILTSTONE/SHALE, extremely weathered, brown, grey-brown, grey, inferred equivalent to soil of hard consistency.
4A	Bedrock	SILTSTONE/SHALE, extremely to highly weathered, brown, grey-brown, inferred very low strength
4B	Bedrock	SILTSTONE/SHALE, highly weathered to moderately weathered shale, inferred very low to low strength, brown grey, grey, dark grey. Assessed Class IV[2] Shale equivalent.
4c	Bedrock	SILTSTONE/SHALE and interbedded SANDSTONE, slightly weathered to fresh, fine grained sandstone, grey, dark grey, medium to high strength. Assessed Class III Shale equivalent.

Notes:

[1] Depth to Unit 4B not known at other locations and is to be confirmed onsite by Geotechnical Engineer or additional investigation.

[2] Rock classifications are in accordance with Pells, P, Mostyn, G & Walker B. (1998) Foundations on Sandstone and Shale in the Sydney Region, Australian Geomechanics, Dec 1998.

4.2 Groundwater Conditions

Groundwater was not observed in the boreholes at the time of investigation. Standpipes were installed in BH03, BH05 and BH10 to record groundwater levels following completion of the drilling works. Preliminary planning for proposed groundwater monitoring bore locations selected BH12, this location was amended to BH03 due to early refusal of the borehole. The standing water level recorded in each well has been provided in the table below. Groundwater was not observed in BH05 and BH10 during augering and could not be observed during flush drilling due to added water; drilling induced water was purged from BH05 and BH10 after drilling.

Table 2 Summary of Groundwater Levels, Depth from surface (m)

	Date	BH03	BH05	BH10
Depth from surface	30/6/23	Dry	-	-
	6/7/23	3.8	3m	3.65m
	20/7/23	1.34m	3.61m	3.82m

No long-term groundwater monitoring was carried out.

4.3 Geotechnical Model

Based on field and laboratory testing, the interpreted geotechnical model at this site is presented in **Table 3** below.

Table 3: Material Unit Depths

BH ID	Material Type / Depth Interval (m BGL)								
	TOPSOIL	RESIDUAL SOIL				XW MATERIAL	BEDROCK		
	UNIT 1	UNIT 2A	UNIT 2B	UNIT 2C	UNIT 2D	UNIT 3	UNIT 4A	UNIT 4B	UNIT 4C
		Soft	Firm	Stiff	Very Stiff - Hard	Hard	Class V SHALE	Class IV SHALE	Class III SHALE
BH01	0.0-0.25	-	-	1.4-1,7	0.25-1.4	1.7-2.7 R	-	2.7 R +	-
BH02	0.0-0.05	-	0.7-0.8	0.05-0.3	0.3-0.7	-	-	0.8-1.5 R +	-
BH03	0.0-0.2	-	0.2-0.3	0.3-0.6	0.6-1.8	1.8-2.5	1.8-2.5	2.5-5.0R +	-
BH04	0.0-0.1	-	-	-	0.1-0.6	1.2-1.7 R	0.6-1.7	1.7 R +	-
BH05	0.0-0.1	-	-	-	0.1-1.5	1.5-1.7	1.7-4.5	4.5-7.3 7.5-8.72 TD +	-
BH06	0.0-0.1	-	-	0.1-0.5	0.5-0.7	0.7-1.6	-	1.6-2.7 R +	-
BH07	0.0-0.05	-	0.05-0.5	0.5-0.9	0.9-1.2	1.2-1.8	-	1.8-2.7 R +	-
BH08	0.0-0.25	-	-	-	-	0.25-0.8	-	0.8-1.2 R	-
BH09	0.0-0.05	-	-	-	-	0.05-1.2 R	0.8-1.2	1.2R +	-
BH10	0.0-0.03	-	-	-	0.03-1.0	-	1.0-2.3	2.3-5.0	5.0-8.8 TD
-BH11	0.0-0.2	0.8-1.2	0.2-0.4, 0.5-0.8, 1.2-1.7	0.4-0.5, 1.7-2.7	2.7-3.0	-	3.0-4.0 R	-	-
BH12	0.0-0.1	-	-	-	0.1-0.4	0.4-1.1	0.4-1.1	1.1-2.0 R +	

Notes:

- *All depths measured in metres below ground level at the time of the investigation.*
- *Refer to attached borehole logs and Glossary of Terms in **Appendix B** for a full list of symbols and terms.*
- *TD = Target depth at termination depth, R = auger refusal on bedrock.*
- *Rock classifications are in accordance with Pells, P, Mostyn, G & Walker B. (1998) Foundations on Sandstone and Shale in the Sydney Region, Australian Geomechanics, Dec 1998.*
- *A gradational change is expected between XW material and Class V shale, in some cases XW material may contain sufficient bands of highly weathered rock for classification as Class V Shale equivalent.*

5. Laboratory Testing

Samples of representative strata were tested in our NATA accredited laboratory for geotechnical testing and SGS for environmental testing in order to characterise engineering properties of encountered soil. The following testing regime was carried out:

- California Bearing Ratio (CBR) x 2;
- Plasticity Index x 3;
- Emerson Class x 3;
- Shrinks Swell Index x 3
- Soil Aggressivity and Salinity x 15;
- Point Load Index x 9.

A summary of laboratory test results is provided below and laboratory test certificates are included in **Appendix C**. Geotechnical laboratory testing was carried out in accordance with '*Australian Standard AS1289 Laboratory Testing for Engineering Purposes*'.

5.1.1 California Bearing Ratio

California Bearing Ratio (CBR) tests were undertaken to aid assessment of subgrade strength to inform pavement design. Results for CBR tests are summarised in **Table 4** below.

Table 4 Summary of California Bearing Ratio Results

Borehole ID	Depth (m BGL)	Material Type	MDD [1] (t/m^3)	OMC [2] (%)	FMC [3] (%)	Swell (%)	CBR (%)
BH01	0.5-1.0	(CH) Silty CLAY	1.56	24.5	26.4	1.0	5.0
BH11	0.5-1.0	(CH) Silty CLAY	1.64	19.0	18.0	3.0	3.0

Notes:

[1] Maximum Dry Density
[2] Optimum Moisture Content
[3] Field Moisture Content

5.1.2 Material Classification Testing

Material classification testing, consisting of Atterberg Limits (AL) and Field Moisture Content (FMC), was undertaken to aid assessment of material characteristics and associated engineering properties. Material classification results are summarised in **Table 5** below.

Table 5 Summary of Atterberg Limits and Moisture Content Results

Borehole ID	Material Type	Depth (m)	FMC (%)[1]	LL (%)[2]	PL(%)[3]	PI (%)[4]
BH01	(CH) Silty CLAY	0.5-1.0	26.4	59	21	38
BH03	CLAY	0.1-1.0	-	69	22	47

Borehole ID	Material Type	Depth (m)	FMC (%)[1]	LL (%)[2]	PL(%)[3]	PI (%)[4]
BH11	(CH) Silty CLAY	0.5-1.0	18.0	59	20	39

Notes:

[1] Field Moisture Content
[2] Liquid Limit
[3] Plastic Limit
[4] Plasticity Index

5.1.3 Emersion Class Dispersion

Results for Emersion Class Dispersion testing are summarised below in **Table 6** below.

Table 6 Summary of Emersion Class Results

Borehole ID	Depth (m BGL)	Material Type	Emersion Class Number
BH01	0.5-1.0	(CH) Silty CLAY	4
BH03	0.1-1.0	(CH) Clay	4
BH11	0.5-1.0	(CH) Silty CLAY	4

5.1.4 Shrink Swell Index

Results for Shrink Swell Index are listed in **Table 7** below.

Table 7 Summary of Shrinnk / Swell Index

Borehole ID	Depth (m)	Shrink Swell Index
BH01	0.3-0.45	1.8
BH03	0.25-0.8	2.4
BH11	0.25-0.9	3.5

5.1.5 Aggressivity Testing & Assessment

Results for soil aggressivity for steel and concrete are summarised in **Table 8** below. Based on the test results of selected representative samples, an exposure classification of 'Mild' should be adopted in design for both concrete and steel exposure. It is recommended that the structural designer reviews this data and nominates suitable protections for soil salinity and aggressivity and suitable specifications.

Table 8 Summary of Aggressivity Testing Results

ID	Depth (m BGL)	Chloride (mg/kg)	pH	Sulphate (mg/kg)	Resisitivity (ohm.cm)	Soil Condition (A[1] or B[2])	Aggressivity to Concrete[3]	Aggressivity to Steel[4]
BH01	0.5	37	5.5	180	4100	B	Non-aggressive	Non-aggressive
BH01	1.5	54	5.8	150	3300	B	Non-aggressive	Non-aggressive
BH01	2.5	25	6.6	57	5600	B	Non-aggressive	Non-aggressive
BH03	3.5	120	8.1	45	2200	B	Non-aggressive	Non-aggressive
BH03	4.5	95	8.2	55	2300	B	Non-aggressive	Non-aggressive
BH05	0.5	90	4.9	65	4400	B	Mild	Non-aggressive
BH05	1.5	220	5.2	64	2600	B	Non-aggressive	Non-aggressive
BH05	2.5	390	8.1	54	1100	B	Non-aggressive	Mild
BH05	3.5	360	8.4	39	1200	B	Non-aggressive	Mild
BH08	0.5	8.5	5.3	40	11000	B	Non-aggressive	Non-aggressive
BH08	1.2	180	5.8	130	2200	B	Non-aggressive	Non-aggressive
BH10	0.5	200	5.1	63	2900	B	Non-aggressive	Non-aggressive
BH10	1.5	86	5.8	29	4700	B	Non-aggressive	Non-aggressive
BH11	0.5	590	4.5	320	870	B	Mild	Moderate
BH11	1.5	600	4.5	350	860	B	Mild	Moderate

Notes:

[1] Based Soil conditions A – high permeability soils (e.g. sands and gravels) that are in groundwater

[2] Based Soil conditions B – low permeability soils (e.g. silts and clays) or all soils above groundwater

[3] Based on Table 6.4.2 (C) AS2159-2009 Exposure classification for concrete piles – piles in soil

[4] Based on Table 6.5.2 (C) AS2159-2009 Exposure classification for steel piles – piles in soil

5.1.5.1 Aggressivity to Concrete

Laboratory test results indicate that the tested samples classify as "mild to non-aggressive" with respect to concrete piles in soil (as per AS2159-2009 *Piling – Design & Installation*). Therefore, for cast-in-place piles and structures with a 50-year design life, minimum concrete strength of 32MPa and a minimum cover to reinforcement of 60mm. The cover should be increased to 75mm for a 100-year design life.

Similarly, for pre-cast/pre-stressed piles and structures with a 50-year design life, minimum concrete strength of 50MPa and a minimum cover to reinforcement of 20mm is recommended in AS2159-2009. The cover should be increased to 30mm for a 100-year design life.

These concrete strength and cover requirements are the minimum as set out in AS2159-2990 table 6.4.3 and should be reviewed by the designer / structural engineer to take other design considerations into account.

5.1.5.2 Aggressivity to Steel

Laboratory test results indicate that the soils as tested are classified as "moderate to non-aggressive" with respect to aggressivity to steel piles (as per AS2159-2009 *Piling – Design & Installation*).

Corrosion allowance, coating protection systems and cathodic protection should be adopted as per AS2159-2009 and designed for a uniform corrosion allowance of 0.02-0.04 mm/year.

5.1.6 Salinity Testing and Assessment

Results for salinity tests are summarized in **Table 9** below.

Table 9 Summary of Salinity Testing Results

Borehole ID	Depth (m BGL)	EC1:5 (µS/cm)	EC1:5 (dS/m)[1]	Soil Texture Group	Multiplication Factor	ECe (dS/m)[1]	Salinity Classification [2]
BH01	0.5	140	0.14	Silty CLAY	7	0.98	Non-saline
BH01	1.5	140	0.14	Silty CLAY	7	0.98	Non-saline
BH01	2.5	85	0.085	Siltstone(XW)	8.5	0.722	Non-saline
BH03	3.5	260	0.26	Silstone (XW)	7	1.82	Non-saline
BH03	4.5	260	0.26	Siltstone (XW)	7	1.82	Non-saline
BH05	0.5	94	0.094	Silty CLAY	7	0.658	Non-saline
BH05	1.5	190	0.19	Silty CLAY	7	1.33	Non-saline
BH05	2.5	500	0.5	Shale (HW)	8.5	4.25	Moderately-saline
BH05	3.5	470	0.47	Shale (HW)	8.5	3.995	Slightly-saline
BH08	0.5	47	0.047	Silty CLAY	7	0.329	Non-saline
BH08	1.2	210	0.21	Siltstone (XW)	7	1.47	Non-saline
BH10	0.5	170	0.17	Silty CLAY	7	1.19	Non-saline
BH10	1.5	82	0.082	Shale (HW)	8.5	0.697	Non-saline
BH11	0.5	630	0.63	Silty CLAY	7	4.41	Moderately-saline
BH11	1.5	590	0.59	Silty CLAY	7	4.13	Moderately-saline

Notes:

[1] (dS/m) Based on EC to Ece multiplication factors from table 6.1 in DLWC (2002).

[2] Based on Table 6.2 of DLWC (2002) where EC_e <2 dS/m = non-saline, EC_e of 2-4 dS/m = slightly saline, EC_e of 4-8 dS/m = moderately saline, EC_e of 8-16 dS/m = very saline and EC_e of >16 dS/m = highly saline.

5.1.7 Point Load Index

Point Load Strength Index (Is50) test results on selected rock core samples are summarised in **Table 10** below, together with an assessment of rock strength class to AS1726-2017 and an estimate of unconfined compressive strength based on correlation with Is50.

Table 10 Summary of Point Load Index Results

Borehole ID	Depth (m BGL)	$Is_{(50)}$ Diametral (MPa)	$Is_{(50)}$ Axial (MPa)	UCS [1] Axial (MPa)	Rock Strength [2]
BH05	7.6	0.41	0.41	9.82	Medium
BH05	8.1	0.65	1.30	31.21	Medium-High
BH05	8.6	1.32	1.58	38.47	High
BH10	4.7	0.39	0.31	7.35	Medium
BH10	5.6	0.17	0.83	18.92	Low-Medium
BH10	6.5	0.33	0.47	11.38	Medium
BH10	7.4	0.60	4.90	119.17	Medium-Very High
BH10	8.4	2.14	3.41	82.9	High-Very High
BH10	8.8	3.59	5.31	129.17	Very High

Notes:

[1] Based on Table 19 of AS1276:2017, using an $Is_{(50)}$ to UCS correlation factor of 20.

[2] Based on Table 19 of AS1276:2017.

6. Discussion and Recommendations

6.1 Preliminary Site Classification

Whilst not strictly applicable to commercial developments, site classification to AS2870-2011 Residential Slabs and Footings has been assessed to provide guidance to designers. It should be noted that the preliminary site classification is likely to vary significantly following earthworks understood to involve significant excavation and filling.

However, based on current fieldwork and limited laboratory testing the site is assessed as Class P in accordance with AS2870-2011. The main factors supporting this assessment are:

- The presence of soft soils to a depth of 1.2m at borehole BH11 and in Zone 2 at the north-western part of the site.
- Moisture variation effects of trees in close proximity to structures, AS2870 Clause 1.3.3c: Abnormal Soil Moisture Conditions likely – Growth of trees too close to footing.
- Possible filling associated with development in Zone 4 and any other surrounding residential developments whereby services may intersect the site. Filling could be associated with historical earthworks and buried services trenches.

- The dam identified in Zone 5 will require adequate remediation in accordance with AS3798: 2007.

Notwithstanding the above, calculations to assess the characteristic surface movement of the site as per AS2870-2011 have been carried out to aid understanding of ground movement in response to seasonal weather variations. The calculations were carried out for the site conditions as is, without anticipating any required earthworks. CS has adopted a shrink swell (Iss) value of 1.2% for topsoil, 1.8 to 3.5% for residual clay and 2% for extremely weathered material. In addition, the relatively greenfield site has been considered to have developed a 'cracked zone' over time and positioned in climatic zone warranting a soil suction depth of 1.8m. Based on the above inputs, the peliminary free surface movement calculation could be in the range of an M Class (20-40mm) for instances where a there is a clay profile with bedrock at a depth of 1.5m. In areas where extremely weathered material and bedrock is encountered directly beneath the topsoil, movement in the range of an S Class (0-20mm) could be expected. This highlights potential differential movement across the site, keeping in mind that anticipated earthworks could increase this value significantly in areas of filling using clay materials and reduced in areas of significant cut where rock is exposed or the overlying soil thickness is reduced.

If additional site classification assessment is required, further investigation and testing would be required following completion of the earthworks phase.

6.2 Earthworks

6.2.1 Reuse Of Site Won Materials

Topsoil Option 1 – Use of Site Won Topsoil for Landscaping Only

It is generally preferred that site won topsoil (Unit 1) is considered as unsuitable material. In this case, topsoil should be stripped to spoil or stockpiled for later re-use for landscaping purposes.

Topsoil Option 2- Limited Reuse of Site Won Topsoil

In parts of the site where the depth of new controlled fill is 5m or greater:

1. Grub shrubs and trees
2. Strip grass and roots
3. Strip topsoil and separately stockpile topsoil which is inorganic clay/silt/sand, free of roots with the exception of trace root fibres. Screening of the material will be required to remove larger tree roots. This prepared topsoil material is designated PTS.
4. Assess the subgrade in accordance with initial subgrade inspection and proof rolling requirements in AS3798:2007
5. Place maximum 250mm of uncompacted material deemed suitable in accordance with a site fill specification.
6. Place 50mm of PTS evenly over the surface and blend into the suitable material by compacting with a sheeps foot compactor roller. The topsoil content shall constitute a maximum 1 part PTS to 6 parts material deemed suitable in accordance with a site fill specification. The blended layer shall be thoroughly mixed and homogenous.
7. Conduct compaction testing in accordance with the site fill specification.
8. Repeat steps 5, 6, and 7 above for additional layers of blended material. The PTS blended layers may not be placed within 4m of the finished fill level.

This option should only be considered where the earthworks contractors has sufficient experience and logistical capability to identify and effectively treat the material.

Reuse of Site Won Materials Other than Topsoil

Material encountered across the site, except topsoil (unless placed as per Section 6.2.1), is considered suitable for re-use as structural fill provided appropriate site preparation and compaction requirements are adhered to as outlined in AS3798:2007. Horizonal layers should remain homogenous to minimise risk of differential movement. Consideration to shrink swell characteristics should be given to clay material as preliminary testing indicated values ranging between 1.8-3.5%. The higher end of the value range would likely coincide with substantial surface movement in response to seasonal weather variations, particularly where the cracked zone has been disturbed by construction plant. The designer should consider these potential impacts on footing and slab thickness' and confirm whether clay with higher shrink swells should be used in the controlled filling phase. If considered a concern, further testing would be required to attempt in delineating the clay profile/ areas into groups of high and low shrink swell characteristics. Weathered rock is considered suitable for filling provided that the placed material conforms with specifications outlined in AS3798: 2007. Further considerations include potential construction related challenges arising from placement of crushed rock within zones where piling or trenching is anticipated. Notwithstanding the above, logically clay materials should be used deeper in the filling profile or within embankments and better-quality crushed rock should be used within the subgrade zone of proposed pavement and slab areas. Additional CBR testing of site won crushed rock should be carried out to verify that the CBR of material placed within the subgrade zone is greater than the CBR adopted for the pavement design.

Although fill was not encountered in the any of the boreholes, it is expected that some filling is likely associated with the residential structure in Zone 4. Unless documentation confirming that any historically placed fill meets controlled conditions as stipulated in AS3798: 2007, uncontrolled fill must be remediated so that requirements of the same document are met.

6.2.2 Site Preparation for Filling

Some level of remediation will likely be required following stripping to increase in-situ strength where firm or weaker material was encountered, namely BH2, BH3, BH7 and BH11. Treatment of encountered weak material is subject to further geotechnical assessment following availability of construction plans to review significance in relation to depth and proximity of weak layers to the proposed development. The weak material was identified to depths ranging from 0.3 to 1.7m BGL, where encountered.

Anticipated remediation of the pond identified in Zone 5 will be required prior to any subsequent filling or construction if the area is to be located within the proposed construction footprint. The dam should be dewatered in accordance with an approved dewatering plan. All organic or overly wet, weak material must be excavated to spoil and, the stripped surface proof rolled and subsequently filled in accordance with AS3798: 2007.

In general, prior to placement of new controlled fill, the site surface must be stripped of vegetation, pre-existing uncontrolled fill, topsoil, significant roots and unsuitable soil, then an initial subgrade inspection and proof rolling conducted by a suitably qualified and experienced geotechnical consultant, in accordance with AS3798: 2007.

6.2.3 Preliminary Guidance for Fill Specification

As general guidance to aid the earthworks contractor, not to serve as replacement to AS3798:2007, controlled filling requirements include:

- All filling should be carried out under level 1 supervision in accordance with AS3798: 2007;
- All filling surfaces must be stripped of unsuitable material and proof rolled to ensure that the surface is within acceptable deflection criteria;
- If rock is encountered at bulk excavation level, the rock should be ripped and recompacted to facilitate dissipation of water ingress and prevent material saturation at the interface;

- Material should be placed and compacted in layers no thicker than 300mm loose or in accordance with council specifications, whichever is lesser;
- Placed material is to be moisture conditioned to ±2% of Standard Optimum Moisture Content (SOMC).
- Compaction criteria of general earthworks fill across the site should be 98% Standard Maximum Dry Density (SMDD) in accordance with AS3798: 2007 for commercial developments unless otherwise specified by the designer or the governing authority.

This does not constitute a full filling specification for the site and proposed development.

6.3 Excavation

6.3.1 General Summary of Expected Conditions

Given the considerable change in elevation across the width of each warehouse structure as discussed in Section 1.2, the contractor must select suitable excavation equipment for soil, weathered rock and potentially medium to high strength rock depending on finalised bulk excavation levels. CS anticipates deeper excavation to the east and south-east of the site and significant filling to the north. The head of the encountered weathered rock traverses the site north to south, however extremely weathered material as a minimum is encountered relatively shallow to the east and west of the ridge line. A deeper residual soil profile was encountered in the south-east corner of the site (BH11). Low to medium strength Sandstone was encountered in BH10 at 4.85m bgl tending towards high strength around 7-8m bgl, around the same drilling depth that sandstone was encountered in BH05. Based on this it is considered likely that the head of better-quality rock will rise with increase in topography.

Building 01 Bulk Excavation Level

CS understand the bulk excavation level for Building 01 will be 106mRL (AHD), the table below has been compiled based on this. This data should be revied and revised upon receipt of detailed survey and updated cut-fill plans.

Table 11 Building 01 Platform Anticipated Excavation Materials

Borehole	Excavation Material	Material at BEL 106mAHD
BH01	Fill Zone	Fill Zone
BH06	Topsoil & Residual soil	Unit 2C Residual soil
BH07	Topsoil, Residual soil, XW Material	Unit 3 XW Material
BH09	Topsoil, Residual soil, XW Material, Unit 4B Class IV Shale, Potential for harder rock, BEL is ~1.4m below auger refusal.	Unit 4B Class IV Shale
BH10	Topsoil, Residual Soil, Unit 4A Class V Shale, Unit 4B Class IV Shale	Unit 4B Class IV Shale
BH11	Topsoil, Residual Soil, Unit 4A Class V Shale, Unit 4B Class IV Shale. Potential for harder roc as BEL is ~2.9m below auger refusal.	Unit 4B Class IV Shale
BH12	Topsoil, Residual Soil, XW Material , Unit 4A Class V Shale, Unit 4B Class IV Shale. Potential for harder rock as BEL is ~1.3m below auger refusal.	Unit 4B Class IV Shale

Notes: Anticipated materials below auger refusal depth are inferred only.

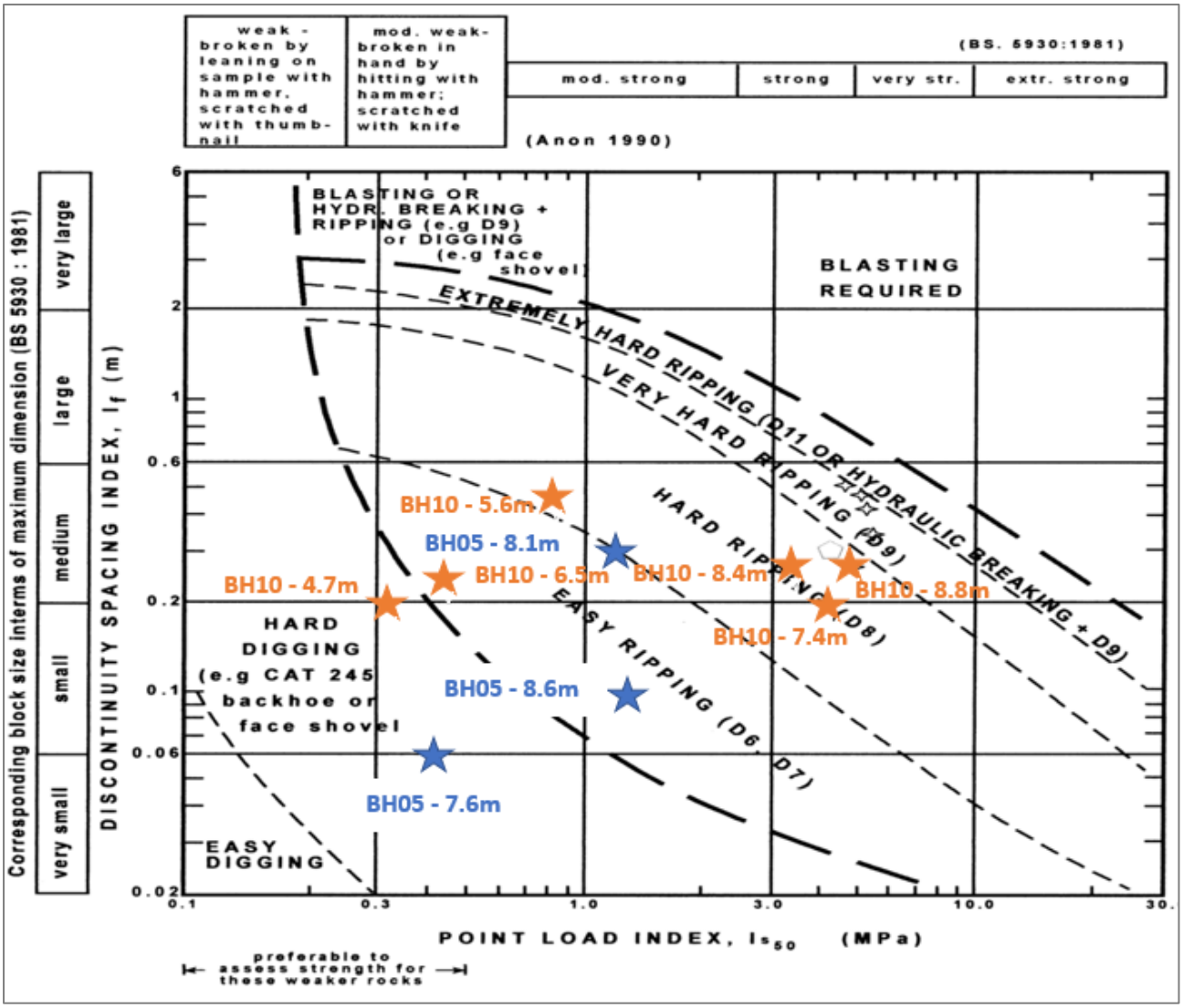
Building 02 Bulk Excavation Level

CS understand the bulk excavation level for Building 01 will be 105.5mRL (AHD). BH02 and BH8 indicate a small amount of cut through topsoil, residual soil and Unit 4B Class IV Shale, which will vary depending on the position of the building platform. In general, most of the building platform for Building 02 is expected to require filling above existing surface levels.

6.3.2 Excavatability

The excavatability assessment is based on the Pettifer & Fookes chart (BS 5930:1981) using point load test results and borehole logs. Figure 5 reproduces the Petifer & Fookes chart (BS 5930: 1981) for excavatability guidance of rock encountered in BH05 and BH10. The figure shows that the excavatability of the rock generally becomes more difficult with depth as strength and discontinuity spacing increases, it serves as guidance only as the rock conditions may vary considerably across the site. Excavation of the residual soil can be readily excavated using conventional earthmoving equipment. Deeper excavations that encounter extremely weathered material will require larger machinery and possibly prior ripping at depth with a tyne attachment. Excavation into bedrock if required would necessitate significant excavation equipment, such as a large excavator and rock-hammer attachment. It is the responsibility of the construction contractor to determine suitable sized machinery to ensure efficiency considering the nature of proposed construction and encountered subsurface conditions.

Figure 5: Excavatability of Rock using Is(50) test results



6.3.3 Batter Angles and Support

All excavation work should be completed with reference to the Code of Practice 'Excavation Work', by Safe Work Australia. Excavation method statements will need to be prepared by the excavation contractor prior to the issue of the CC.

Work OHS generally limits the maximum height of an unsupported excavation to 1.5m, however, greater depths can be achieved by applying interim benching methods or shoring boxes. Alternatively, inspection can be undertaken by a Geotechnical Engineer to assess the stability of the cut face/ trench to allow personnel to work in the excavation for a given period under the necessary conditions to ensure the safety of all personnel.

As general guidance, based on the site investigation, it is considered that the material above the rock generally comprising stiff or better residual soils and extremely weathered material will be relatively stable during excavation provided batter angles are maintained within the allowable maximum recommended in Error! Reference source not found.**2** below.

Table 12 Maximum Recommended Batter Angles

Unit	Permanent (when not retained) (H:V)	Temporary (H:V)
Unit 2A – Silty CLAY - Soft	NR	NR
Controlled Fill	2 : 1	1 : 1
Unit 2B, 2C, 2D, Unit 3 – Residual soils, Extremely weathered material and Class V Shale	2 : 1	1 : 1
Unit 4-6 – Weathered Rock	Subject to assessment and certification by a Geotechnical Engineer	

Notes:

- *Temporary batters must have a maximum unsupported time of 1 month and maximum height of 3m to 5m, subject to further assessment by a geotechnical engineer.*
- *Batter angles are subject to the absence of surcharge loads and sensitive structures or services, which may have a zone of influence affecting the batter.*
- *Permanent batter angles should be considered as preliminary, detailed design should include additional assessment by a geotechnical engineer or detailed designer, with provision for drainage and erosion control.*

Temporary embankments/batters are to be protected with conventional surface erosion control techniques, such as redirection of surface run-off and/or protection with geotextile products. Longer term temporary or permanent cut/fill embankments should be stabilised using industry standard practices such as hydro-mulching or jute mesh and grass seed as appropriate, with surface drainage provided in such a way as to reduce erosion potential. Surface water should not be allowed to flow over any un-sealed batters. Sealing/stabilisation of batters should happen concurrently with other works or as soon as is practicable to minimise erosion.

Where temporary or permanent batter slopes cannot be accommodated in the development or are not desired, temporary shoring and/or permanent retaining support will be required designed based on parameters given in Sections 5.1 and 5.2, however, additional Geotechnical Investigation may need to be carried out to collect spatially relevant data. Consideration may be given to the following options:

- Gravity retaining structures, where the depth of excavation is relatively low;

- Engineered reinforced concrete or block walls, where the depth of excavation or height of retention does not exceed about 2.0-2.5m without bracing provided by integral structures;
- Cantilevered reinforced concrete bored or continuous flight auger (CFA) soldier walls with mesh reinforced shotcrete in-fill panels for excavations;
- Soil nail walls / rock bolts;
- A combination of the above.

The suitability of the retention system may be influenced by proximity to other structures/ services, consent conditions and the relative stiffness required to limit lateral and vertical deformations to an acceptable level. In addition, pile walls could be designed to provide permanent support to proposed structures. However, pile sockets in rock may need to be longer to accommodate additional lateral and axial loads. For design of temporary and permanent support, we recommend:

- Geotechnical design parameters presented in **Table 14** are adopted for preliminary design of flexible retaining walls, considering a triangular earth pressure distribution.
- Rigid retaining structures, such as propped or anchored walls, are adopted to limit lateral and vertical movements when in close proximity to existing buildings/ structures and buried services.
- Subsoil drainage is to be provided behind retaining walls to limit static water pressures on the retaining walls.
- Avoid surcharge loading from construction equipment, vehicular traffic and materials storage within the zone of influence of excavations, which in the absence of site-specific geotechnical advice should a horizontal distance back from the crest not less the depth of excavation.
- CS recommends the use of stress/strain dependent analysis (including soil-structure interaction analysis) during detailed design to further consider likely deformations and to better model the earth pressures and influence of the excavation on adjacent structures and services.

Rock bolts if needed may comprise hot-dipped galvanised steel bars, or similar. Where long-term support is required, rock bolts must be provided with a high level of corrosion protection if they cannot be maintained (i.e. inspected and replaced, if necessary). At least two layers of corrosion protection should be provided such as bolts encapsulated in cement grout and PVC sheaths.

Rock bolts and anchors should generally be specified in terms of performance requirements and constructed by contractors experienced in ground anchor technology. Allowable bond stresses will depend on the purpose of design, loads and method of installation.

It is recommended that there be provision for an experienced Geotechnical Engineer to inspect excavation support installations as excavation progresses (at least every 1.5m excavation depth intervals) in order to confirm inferred geotechnical conditions, assess the suitability of design assumptions and provide further advice with regards to excavation retention/ support and proposed construction methodologies, if required.

Given the presence of groundwater recorded in the three installed groundwater monitoring wells, construction and water table interactions must be considered in further detail. The geotechnical aspects are highlighted below should bulk earthworks depths exceed ground water depth.

- Provisions for sufficient drainage within the design;
- Allowance for increased slope stability measures as groundwater will have significant reduction on slope stability both in short term and permanent situations;
- If the groundwater is not designed to discharge into an approved system, buoyancy affects should be considered;
- If groundwater is discharged, a dewatering assessment should be carried out to determine impacts on surrounding land and any infrastructure within the affected radius.

6.4 Erosion Control

Emerson crumb testing was conducted on three samples selected from the residual clay dominant soils at the site. The limited testing can be considered a preliminary indication of soil dispersivity. CS recommend further testing and assessment after receipt of detailed plans and designs. All three tests indicate the residual soils (Units 2A, 2B, 2C, 2D) have an Emerson Class number of 4. The residual soils observed appeared consistent with residual soil landscape of the Blacktown group (bty) which are generally described in literature (NSW Government Soil and Land Resource Mapping for the Western Sydney Area) as having low occurrences of foundation hazard and gully erosion risk. Mapping and associated data from the NSW Government Department of Environment indicates, "*The erosion hazard for non-concentrated flows is slight to moderate but ranges from low to very high. Calculated soil loss during the first twelve months of urban development for topsoil and exposed subsoil tends to be low (7–11 t/ha). Soil erosion hazard for concentrated flows is moderate to high*."

Topsoil at the site was generally thin, ranging from 0.1m to 0.3m over the boreholes logged, localised areas of deeper topsoil should be expected at areas designated Zone 2 and Zone 5. Higher silt content in alluvial and topsoil deposits may be subject to increased erodibility in the absence of vegetation.

Site preparation and planning for erosion control during the construction phase should consider the following:

- Gully erosion risk
- High run-on, when concentrated large volumes of overland flow move onto an area. Areas with high run-on are often prone to temporary localised flooding.
- Mass movement hazard – short and long term slope stability hazard
- Permanent waterlogging – Where there is a permanent water table at or near the surface. The north-western low-lying part of the site has been mapped (by others) as a creek zone with potential for flooding. At the time of the fieldwork, soils in this zone were observed to be wet to saturated at shallow depth.

Erosion control measures should be formed based on, but not limited to the following:

- Fairfield City Council, Specification for Roadworks and Drainage associated with subdivision or other development, Policy No. 4-515
- Landcom (2004) Soils and Construction Volume 1, Edition 4, Managing Urban Stormwater.
- Witheridge, G. (2012) Principles of Construction Site Erosion and Sediment Control, Publication of Catchments & Creeks Pty Ltd

Construction Sciences can assist in sourcing a suitable consultant for formulation of Erosion and Sediment Control Plans (ESCPs) and Soil and Water Management Plans (SWMPs).

6.5 Geotechnical Parameters for Design

Geotechnical parameters have been derived for assessed encountered materials within the depths reached during the investigation. Suitability of foundation and retaining wall types are subject to bulk earthworks and proposed structural design. The parameters provided below are considered preliminary to aid design. Further detailed investigation may be required to reduce the risk of inhomogeneities following finalisation of bulk earthworks plans, especially in the circumstance where higher parameters for greater than Class III are adopted.

Geotechnical design parameters for high and deep level foundations, anticipated retaining walls and pavements are provided in in the sections below.

6.5.1 Geotechnical Advice for Foundations

Based on the nature of the proposed development as summarised in Section 1.2 and the surface and subsurface conditions described in Section 3 and 4, respectively, the following footing types may be considered for the proposed development subject to consideration of bulk excavations and structural loadings.

- Large diameter bored piers founded within rock as the dominant footing system for the warehouses. Particularly to the west of the site were depths to suitable rock are expected to be deeper than what would be considered reasonable for a high-level footing.
- Shallow pad/strip footings founded on rock may be considered at the eastern and southern extent where bulk excavation is considered likely to intersect underlying rock.
- Shallow pad/strip footings on controlled fill may be considered where the zone of influence of loads from the footing can be accommodated by nearby structures, including retaining walls or embankments.
- At locations near the crest of existing batters or retaining walls, bored piers founded in weathered rock will be required.
- Bored piles may require the use of permanent or temporary steel liners as pile excavations are likely to encounter groundwater, and concrete pouring should utilise a tremie system. There should be several further rounds of groundwater level measurements within the installed monitoring wells in the period leading up to finalising the design and then again prior to construction to finalise temporary and permanent drainage works during bulk excavation, footing and building construction.

Geotechnical parameters recommended for design of footings are summarised in **Table 13** below.

Table 13: Geotechnical Parameters for Footings

Unit No.	AEB – Shallow Footings (kPa)	AEB – Bored Piles (kPa)	USF – Bored Piles (kPa)	UEBC (kPa)
1	*Not Recommended*			
2A/ 2B	*Not Recommended*			
2C	100	150	40	300
2D	150	250	40	450
3 XW Material	200	400	40	600
4A Class V Shale	700	700	50	2100
4B Class IV Shale	1000	1000	150	3000
4C Class III Shale	2000	2000	450	6000

Notes:

1. *AEB: Allowable end bearing capacity. USF: Ultimate skin friction in compression. UEBC: Ultimate end bearing capacity*
2. *The zone of influence of loads from each footing/pile shall not affect any nearby excavation, embankment, retaining wall or buried structure, unless the design of the affected structure allows for additional loads from the footing.*
3. *Pile length must be minimum 5 x pile diameters to adopt allowable end bearing capacities.*
4. *Allowable end bearing pressure for shallow footings assuming a factor of safety of 3.*
5. *Ultimate end bearing capacity is provided unfactored. A geotechnical strength reduction factor of 0.5 (φg) may be used for pile capacity calculations in accordance with AS2159 Australian Standard Piling Design and Installation.*
6. *Parameters allow for design assuming settlement of 1% of minimum footing width, or about 10mm to 20mm*
7. *Pile and footing excavations shall be cleaned of spoil and moisture softened material prior to pouring concrete.*

8. *High level footings designed for >150 kPa shall have a minimum depth of 1m where in soil or XW material. This may be optimised by detailed bearing capacity assessment.*

Notwithstanding the ranges of allowable bearing capacities detailed in **Table 13** for all encountered strata, it is recommended structures be founded on strata of similar stiffness to limit potential differential settlement.

Bored piers founded as described above can be expected to settle up to about 1% of the pier diameter when constructed in accordance with good building practices. Similarly, pad and strip footings founded as described above described above can be expected to settle about 10-20mm dependent on footing type and dimensions. These settlement values assume good construction practice including inspection and verification of bearing strata and base cleanliness by a geotechnical or structural engineer prior to concreting.

The above design parameters are based on the assumptions that the base of footing excavations is free of loose or soft soils and water prior to placement of concrete. For bored piers the above ABP values assume a depth to diameter embedment ratio of not less than 5.

It should be noted that depths to different rock classes as identified in the geotechnical model have been identified by referring to defect spacing and allowable seams in addition to rock strength. As such, medium and high strength rock may be encountered when excavating piles above the depths noted for Class III etc. in the geotechnical model (for example in the vicinity of BH10). As such, suitable piling equipment capable of drilling through high strength rock should be allowed for, subject to bulk excavation levels.

Footing / pile excavations should be inspected by a Geotechnical Engineer or Principal Certifying Authority (PCA) and constructed with minimal delay following excavation. The Geotechnical Engineer is to confirm encountered conditions satisfy design assumptions.

6.5.2 Geotechnical Design Parameters for Retaining Wall Design

In absence of proposed retaining wall heights, generalised design parameters have been provided for the encountered material units described in **Table 2**. The onus is on the designer to select a suitable retaining system with respect to site geometry and the existing ground conditions. Geotechnical design parameters have been derived from published empirical correlations and are provided in **Table 14** below.

Table 14 Geotechnical Design Parameters for Retaining Wall Design

Unit [1]	Unit Weight [2] (kN/m^3)	Undrained Shear Strength [3] (kPa)	Effective Cohesion C′ (kPa)	Internal angle of friction [4] Φ°	Young's Modulus [5] E′ (MPa)	Ka	Ko	Kp
2C (St)	18	200	10	25	10	0.41	0.58	2.47
2D (Vst-H)	18	200	10	25	30	0.41	0.58	2.47
3 (XW Matl)	19	150	10	28	40	0.36	0.53	2.77
4A Class V Shale	22	-	10	28	300	0.36	0.53	2.77
4B Class IV Shale	23	-	80	28	400	0.22	0.53	4.6
4C Class III Shale	24	-	63	32	500	0.22	0.53	4.6

Notes:
*1 Refer to **Table 1** and the borehole logs in **Appendix B** for material description details.*
2 Inferred average in-situ unit weight for layer, based on visual assessment only (±2 kN/m3)
3 Average undrained shear strength (± 5 kPa) assuming normally consolidated clay.

4 Effective internal friction angle (± 2°) assuming drained conditions, inferred based on available data, triaxial testing has not been conducted..
5 Effective Elastic Modulus (±10 %).

6.5.3 Design Considerations for Block Retaining Walls

It is anticipated that block retaining walls restrained by geosynthetic strap reinforced earth may be selected for this development. These are also commonly referred to as Reinforced Earth and Keystone retaining walls. The following should be considered for the design of these retaining walls:

- Footing designs for the retaining wall should not exceed the maximum recommended bearing capacities provided in Table 12.
- If high bearing pressures are anticipated, the retaining wall footing should be widened with a structural engineer designed spread footing, such that the design bearing pressures do not exceed maximum recommended bearing capacities provided in Table 12. Alternatively a piled footing system may be required.
- If footing design drawings require confirmation of a bearing capacity for the strap zone of the retaining wall, note that this would require the strap zone to be treated as a large footing. This would need stringent checks by a geotechnical engineer prior to field confirmation of the target bearing capacity. Ideally the design should accommodate potential ground conditions in the strap zone.
- Adequate field quality control is required during installation, such that target compaction is achieved and straps are installed at the correct configuration and tension. In CS' experience, failure of reinforced-earth block retaining walls can occur due to incorrect placement of reinforcing elements.

6.5.4 Design CBR for Pavement Design

Limited CBR testing has been carried out at this stage of investigation due to significant anticipated earthworks. Both CBR tests were carried on residual high plasticity clay found across the site identified as unit 2. Testing resulted in a CBR of 3% and 5% for samples recovered from BH01 (0.5-1.0m) and BH11 (0.5-1.0m), respectively. In view of the above, current site conditions would dictate that a low design CBR of 3% would need to be adopted, subject to additional CBR testing, for pavements founded on unit 2. Subgrade remediation would likely be necessary in the weak areas identified in Section 6.3. Remediation could include subgrade replacement using better quality crushed rock and possibly the use of a geogrid, otherwise lime stabilisation may be suitable if the pavement footprint geometry and exposed subgrade materials permit. In the instance where subgrade remediation is required, further geotechnical assessment would be required to determine appropriate remedial measures.

However, given the anticipated significant excavation that will likely expose better quality materials at depth, there is opportunity to stockpile such material for use in the pavement subgrade zone. Further assessment would be required quantify the amount of available better-quality material won from bulk excavation. Additional CBR testing would be required to determine the design CBR if this option is pursued.

If the subgrade comprises of varied subgrade material i.e partly founded on rock and soil, the design should include the provision of articulation joints where necessary.

7. Closure

CS appreciates the opportunity to work collaboratively with you on this project. Our team looks forward to bringing our high level of expertise to deliver successful outcomes in the project phases that follow and other future projects.

Your attention is drawn to the appended document titled *"Important Information about this Geotechnical Report"*. This document is intended to clarify to the reader what the realistic expectations of this report should

be, and what is the correct use of the document. Misinterpretation of geotechnical information presents significant risk to projects: The document includes a discussion on general limitations of geotechnical services, which by nature, are based extensively on opinion and judgement.

The statements included in this document are not intended to be exculpatory clauses or to reduce the general responsibility accepted by Construction Sciences, but rather to identify where Construction Sciences and our Client's responsibilities lie. The statements ensure that all parties that may rely on the report are aware of their respective responsibilities.

Important Information about this Geotechnical Report

Scope of Work

The purpose of this report and any associated documentation is expressly stated in the document. This document does not form a complete assessment of the site, and no implicit determinations about Construction Sciences scope can be taken if not specifically referenced. Whilst this report is intended to reduce geotechnical risk, no level of detail or scope of work can entirely eliminate risk.

The nature of geotechnical data typically precludes auxiliary environmental assessment without undertaking specific methods in the investigation. Therefore, unless it is explicitly stated in the scope of work, this report does not provide any contamination or environmental assessment of the site or adjacent sites, nor can it be inferred or implied from any component of the document.

The scope of work, geotechnical information, and assessments made by Construction Sciences may be summarised in the report; however, all aspects of the document, including associated data and limitations should be reviewed in its entirety.

Standard of care

Construction Sciences have undertaken investigations, performed consulting services, and prepared this report based on the Client's specific requirements, data that was available or was collected, and previous experience.

Construction Sciences findings and assessment represent its reasonable judgment, diligence, skill, with sound professional standards, within the time and budget constraints of its commission. No warranty, expressed or implied, is made as to the professional advice included in this report.

Data sources

In preparing this document, or providing any consulting services during the commission, Construction Sciences may have relied on information from third parties including, but not limited to; sub-consultants, published data, and the Client including its employees or representatives. This data may not be verified, and Construction Sciences assumes no responsibility for the adequacy, incompleteness, inaccuracies, or reliability of this information.

Construction Sciences does not assume any responsibility for assessments made partly, or entirely based on information provided by third parties.

Variability in conditions and limitations of data

Subsurface conditions are complex and can be highly variable; they cannot be accurately defined by discrete investigations. Geotechnical data is based on investigation locations which are explicitly representative of the specific sample or test points. Interpretation of conditions between such points cannot be assumed to represent actual subsurface information and there are unknowns or variations in ground conditions between test locations that cannot be inferred or predicted.

The precision and reliability of interpretive assessment between discrete points is dependent on the uniformity of the subsurface strata, as well as the frequency, detail, and method of sampling or testing.

Subsurface conditions are formed by various natural and anthropogenic processes and therefore are subject to change over time. This is particularly relevant with changes to the site ownership or usage, site boundary or layout, and design or planning modifications. Aspects of the site may also not be able to be determined due to physical or project related constraints and any information provided by Construction Sciences cannot apply following modification to the site, regulations, standards, or the development itself.

It is important to appreciate that no level of detail in investigation, or diligence in assessment, can eliminate uncertainty related to subsurface conditions and thus, geotechnical risk. Construction Sciences cannot and

does not provide unqualified warranties nor does it assume any liability for site conditions not observed or accessible during the investigations.

Verification of opinions and recommendations

Geotechnical information, by nature, represents an opinion and is based extensively on judgment of both data and interpretive assessments or observation. This report and its associated documentation are provided explicitly based on Construction Sciences opinion of the site at the time of inspection and cannot be extended beyond this.

Any recommendations or design are provided as preliminary until verified on site during project implementation or construction. Inspection and verification on site shall be conducted by a suitably qualified geotechnical consultant or engineer, and where subsurface conditions or interpretations differ from those provided in this document or otherwise anticipated, Construction Sciences must be notified and be provided with an opportunity to review the recommendations.

Client and copyright

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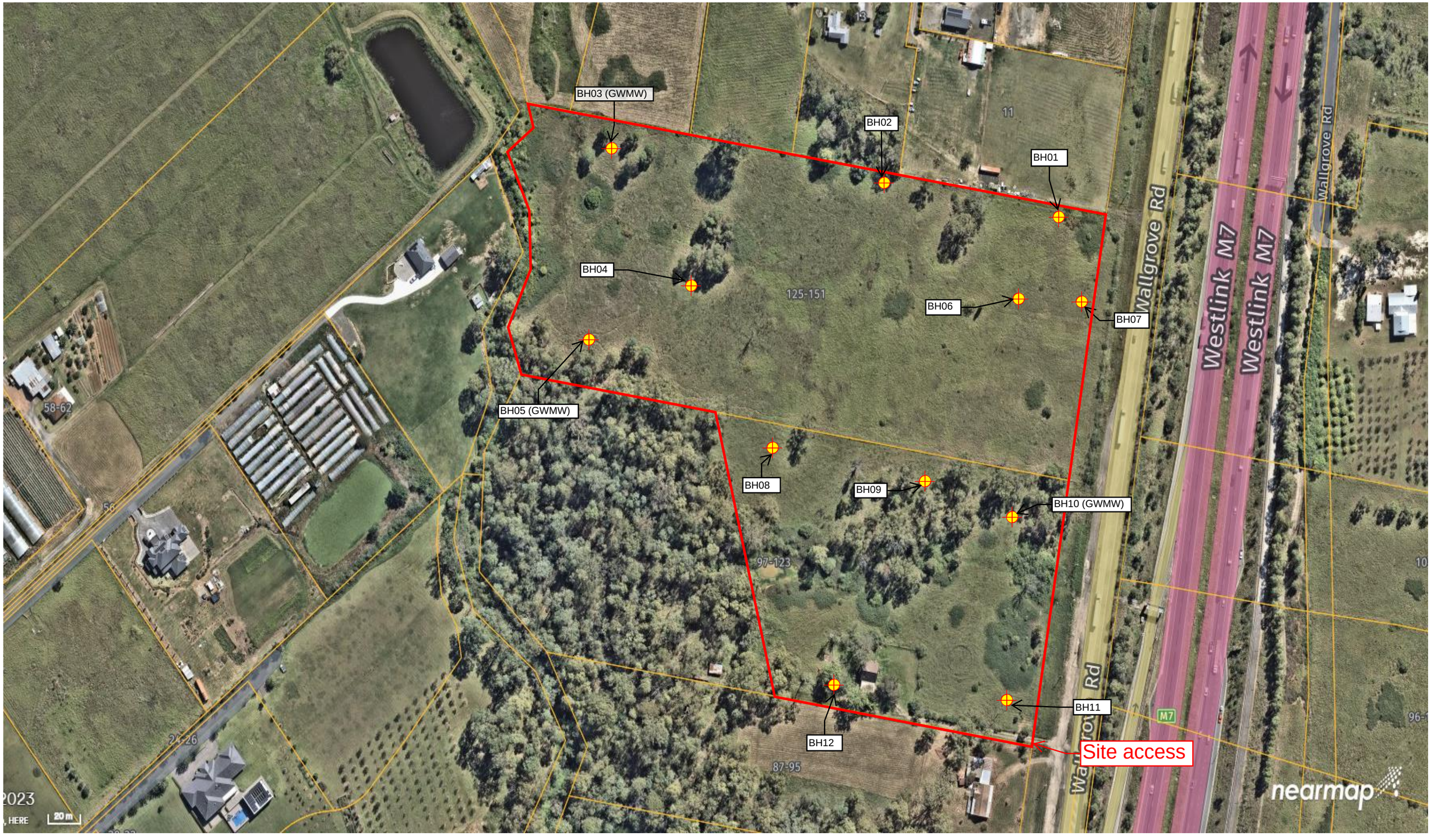
Appendix A

Site Plan & Geotechnical Zone Plan



LEGEND:

APPROXIMATE SITE BOUNDARY

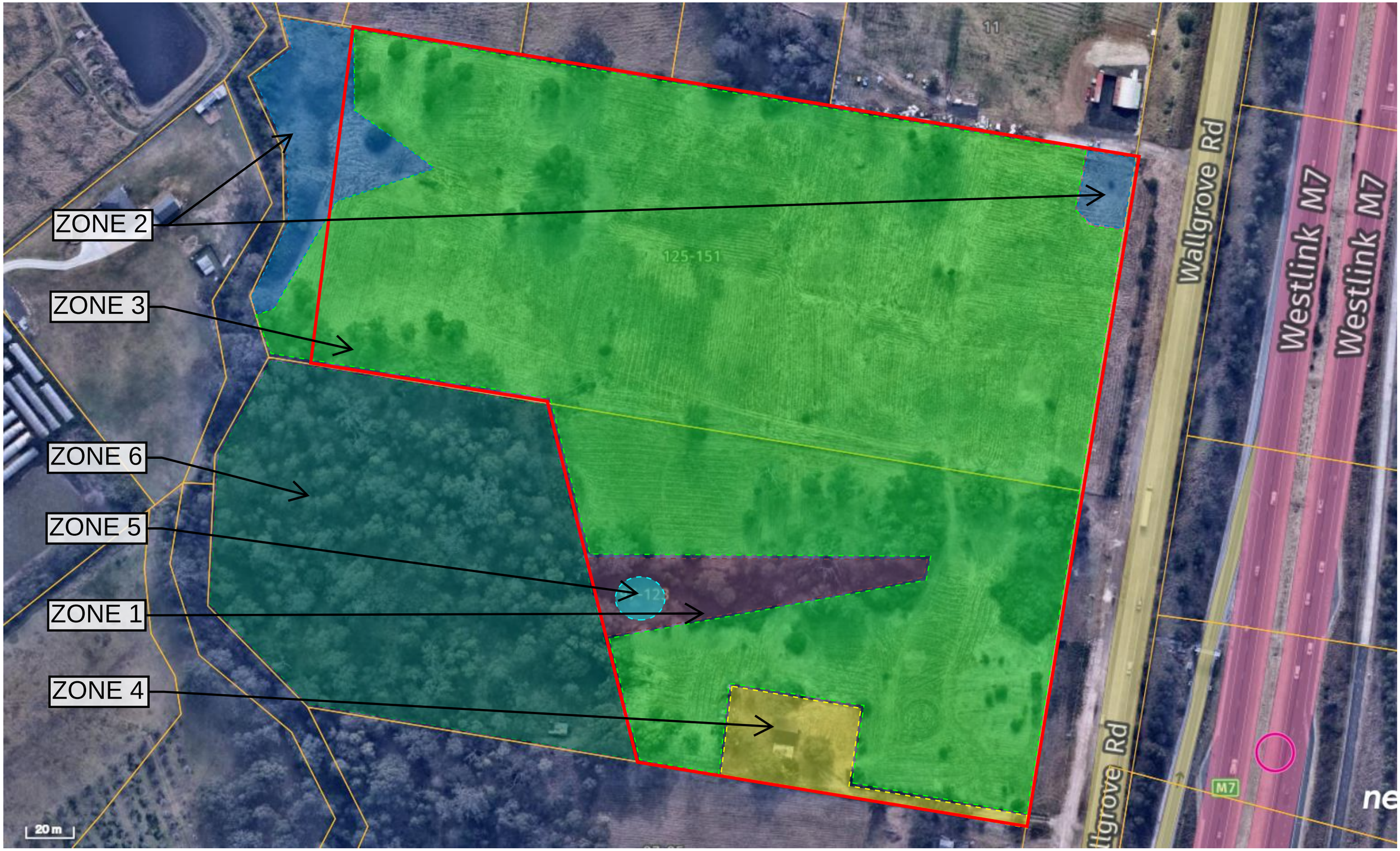
APPROXIMATE BOREHOLE LOCATION

DATA SHOWN IS INTENDED TO ILLUSTRATE APPROXIMATE TEST LOCATIONS. BASEMAP COPYRIGHT REMAINS WITH NEARMAP

Construction Sciences

2/4 Kellogg Road
ROOTY HILL NSW 2766
Tel: 1300 165 769
Web: www.constructionsciences.net

SCALE: NOT TO SCALE		CLIENT: WESTERN SYDNEY PARKLANDS TRUST (WSPT)
DATE: 31 August 2023		PROJECT: GEOTECHNICAL INVESTIGATION FOR WALLGROVE BUSINESS HUB
DRAWN BY: SG		LOCATION: 97-123 & 125-151 WALLGROVE ROAD, CECIL PARK, NSW 2178
DRAWING No.: FIGURE A1	Sheet: 1 of 1	**SITE PLAN**



LEGEND:

APPROXIMATE SITE BOUNDARY

N

DATA SHOWN IS INTENDED TO ILLUSTRATE APPROXIMATE ZONES. BASEMAP COPYRIGHT REMAINS WITH NEARMAP

Construction Sciences

2/4 Kellogg Road
ROOTY HILL NSW 2766
Tel: 1300 165 769
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SCALE: NOT TO SCALE	CLIENT: WESTERN SYDNEY PARKLANDS TRUST (WSPT)
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DRAWN BY: SG	LOCATION: 97-123 & 125-151 WALLGROVE ROAD, CECIL PARK, NSW 2178
DRAWING No.: FIGURE A2 — Sheet: 1 of 1	**GEOTECHNICAL ZONES**

Appendix B

Borehole Logs and Explanatory Notes

Construction Sciences

BOREHOLE LOG SHEET

Client: Western Sydney Parklands Trust
Project: Geotechnical Investigation for Wallgrove Business Hub
Location: 97-123 & 125-151 Wallgrove Road, Cecil Park

Hole No: BH01

Job No: 10791E-P-710 **Sheet:** 1 of 1

Position: E300717.000 N6250323.000 56 MGA94 **Angle from Horizontal:** 90° **Surface Elevation:** 105.000 m AHD
Rig Type: Ute Mounted Drill Rig **Mounting:** 4WD Utility **Driller:** SM
Casing/Hole Diameter: / 100 mm **Contractor:** Geo Engineering
Date Started: 30/6/23 **Date Completed:** 30/6/23 **Logged By:** SB **Checked By:** ZG/JH

Drilling: Method	Drilling: Resistance	Drilling: Casing	Water	Sampling & Testing: Sample or Field Test	Sampling & Testing: DCP	RL (m AHD)	Depth (m)	Material Description: Graphic Log	Classification	SOIL TYPE, plasticity or particle characteristic, colour, secondary and minor components ROCK TYPE, grain size and type, colour, fabric & texture, strength, weathering, defects and structure	Moisture Condition	Consistency Relative Density	STRUCTURE & Other Observations
AD/T	F		Groundwater Not Encountered	ASS 0.00 - 0.20 m ES 0.00 - 0.20 m	2 10 9					TOPSOIL: Clayey SILT: low plasticity, brown, dark brown	M (>PL)		TOPSOIL
				ASS 0.25 - 0.45 m ES 0.25 - 0.45 m	5 7					0.25m Silty CLAY: medium to high plasticity, brown, orange-brown		VSt	RESIDUAL SOIL
				CBR 0.50 - 1.00 m D 0.50 - 0.60 m	8 12 12 15 12 10 8 7 5 2	104.5 104.0 103.5	0.5 1.0 1.5		CI-CH			H VSt F to St	
				D 1.50 - 1.60 m	3 6 11 12 18 17 26 25	103.0	2.0			1.70m EXTREMELY WEATHERED SILTSTONE, remoulds as Silty CLAY, medium plasticity, dark brown-grey	M (<PL)	VSt	EXTREMELY WEATHERED MATERIAL
	H-VH			D 2.50 - 2.60 m		102.5	2.5		XW	2.70m		H	2.30 m: DCP practical refusal.
						102.0 101.5 101.0 100.5	3.0 3.5 4.0 4.5			TERMINATED AT 2.70 m Refusal			2.70 m: TC bit refusal on SILTSTONE, inferred low to medium strength.

METHOD
EX Excavator bucket
R Ripper
HA Hand auger
PT Push tube
SON Sonic drilling
AH Air hammer
PS Percussion sampler
AS Short spiral auger
AD/V Solid flight auger: V-Bit
AD/T Solid flight auger: TC-Bit
HFA Hollow flight auger
WB Washbore drilling
RR Rock roller

PENETRATION
VE Very Easy (No Resistance)
E Easy
F Firm
H Hard
VH Very Hard (Refusal)

WATER
Water Level on Date shown
water inflow
water outflow

FIELD TESTS
SPT - Standard Penetration Test
PP - Hand/Pocket Penetrometer
DCP - Dynamic Cone Penetrometer
PSP - Perth Sand Penetrometer
MC - Moisture Content
PLT - Plate Load Test
IMP - Borehole Impression Test
PID - Photoionisation Detector
VS - Vane Shear; P=Peak, R=Residual (uncorrected kPa)

SAMPLES
B - Bulk disturbed sample
D - Disturbed sample
ES - Environmental sample
U - Thin wall tube 'undisturbed'
SPT - Standard Penetration Test

MOISTURE
D - Dry
M - Moist
W - Wet
PL - Plastic limit
LL - Liquid limit
w - Moisture content

SOIL CONSISTENCY
VS - Very Soft
S - Soft
F - Firm
St - Stiff
VSt - Very Stiff
H - Hard

RELATIVE DENSITY
VL - Very Loose
L - Loose
MD - Medium Dense
D - Dense
VD - Very Dense

Refer to explanatory notes for details of abbreviations and basis of descriptions

CONSTRUCTION SCIENCES PTY LTD

Construction Sciences

BOREHOLE LOG SHEET

Client: Western Sydney Parklands Trust
Project: Geotechnical Investigation for Wallgrove Business Hub
Location: 97-123 & 125-151 Wallgrove Road, Cecil Park

Hole No: BH02

Job No: 10791E-P-710 **Sheet:** 1 of 1

Position: E300588.000 N6250338.000 56 MGA94 **Angle from Horizontal:** 90° **Surface Elevation:** 106.800 m AHD
Rig Type: Ute Mounted Drill Rig **Mounting:** 4WD Utility **Driller:** SM
Casing/Hole Diameter: / 100 mm **Contractor:** Geo Engineering
Date Started: 29/6/23 **Date Completed:** 29/6/23 **Logged By:** SB **Checked By:** ZG/JH

Drilling: Method	Drilling: Resistance	Drilling: Casing	Water	Sampling & Testing: Sample or Field Test	Sampling & Testing: DCP	RL (m AHD)	Depth (m)	Material Description: Graphic Log	Classification	SOIL TYPE, plasticity or particle characteristic, colour, secondary and minor components ROCK TYPE, grain size and type, colour, fabric & texture, strength, weathering, defects and structure	Moisture Condition	Consistency Relative Density	STRUCTURE & Other Observations
AD/T	VE		Groundwater Not Encountered		2	106.8	0.05m			TOPSOIL: Silty CLAY: low plasticity, dark brown, with roots and organics			TOPSOIL
					3							St	RESIDUAL SOIL
					5					Silty CLAY: high plasticity, brown, dark brown mottled orange			
					8	106.5							
	E-F				8		0.5		CH		M (<PL)		
				D 0.50 - 0.60 m	9							VSt	
					11								
					Bouncing								0.70 m: DCP refusal, bouncing hammer.
					2	106.0	0.80m						
							1.0			SILTSTONE: highly weathered, very low to low strength, fine grained, brown			WEATHERED ROCK
	F-H					105.5							
				D 1.40 - 1.50 m			1.5						
							1.50m			TERMINATED AT 1.50 m Refusal			1.50 m: TC bit refusal on SILTSTONE, inferred low to medium strength.
						105.0	2.0						
						104.5	2.5						
						104.0	3.0						
						103.5	3.5						
						103.0	4.0						
						102.5	4.5						
						102.0							

METHOD
EX Excavator bucket
R Ripper
HA Hand auger
PT Push tube
SON Sonic drilling
AH Air hammer
PS Percussion sampler
AS Short spiral auger
AD/V Solid flight auger: V-Bit
AD/T Solid flight auger: TC-Bit
HFA Hollow flight auger
WB Washbore drilling
RR Rock roller

PENETRATION
VE Very Easy (No Resistance)
E Easy
F Firm
H Hard
VH Very Hard (Refusal)

WATER
Water Level on Date shown
water inflow
water outflow

FIELD TESTS
SPT - Standard Penetration Test
PP - Hand/Pocket Penetrometer
DCP - Dynamic Cone Penetrometer
PSP - Perth Sand Penetrometer
MC - Moisture Content
PLT - Plate Load Test
IMP - Borehole Impression Test
PID - Photoionisation Detector
VS - Vane Shear; P=Peak, R=Residual (uncorrected kPa)

SAMPLES
B - Bulk disturbed sample
D - Disturbed sample
ES - Environmental sample
U - Thin wall tube 'undisturbed'
SPT - Standard Penetration Test

MOISTURE
D - Dry
M - Moist
W - Wet
PL - Plastic limit
LL - Liquid limit
w - Moisture content

SOIL CONSISTENCY
VS - Very Soft
S - Soft
F - Firm
St - Stiff
VSt - Very Stiff
H - Hard

RELATIVE DENSITY
VL - Very Loose
L - Loose
MD - Medium Dense
D - Dense
VD - Very Dense

Refer to explanatory notes for details of abbreviations and basis of descriptions

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BOREHOLE LOG SHEET

Client: Western Sydney Parklands Trust
Project: Geotechnical Investigation for Wallgrove Business Hub
Location: 97-123 & 125-151 Wallgrove Road, Cecil Park

Hole No: BH03

Job No: 10791E-P-710 **Sheet:** 1 of 1

Position: E300422.000 N6250358.000 56 MGA94 **Angle from Horizontal:** 90° **Surface Elevation:** 94.200 m AHD
Rig Type: Ute Mounted Drill Rig **Mounting:** 4WD Utility **Driller:** SM
Casing/Hole Diameter: / 100 mm **Contractor:** Geo Engineering
Date Started: 30/6/23 **Date Completed:** 30/6/23 **Logged By:** SB **Checked By:** ZG/JH

Drilling				Sampling & Testing				Material Description					
Method	Resistance	Casing	Water	Sample or Field Test	DCP	RL (m AHD)	Depth (m)	Graphic Log	Classification	SOIL TYPE, plasticity or particle characteristic, colour, secondary and minor components ROCK TYPE, grain size and type, colour, fabric & texture, strength, weathering, defects and structure	Moisture Condition	Consistency Relative Density	STRUCTURE & Other Observations
AD/T	E			ASS 0.00 - 0.10 m ES 0.00 - 0.10 m	2 3	94.0	0.5			TOPSOIL: Clayey SILT: low plasticity, brown, dark brown	M (>PL)		TOPSOIL
										0.20m			
	E-F			ASS 0.20 - 0.30 m ES 0.20 - 0.30 m	2 5					CLAY: medium to high plasticity, orange-brown		F St	RESIDUAL SOIL
					4								
				CBR 0.50 - 1.00 m D 0.50 - 0.60 m	4 11	93.5	1.0		CI-CH	colour grading to mottled yellow-brown-pale grey	M (<PL)	VSt to H	0.90 m: DCP practical refusal.
					16 22 25								
				D 1.50 - 1.60 m		93.0	1.5						
						92.5	2.0			1.80m SILTSTONE: highly weathered to extremely weathered, very low strength, grey brown			EXTREMELY WEATHERED MATERIAL
	F-H			D 2.50 - 2.60 m		92.0	2.5			2.50m SILTSTONE: highly weathered, very low to low strength, grey-brown, brown-grey.			WEATHERED ROCK
			04/07/23			91.5	3.0						
				D 3.50 - 3.60 m		91.0	3.5						
						90.5	4.0						
				D 4.50 - 4.60 m		90.0	4.5						
						89.5	5.0			5.00m TERMINATED AT 5.00 m Refusal			5.00 m: BH terminated at target depth.
						89.0							

METHOD
EX Excavator bucket
R Ripper
HA Hand auger
PT Push tube
SON Sonic drilling
AH Air hammer
PS Percussion sampler
AS Short spiral auger
AD/V Solid flight auger: V-Bit
AD/T Solid flight auger: TC-Bit
HFA Hollow flight auger
WB Washbore drilling
RR Rock roller

PENETRATION
VE Very Easy (No Resistance)
E Easy
F Firm
H Hard
VH Very Hard (Refusal)

WATER
Water Level on Date shown
water inflow
water outflow

FIELD TESTS
SPT - Standard Penetration Test
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DCP - Dynamic Cone Penetrometer
PSP - Perth Sand Penetrometer
MC - Moisture Content
PLT - Plate Load Test
IMP - Borehole Impression Test
PID - Photoionisation Detector
VS - Vane Shear; P=Peak, R=Residual (uncorrected kPa)

SAMPLES
B - Bulk disturbed sample
D - Disturbed sample
ES - Environmental sample
U - Thin wall tube 'undisturbed'
SPT - Standard Penetration Test

MOISTURE
D - Dry
M - Moist
W - Wet
PL - Plastic limit
LL - Liquid limit
w - Moisture content

SOIL CONSISTENCY
VS - Very Soft
S - Soft
F - Firm
St - Stiff
VSt - Very Stiff
H - Hard

RELATIVE DENSITY
VL - Very Loose
L - Loose
MD - Medium Dense
D - Dense
VD - Very Dense

Refer to explanatory notes for details of abbreviations and basis of descriptions

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BOREHOLE LOG SHEET

Client: Western Sydney Parklands Trust
Project: Geotechnical Investigation for Wallgrove Business Hub
Location: 97-123 & 125-151 Wallgrove Road, Cecil Park

Hole No: BH04

Job No: 10791E-P-710 **Sheet:** 1 of 1

Position: E300477.000 N62503292.000 56 MGA94 **Angle from Horizontal:** 90° **Surface Elevation:** 98.600 m AHD

Rig Type: Ute Mounted Drill Rig **Mounting:** 4WD Utility **Driller:** SM

Casing/Hole Diameter: / 100 mm **Contractor:** Geo Engineering

Date Started: 30/6/23 **Date Completed:** 30/6/23 **Logged By:** SB **Checked By:** ZG/JH

Drilling: Method	Drilling: Resistance	Drilling: Casing	Water	Sampling & Testing: Sample or Field Test	Sampling & Testing: DCP	RL (m AHD)	Depth (m)	Material Description: Graphic Log	Classification	SOIL TYPE, plasticity or particle characteristic, colour, secondary and minor components ROCK TYPE, grain size and type, colour, fabric & texture, strength, weathering, defects and structure	Moisture Condition	Consistency Relative Density	STRUCTURE & Other Observations
AD/T	E		Groundwater Not Encountered	ASS 0.00 - 0.10 m ES 0.00 - 0.10 m	5	98.5				0.10m TOPSOIL: Clayey SILT: low plasticity, dark brown	M (>PL)		TOPSOIL
				ASS 0.10 - 0.20 m ES 0.10 - 0.20 m	8 12					Silty CLAY: medium to high plasticity, pale brown, brown			RESIDUAL SOIL
	E-F				14 17		0.5		CI-CH			VSt to H	
				D 0.50 - 0.60 m	20	98.0				0.60m			
					22 25		1.0			SILTSTONE: highly weathered to extremely weathered, very low strength, fine grained, grey brown	M (<PL)		EXTREMELY WEATHERED MATERIAL 0.70 m: DCP practical refusal.
	F-H					97.5				1.20m			
				D 1.50 - 1.60 m		97.0	1.5		XW	EXTREMELY WEATHERED SILTSTONE, remoulds as Silty CLAY, medium plasticity, grey		H	
										1.70m			
						96.5	2.0			TERMINATED AT 1.70 m Refusal			1.70 m: TC bit refusal on SILTSTONE, inferred low to medium strength.
						96.0	2.5						
						95.5	3.0						
						95.0	3.5						
						94.5	4.0						
						94.0	4.5						

METHOD
EX Excavator bucket
R Ripper
HA Hand auger
PT Push tube
SON Sonic drilling
AH Air hammer
PS Percussion sampler
AS Short spiral auger
AD/V Solid flight auger: V-Bit
AD/T Solid flight auger: TC-Bit
HFA Hollow flight auger
WB Washbore drilling
RR Rock roller

PENETRATION
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WATER
Water Level on Date shown
water inflow
water outflow

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CONSTRUCTION SCIENCES PTY LTD

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BOREHOLE LOG SHEET

Client: Western Sydney Parklands Trust
Project: Geotechnical Investigation for Wallgrove Business Hub
Location: 97-123 & 125-151 Wallgrove Road, Cecil Park

Hole No: BH05

Job No: 10791E-P-710 **Sheet:** 1 of 3

Position: E300404.000 N6250264.000 56 MGA94 **Angle from Horizontal:** 90° **Surface Elevation:** 95.400 m AHD
Rig Type: Ute Mounted Drill Rig **Mounting:** 4WD Utility **Driller:**
Casing/Hole Diameter: / 100 mm **Contractor:** Stratacore
Date Started: 30/6/23 **Date Completed:** 30/6/23 **Logged By:** SB **Checked By:** ZG/JH

Drilling: Method	Drilling: Resistance	Drilling: Casing	Drilling: Water	Sampling & Testing: Sample or Field Test	RL (m AHD)	Depth (m)	Material Description: Graphic Log	Classification	SOIL TYPE, plasticity or particle characteristic, colour, secondary and minor components ROCK TYPE, grain size and type, colour, fabric & texture, strength, weathering, defects and structure	Moisture Condition	Consistency Relative Density	STRUCTURE & Other Observations
AD/T	E								0.10m TOPSOIL: Silty CLAY: low plasticity, brown, dark brown, with roots and organics	M (>PL)		TOPSOIL
								CL	Silty CLAY: low plasticity, brown, orange-brown			RESIDUAL SOIL
					95.0	0.5			0.50m			
				D 0.50 - 0.60 m SPT 0.50 - 0.95 m 6, 9, 13 N=22 REC= m					Silty CLAY: low to medium plasticity, pale brown, grey mottled orange		VSt	
	E-F				94.5	1.0		CL-CI		M (<PL)		
					94.0	1.5			1.50m			
				D 1.50 - 1.60 m SPT 1.50 - 1.95 m 3, 17, 4 N=21 REC= m				XW	EXTREMELY WEATHERED SILTSTONE, remoulds as Silty CLAY, medium plasticity, brown-grey		H	EXTREMELY WEATHERED MATERIAL
									1.70m SHALE: extremely weathered to highly weathered, very low strength, brown, grey-brown			WEATHERED ROCK
					93.5	2.0						
					93.0	2.5						
				D 2.50 - 2.60 m								
					92.5	3.0						
	H				92.0	3.5						
				D 3.50 - 3.60 m								
					91.5	4.0						
					91.0	4.5			4.50m SHALE: highly weathered, very low to low strength, brown, grey-brown			
			04/07/23		90.5							

METHOD
EX Excavator bucket
R Ripper
HA Hand auger
PT Push tube
SON Sonic drilling
AH Air hammer
PS Percussion sampler
AS Short spiral auger
AD/V Solid flight auger: V-Bit
AD/T Solid flight auger: TC-Bit
HFA Hollow flight auger
WB Washbore drilling
RR Rock roller

PENETRATION
VE Very Easy (No Resistance)
E Easy
F Firm
H Hard
VH Very Hard (Refusal)

WATER
Water Level on Date shown
water inflow
water outflow

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RELATIVE DENSITY
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Refer to explanatory notes for details of abbreviations and basis of descriptions

CONSTRUCTION SCIENCES PTY LTD

Construction Sciences

BOREHOLE LOG SHEET

Client: Western Sydney Parklands Trust
Project: Geotechnical Investigation for Wallgrove Business Hub
Location: 97-123 & 125-151 Wallgrove Road, Cecil Park

Hole No: BH05

Job No: 10791E-P-710 **Sheet:** 2 of 3

Position: E300404.000 N6250264.000 56 MGA94 **Angle from Horizontal:** 90° **Surface Elevation:** 95.400 m AHD
Rig Type: Ute Mounted Drill Rig **Mounting:** 4WD Utility **Driller:**
Casing/Hole Diameter: / 100 mm **Contractor:** Stratacore
Date Started: 30/6/23 **Date Completed:** 30/6/23 **Logged By:** SB **Checked By:** ZG/JH

Drilling				Sampling & Testing			Material Description					
Method	Resistance	Casing	Water	Sample or Field Test	RL (m AHD)	Depth (m)	Graphic Log	Classification	SOIL TYPE, plasticity or particle characteristic, colour, secondary and minor components ROCK TYPE, grain size and type, colour, fabric & texture, strength, weathering, defects and structure	Moisture Condition	Consistency Relative Density	STRUCTURE & Other Observations
AD/T					90.0	5.5			SHALE: highly weathered, very low to low strength, brown, grey-brown *(continued)*			WEATHERED ROCK
				SPT 6.00 - 6.45 m 18, 5, 0 N=5 REC= m	89.5	6.0						
					89.0	6.5						
	H				88.5	7.0			6.80m SHALE: moderately weathered to moderately weathered, low strength, brown grey			
									7.30m Continued as Cored Drill Hole			
					88.0	7.5						
					87.5	8.0						
					87.0	8.5						
					86.5	9.0						
					86.0	9.5						
					85.5							

METHOD
EX Excavator bucket
R Ripper
HA Hand auger
PT Push tube
SON Sonic drilling
AH Air hammer
PS Percussion sampler
AS Short spiral auger
AD/V Solid flight auger: V-Bit
AD/T Solid flight auger: TC-Bit
HFA Hollow flight auger
WB Washbore drilling
RR Rock roller

PENETRATION
VE Very Easy (No Resistance)
E Easy
F Firm
H Hard
VH Very Hard (Refusal)

WATER
Water Level on Date shown
water inflow
water outflow

FIELD TESTS
SPT - Standard Penetration Test
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MC - Moisture Content
PLT - Plate Load Test
IMP - Borehole Impression Test
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VS - Vane Shear; P=Peak, R=Residual (uncorrected kPa)

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SPT - Standard Penetration Test

MOISTURE
D - Dry
M - Moist
W - Wet
PL - Plastic limit
LL - Liquid limit
w - Moisture content

SOIL CONSISTENCY
VS - Very Soft
S - Soft
F - Firm
St - Stiff
VSt - Very Stiff
H - Hard

RELATIVE DENSITY
VL - Very Loose
L - Loose
MD - Medium Dense
D - Dense
VD - Very Dense

Refer to explanatory notes for details of abbreviations and basis of descriptions

CONSTRUCTION SCIENCES PTY LTD

Construction Sciences

CORE LOG SHEET

Client: Western Sydney Parklands Trust
Project: Geotechnical Investigation for Wallgrove Business Hub
Location: 97-123 & 125-151 Wallgrove Road, Cecil Park

Hole No: BH05

Job No: 10791E-P-710 **Sheet:** 3 of 3

Position: E300404.000 N6250264.000 56 MGA94 **Angle from Horizontal:** 90° **Surface Elevation:** 95.400 m AHD
Rig Type: Ute Mounted Drill Rig **Mounting:** 4WD Utility **Driller:**
Casing Diameter: **Bit Type:** **Bit Condition:** **Contractor:** Stratacore
Date Started: 30/6/23 **Date Completed:** 30/6/23 **Logged By:** SB **Checked By:** ZG/JH

Coring						Material Description			Defect Description		
Method	Fluid	TCR (%)	RQD (%)	RL (m AHD)	Depth (m)	Graphic Log	SOIL TYPE, plasticity or particle characteristic, colour, secondary & minor components ROCK NAME, grain size and type, colour, fabric and texture, inclusions & minor components	Weathering	Estimated Strength $Is_{(50)}$ MPa (● - Axial O - Diametral □ - Irregular Lump) VL 0.1 L 0.3 M 1 H 3 VH 10 EH	Average Natural Defect Spacing (mm) 20 60 200 600 2000	Visual	Additional Data DEFECT TYPE, orientation, shape, roughness, infilling or coating, thickness, other
				90.0	5.5							
				89.5	6.0							
				89.0	6.5							
				88.5	7.0							
							7.30m START CORING AT 7.30m					
NMLC		100	64	88.0	7.5		NO CORE 7.50m					
							SILTSTONE: dark grey 7.78m	SW	0.42			7.50 m: JT, 90°, IR, S, CN, =30 mm 7.54 m: JT, 0°, PR, S, CN 7.60 m: BP, 0°
				87.5	8.0		SANDSTONE and shale interbedded: fine grained, fine grained sandstone, dark grey with occasional lamina at (0-5)°		1.06			7.72 m: JT, 0 - 5°, PR, S, CN 7.78 m: JT, 0°, PR, RF, CN 7.80 m: JT, 0°, PR, RF, CN 7.84 m: JT, 10°, IR, RF, CN 7.86 m: JT, 0°, PR, S, CN
				87.0	8.5		8.72m		1.63			8.16 m: JT, 5°, PR, S, CN 8.41 m: BP, 0° 8.43 m: BP, 0° 8.55 m: BP, 0° 8.56 m: BP, 0° 8.68 m: JT, 5°, PR, RF, CN
							TERMINATED AT 8.72 m Target depth					
				86.5	9.0							
				86.0	9.5							
				85.5								

DRILLING
AD/V Solid flight auger: V-Bit
AD/T Solid flight auger: TC-Bit
HFA Hollow flight auger
WB Washbore drilling
RR Rock roller
PQ Rotary core (85mm)
HQ Rotary core (63.5mm)
NMLC Rotary core (51.94mm)
DT Diatube concrete coring
PT Push tube
PS Percussion sampling
SON Sonic drilling
AH Air hammer

WATER
Water Level on date shown
water inflow
water outflow

ROCK QUALITY DESCRIPTIONS
RQD Rock Quality Designation (%)
TCR Total Core Recovery (%)

ROCK STRENGTH
EH Extremly High
VH Very High
H High
M Medium
L Low
VL Very Low

ROCK WEATHERING
F Fresh
SW Slightly Weathered
DW Distinctly Weathered
MW Moderately Weathered
HW Highly Weathered
XW Extremly Weathered

DEFECT TYPE
JT Joint
SZ Sheared zone
BP Bedding Parting
SM Seam
FL Foliation
VN Vein
CL Cleavage
CS Crushed Seam
FZ Fracture Zone
HB Handing Break
DB Drilling Break

PLANARITY
CU Curved
DIS Discontinuous
IR Irregular
PR Planar
ST Stepped
UN Undulose

ROUGHNESS
VR Very Rough
RF Rough
S Smooth
SL Slockensided
POL Polished

COATING
CN Clean
SN Stained
VNR Veneer (thin or patchy)
CT Coating (up to 1mm)

INFILL MATERIALS
X Carbonaceus
MU Unidentified minteral
MS Secondary mineral
KT Chlorite
CA Calcite
Fe Iron Oxide
Qz Quartz

Refer to explanatory notes for details of abbreviations and basis of descriptions

CONSTRUCTION SCIENCES PTY LTD

Construction Sciences

www.constructionsciences.net

BH No: 5

Client: Parramatta Park & W. Sydney Parkland Trust

Project: Wallgrove Business Park, Cecil Park

Location: 97-123 & 125-151 Wallgrove Road, Cecil Park, NSW 2178

Job No: 10791E/P/710

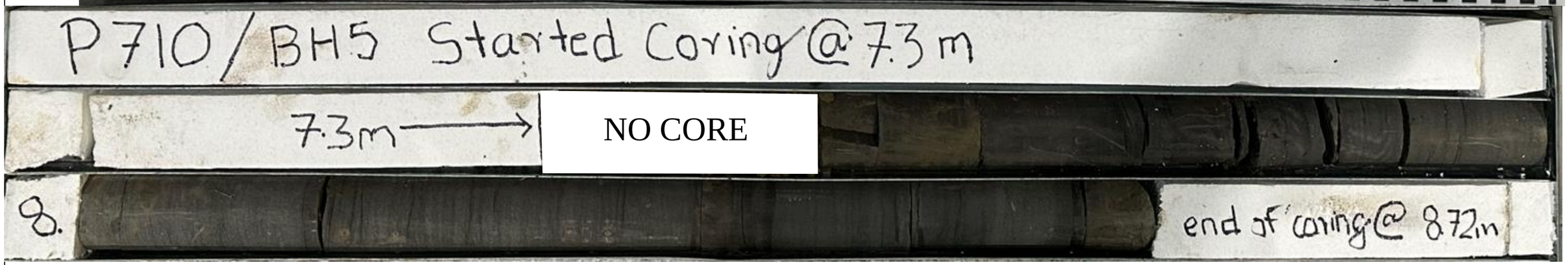
Date: 30/06/2023

Depth: 8.72m

Core Tray No: 1/1

Logged By: S.B

Driller: Strata Core



	Construction Sciences 2/4 Kellogg Road ROOTY HILL NSW 2766 Tel: 1300 165 769 Web: www.constructionsciences.net	SCALE: NOT TO SCALE	CLIENT: PARRAMATTA PARK & WESTERN SYDNEY PARKLAND TRUST
		DATE: 4 AUGUST 2023	PROJECT: GEOTECHNICAL WALLGROVE BUSINESS PARK, CECIL PARK
		DRAWN: SB	LOCATION: 97-123 & 125-151 WALLGROVE ROAD, CECIL PARK, NSW 2178
		DRAWING No.: 10791E-P-710-CP2 Sheet: 1 of 1	**CORE PHOTOGRAPH**

Construction Sciences

BOREHOLE LOG SHEET

Client: Western Sydney Parklands Trust
Project: Geotechnical Investigation for Wallgrove Business Hub
Location: 97-123 & 125-151 Wallgrove Road, Cecil Park

Hole No: BH06

Job No: 10791E-P-710 **Sheet:** 1 of 1

Position: E300690.000 N6250277.000 56 MGA94 **Angle from Horizontal:** 90° **Surface Elevation:** 106.500 m AHD
Rig Type: Ute Mounted Drill Rig **Mounting:** 4WD Utility **Driller:** SM
Casing/Hole Diameter: / 100 mm **Contractor:** Geo Engineering
Date Started: 29/6/23 **Date Completed:** 29/6/23 **Logged By:** SB **Checked By:** ZG/JH

Drilling: Method	Drilling: Resistance	Drilling: Casing	Water	Sampling & Testing: Sample or Field Test	Sampling & Testing: DCP	RL (m AHD)	Depth (m)	Graphic Log	Classification	Material Description: SOIL TYPE, plasticity or particle characteristic, colour, secondary and minor components ROCK TYPE, grain size and type, colour, fabric & texture, strength, weathering, defects and structure	Moisture Condition	Consistency Relative Density	Material Description: STRUCTURE & Other Observations
AD/T	E		Groundwater Not Encountered		2	106.0	0.0			0.10m TOPSOIL: Silty CLAY: low plasticity, dark brown, with roots and organics			TOPSOIL
					5					Silty CLAY: high plasticity, colour change to dark brown mottled orange			RESIDUAL SOIL
	E-F				3				CH		M (>PL)	St	
					5								
					5								
				D 0.50 - 0.60 m	18		0.5						
					25					0.70m			0.60 m: DCP practical refusal.
						105.5	1.0			EXTREMELY WEATHERED SHALE, remoulds as Silty CLAY, low to medium plasticity, brown mottled light brown			EXTREMELY WEATHERED MATERIAL
									XW		M (<PL)	H	
				D 1.50 - 1.60 m		105.0	1.5			1.60m			
	F-H									SHALE: highly weathered, very low to low strength, fine grained, brown			WEATHERED ROCK
						104.5	2.0						
				D 2.50 - 2.60 m		104.0	2.5						
										2.70m			
										TERMINATED AT 2.70 m Refusal			2.70 m: TC bit refusal on SHALE, inferred low to medium strength.
						103.5	3.0						
						103.0	3.5						
						102.5	4.0						
						102.0	4.5						

METHOD
EX Excavator bucket
R Ripper
HA Hand auger
PT Push tube
SON Sonic drilling
AH Air hammer
PS Percussion sampler
AS Short spiral auger
AD/V Solid flight auger: V-Bit
AD/T Solid flight auger: TC-Bit
HFA Hollow flight auger
WB Washbore drilling
RR Rock roller

PENETRATION
VE Very Easy (No Resistance)
E Easy
F Firm
H Hard
VH Very Hard (Refusal)

WATER
Water Level on Date shown
water inflow
water outflow

FIELD TESTS
SPT - Standard Penetration Test
PP - Hand/Pocket Penetrometer
DCP - Dynamic Cone Penetrometer
PSP - Perth Sand Penetrometer
MC - Moisture Content
PLT - Plate Load Test
IMP - Borehole Impression Test
PID - Photoionisation Detector
VS - Vane Shear; P=Peak, R=Residual (uncorrected kPa)

SAMPLES
B - Bulk disturbed sample
D - Disturbed sample
ES - Environmental sample
U - Thin wall tube 'undisturbed'
SPT - Standard Penetration Test

MOISTURE
D - Dry
M - Moist
W - Wet
PL - Plastic limit
LL - Liquid limit
w - Moisture content

SOIL CONSISTENCY
VS - Very Soft
S - Soft
F - Firm
St - Stiff
VSt - Very Stiff
H - Hard

RELATIVE DENSITY
VL - Very Loose
L - Loose
MD - Medium Dense
D - Dense
VD - Very Dense

Refer to explanatory notes for details of abbreviations and basis of descriptions

CONSTRUCTION SCIENCES PTY LTD

Construction Sciences

BOREHOLE LOG SHEET

Client: Western Sydney Parklands Trust
Project: Geotechnical Investigation for Wallgrove Business Hub
Location: 97-123 & 125-151 Wallgrove Road, Cecil Park

Hole No: BH07

Job No: 10791E-P-710 **Sheet:** 1 of 1

Position: E300724.000 N6250278.000 56 MGA94 **Angle from Horizontal:** 90° **Surface Elevation:** 107.600 m AHD
Rig Type: Ute Mounted Drill Rig **Mounting:** 4WD Utility **Driller:** SM
Casing/Hole Diameter: / 100 mm **Contractor:** Geo Engineering
Date Started: 29/6/23 **Date Completed:** 29/6/23 **Logged By:** SB **Checked By:** ZG/JH

Drilling: Method	Drilling: Resistance	Drilling: Casing	Drilling: Water	Sampling & Testing: Sample or Field Test	Sampling & Testing: DCP	RL (m AHD)	Depth (m)	Material Description: Graphic Log	Classification	SOIL TYPE, plasticity or particle characteristic, colour, secondary and minor components ROCK TYPE, grain size and type, colour, fabric & texture, strength, weathering, defects and structure	Moisture Condition	Consistency Relative Density	STRUCTURE & Other Observations
AD/T	E-F		Groundwater Not Encountered	D 0.50 - 0.60 m	2, 2, 3, 3, 2, 3, 3, 4, 4, 11, 7, 25	107.5	0.5		CH	0.05m TOPSOIL: Silty CLAY: low plasticity, dark brown, with roots and organics Silty CLAY: medium to high plasticity, brown mottled orange, DCP refusal at 1.2m	M (<PL)	F to St St VSt to H	TOPSOIL RESIDUAL SOIL 0.05 m: DCP refusal at 1.2m
						107.0	1.0						
						106.5	1.5			1.20m EXTREMELY WEATHERED SHALE, remoulds as Silty CLAY, low to medium plasticity, brown mottled light brown			1.10 m: DCP practical refusal. EXTREMELY WEATHERED MATERIAL
	F-H			D 1.50 - 1.60 m		106.0	2.0		XW			H	
						105.5	2.5			1.80m SHALE: highly weathered, very low to low strength, fine grained, brown			WEATHERED ROCK
	H			D 2.50 - 2.60 m		105.0	3.0			2.70m TERMINATED AT 2.70 m Refusal			2.70 m: TC bit refusal on SHALE, inferred low to medium strength.
						104.5	3.5						
						104.0	4.0						
						103.5	4.5						
						103.0							

METHOD
EX Excavator bucket
R Ripper
HA Hand auger
PT Push tube
SON Sonic drilling
AH Air hammer
PS Percussion sampler
AS Short spiral auger
AD/V Solid flight auger: V-Bit
AD/T Solid flight auger: TC-Bit
HFA Hollow flight auger
WB Washbore drilling
RR Rock roller

PENETRATION
VE Very Easy (No Resistance)
E Easy
F Firm
H Hard
VH Very Hard (Refusal)

WATER
Water Level on Date shown
water inflow
water outflow

FIELD TESTS
SPT - Standard Penetration Test
PP - Hand/Pocket Penetrometer
DCP - Dynamic Cone Penetrometer
PSP - Perth Sand Penetrometer
MC - Moisture Content
PLT - Plate Load Test
IMP - Borehole Impression Test
PID - Photoionisation Detector
VS - Vane Shear; P=Peak, R=Residual (uncorrected kPa)

SAMPLES
B - Bulk disturbed sample
D - Disturbed sample
ES - Environmental sample
U - Thin wall tube 'undisturbed'
SPT - Standard Penetration Test

MOISTURE
D - Dry
M - Moist
W - Wet
PL - Plastic limit
LL - Liquid limit
w - Moisture content

SOIL CONSISTENCY
VS - Very Soft
S - Soft
F - Firm
St - Stiff
VSt - Very Stiff
H - Hard

RELATIVE DENSITY
VL - Very Loose
L - Loose
MD - Medium Dense
D - Dense
VD - Very Dense

Refer to explanatory notes for details of abbreviations and basis of descriptions

CONSTRUCTION SCIENCES PTY LTD

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BOREHOLE LOG SHEET

Client: Western Sydney Parklands Trust
Project: Geotechnical Investigation for Wallgrove Business Hub
Location: 97-123 & 125-151 Wallgrove Road, Cecil Park

Hole No: BH08

Job No: 10791E-P-710 **Sheet:** 1 of 1

Position: E300532.000 N6250204.000 56 MGA94 **Angle from Horizontal:** 90° **Surface Elevation:** 106.100 m AHD
Rig Type: Ute Mounted Drill Rig **Mounting:** 4WD Utility **Driller:** SM
Casing/Hole Diameter: / 100 mm **Contractor:** Geo Engineering
Date Started: 29/6/23 **Date Completed:** 29/6/23 **Logged By:** SB **Checked By:** ZG/JH

Drilling: Method	Drilling: Resistance	Drilling: Casing	Water	Sampling & Testing: Sample or Field Test	Sampling & Testing: DCP	RL (m AHD)	Depth (m)	Material Description: Graphic Log	Material Description: Classification	Material Description: SOIL TYPE, plasticity or particle characteristic, colour, secondary and minor components ROCK TYPE, grain size and type, colour, fabric & texture, strength, weathering, defects and structure	Material Description: Moisture Condition	Material Description: Consistency Relative Density	Material Description: STRUCTURE & Other Observations
AD/T	E		Groundwater Not Encountered		8 7 6	106.0	0			TOPSOIL: Silty CLAY: low plasticity, dark brown, with roots and organics	M (>PL)		TOPSOIL
										0.25m			
	E-F				8 6				CI-CH	Silty CLAY: medium to high plasticity, brown	M (<PL)	VSt	RESIDUAL SOIL
				D 0.50 - 0.60 m	9 14	105.5	0.5						0.50 m: DCP refusal, bouncing hammer.
										0.80m		H	
	F-H			D 1.10 - 1.20 m		105.0	1.0			SILTSTONE: highly weathered, very low to low strength, grey brown			WEATHERED ROCK
										1.20m			
										TERMINATED AT 1.20 m Refusal			1.20 m: TC bit refusal on SHALE, inferred low to medium strength.
						104.5	1.5						
						104.0	2.0						
						103.5	2.5						
						103.0	3.0						
						102.5	3.5						
						102.0	4.0						
						101.5	4.5						

METHOD
EX Excavator bucket
R Ripper
HA Hand auger
PT Push tube
SON Sonic drilling
AH Air hammer
PS Percussion sampler
AS Short spiral auger
AD/V Solid flight auger: V-Bit
AD/T Solid flight auger: TC-Bit
HFA Hollow flight auger
WB Washbore drilling
RR Rock roller

PENETRATION
VE Very Easy (No Resistance)
E Easy
F Firm
H Hard
VH Very Hard (Refusal)

WATER
Water Level on Date shown
water inflow
water outflow

FIELD TESTS
SPT - Standard Penetration Test
PP - Hand/Pocket Penetrometer
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PSP - Perth Sand Penetrometer
MC - Moisture Content
PLT - Plate Load Test
IMP - Borehole Impression Test
PID - Photoionisation Detector
VS - Vane Shear; P=Peak, R=Residual (uncorrected kPa)

SAMPLES
B - Bulk disturbed sample
D - Disturbed sample
ES - Environmental sample
U - Thin wall tube 'undisturbed'
SPT - Standard Penetration Test

MOISTURE
D - Dry
M - Moist
W - Wet
PL - Plastic limit
LL - Liquid limit
w - Moisture content

SOIL CONSISTENCY
VS - Very Soft
S - Soft
F - Firm
St - Stiff
VSt - Very Stiff
H - Hard

RELATIVE DENSITY
VL - Very Loose
L - Loose
MD - Medium Dense
D - Dense
VD - Very Dense

Refer to explanatory notes for details of abbreviations and basis of descriptions

CONSTRUCTION SCIENCES PTY LTD

Construction Sciences

BOREHOLE LOG SHEET

Client: Western Sydney Parklands Trust
Project: Geotechnical Investigation for Wallgrove Business Hub
Location: 97-123 & 125-151 Wallgrove Road, Cecil Park

Hole No: BH09

Job No: 10791E-P-710 **Sheet:** 1 of 1

Position: E300618.000 N6250187.000 56 MGA94 **Angle from Horizontal:** 90° **Surface Elevation:** 108.600 m AHD
Rig Type: Ute Mounted Drill Rig **Mounting:** 4WD Utility **Driller:** SM
Casing/Hole Diameter: / 100 mm **Contractor:** Geo Engineering
Date Started: 29/6/23 **Date Completed:** 29/6/23 **Logged By:** SB **Checked By:** ZG/JH

Drilling: Method	Drilling: Resistance	Drilling: Casing	Water	Sampling & Testing: Sample or Field Test	Sampling & Testing: DCP	RL (m AHD)	Depth (m)	Material Description: Graphic Log	Classification	SOIL TYPE, plasticity or particle characteristic, colour, secondary and minor components ROCK TYPE, grain size and type, colour, fabric & texture, strength, weathering, defects and structure	Moisture Condition	Consistency Relative Density	STRUCTURE & Other Observations
AD/T	E		Groundwater Not Encountered		2	108.5	0			0.05m TOPSOIL: Silty CLAY: medium plasticity, brown, with roots and organics			TOPSOIL
					4					EXTREMELY WEATHERED SHALE, remoulds as Silty CLAY, low to medium plasticity, brown mottled light brown			EXTREMELY WEATHERED MATERIAL
	F-H				5								
					9								
					8				XW		M (<PL)	H	
					13		0.5						
					11	108.0							0.60 m: DCP refusal, bouncing hammer.
										0.80m			
	H									SHALE: highly weathered to extremely weathered, low strength, fine grained, grey brown			
						107.5	1.0			1.20m			
										TERMINATED AT 1.20 m Refusal			1.20 m: TC bit refusal on SHALE, inferred low to medium strength.
						107.0	1.5						
							2.0						
						106.5							
							2.5						
						106.0							
							3.0						
						105.5							
							3.5						
						105.0							
							4.0						
						104.5							
							4.5						
						104.0							

METHOD
EX Excavator bucket
R Ripper
HA Hand auger
PT Push tube
SON Sonic drilling
AH Air hammer
PS Percussion sampler
AS Short spiral auger
AD/V Solid flight auger: V-Bit
AD/T Solid flight auger: TC-Bit
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WB Washbore drilling
RR Rock roller

PENETRATION
VE Very Easy (No Resistance)
E Easy
F Firm
H Hard
VH Very Hard (Refusal)

WATER
Water Level on Date shown
water inflow
water outflow

FIELD TESTS
SPT - Standard Penetration Test
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DCP - Dynamic Cone Penetrometer
PSP - Perth Sand Penetrometer
MC - Moisture Content
PLT - Plate Load Test
IMP - Borehole Impression Test
PID - Photoionisation Detector
VS - Vane Shear; P=Peak, R=Residual (uncorrected kPa)

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U - Thin wall tube 'undisturbed'
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MOISTURE
D - Dry
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W - Wet
PL - Plastic limit
LL - Liquid limit
w - Moisture content

SOIL CONSISTENCY
VS - Very Soft
S - Soft
F - Firm
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H - Hard

RELATIVE DENSITY
VL - Very Loose
L - Loose
MD - Medium Dense
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VD - Very Dense

Refer to explanatory notes for details of abbreviations and basis of descriptions

CONSTRUCTION SCIENCES PTY LTD

Construction Sciences

BOREHOLE LOG SHEET

Client: Western Sydney Parklands Trust
Project: Geotechnical Investigation for Wallgrove Business Hub
Location: 97-123 & 125-151 Wallgrove Road, Cecil Park

Hole No: BH10

Job No: 10791E-P-710 **Sheet:** 1 of 3

Position: E300680.000 N6250167.000 56 MGA94 **Angle from Horizontal:** 90° **Surface Elevation:** 109.500 m AHD
Rig Type: Ute Mounted Drill Rig **Mounting:** 4WD Utility **Driller:**
Casing/Hole Diameter: / 100 mm **Contractor:** Stratacore
Date Started: 30/6/23 **Date Completed:** 30/6/23 **Logged By:** SB **Checked By:** ZG/JH

Drilling: Method	Drilling: Resistance	Drilling: Casing	Drilling: Water	Sampling & Testing: Sample or Field Test	Sampling & Testing: DCP	RL (m AHD)	Depth (m)	Material Description: Graphic Log	Material Description: Classification	Material Description: SOIL TYPE, plasticity or particle characteristic, colour, secondary and minor components ROCK TYPE, grain size and type, colour, fabric & texture, strength, weathering, defects and structure	Material Description: Moisture Condition	Material Description: Consistency Relative Density	Material Description: STRUCTURE & Other Observations
AD/T	E-F				4					0.03m TOPSOIL: Silty CLAY: low plasticity, dark grey, with roots and organics		St	TOPSOIL
					7					Silty CLAY: medium to high plasticity, red, orange-brown			RESIDUAL SOIL
					8							VSt	
					9								
					14				CI-CH				
				D 0.50 - 0.60 m SPT 0.50 - 0.95 m 8, 12, 17 N=29 REC= m	13	109.0	0.5					H	
					17								
					19								
					22					0.80m			
					13					SHALE: extremely weathered to highly weathered, very low strength, brown-grey, brown, with fine iron indurated gravel, trace of clay seams.			WEATHERED ROCK
					4	108.5	1.0						1.00 m: DCP refusal, bouncing hammer.
				D 1.50 - 1.60 m		108.0	1.5						
						107.5	2.0						
										2.30m			
	F-H					107.0	2.5			SHALE: highly weathered, very low to low strength, brown grey			
						106.5	3.0						
						106.0	3.5						
						105.5	4.0						
						105.0	4.5			4.50m			
										Continued as Cored Drill Hole			

METHOD
EX Excavator bucket
R Ripper
HA Hand auger
PT Push tube
SON Sonic drilling
AH Air hammer
PS Percussion sampler
AS Short spiral auger
AD/V Solid flight auger: V-Bit
AD/T Solid flight auger: TC-Bit
HFA Hollow flight auger
WB Washbore drilling
RR Rock roller

PENETRATION
VE Very Easy (No Resistance)
E Easy
F Firm
H Hard
VH Very Hard (Refusal)

WATER
Water Level on Date shown
water inflow
water outflow

FIELD TESTS
SPT - Standard Penetration Test
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IMP - Borehole Impression Test
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VS - Vane Shear; P=Peak, R=Residual (uncorrected kPa)

SAMPLES
B - Bulk disturbed sample
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U - Thin wall tube 'undisturbed'
SPT - Standard Penetration Test

MOISTURE
D - Dry
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PL - Plastic limit
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w - Moisture content

SOIL CONSISTENCY
VS - Very Soft
S - Soft
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H - Hard

RELATIVE DENSITY
VL - Very Loose
L - Loose
MD - Medium Dense
D - Dense
VD - Very Dense

Refer to explanatory notes for details of abbreviations and basis of descriptions

CONSTRUCTION SCIENCES PTY LTD

Construction Sciences

CORE LOG SHEET

Client: Western Sydney Parklands Trust
Project: Geotechnical Investigation for Wallgrove Business Hub
Location: 97-123 & 125-151 Wallgrove Road, Cecil Park

Hole No: BH10

Job No: 10791E-P-710 **Sheet:** 2 of 3

Position: E300680.000 N6250167.000 56 MGA94 **Angle from Horizontal:** 90° **Surface Elevation:** 109.500 m AHD
Rig Type: Ute Mounted Drill Rig **Mounting:** 4WD Utility **Driller:**
Casing Diameter: **Bit Type:** **Bit Condition:** **Contractor:** Stratacore
Date Started: 30/6/23 **Date Completed:** 30/6/23 **Logged By:** SB **Checked By:** ZG/JH

Coring						Material Description			Defect Description		
Method	Fluid	TCR (%)	RQD (%)	RL (m AHD)	Depth (m)	Graphic Log	SOIL TYPE, plasticity or particle characteristic, colour, secondary & minor components ROCK NAME, grain size and type, colour, fabric and texture, inclusions & minor components	Weathering	Estimated Strength $Is_{(50)}$ MPa (● - Axial O - Diametral □ - Irregular Lump) VL 0.1 L 0.3 M 1 H 3 VH 10 EH	Average Natural Defect Spacing (mm) 20 60 200 600 2000	Visual	Additional Data DEFECT TYPE, orientation, shape, roughness, infilling or coating, thickness, other
				109.0	0.5							
				108.5	1.0							
				108.0	1.5							
				107.5	2.0							
				107.0	2.5							
				106.5	3.0							
				106.0	3.5							
				105.5	4.0							
				105.0	4.5		4.50m START CORING AT 4.50m					
NMLC	04/07/23	100	89				SHALE: dark grey, bedding at (0-5)° 4.85m	MW	0.31			4.55 m: BP, 0° 4.80 m: JT, 0°, PR, S, CN 4.85 m: JT, 0°, IR, RF, =20 mm 4.90 m: JT, 0°, IR, RF, =2 mm

DRILLING
AD/V Solid flight auger: V-Bit
AD/T Solid flight auger: TC-Bit
HFA Hollow flight auger
WB Washbore drilling
RR Rock roller
PQ Rotary core (85mm)
HQ Rotary core (63.5mm)
NMLC Rotary core (51.94mm)
DT Diatube concrete coring
PT Push tube
PS Percussion sampling
SON Sonic drilling
AH Air hammer

WATER
Water Level on date shown
water inflow
water outflow

ROCK QUALITY DESCRIPTIONS
RQD Rock Quality Designation (%)
TCR Total Core Recovery (%)

ROCK STRENGTH
EH Extremely High
VH Very High
H High
M Medium
L Low
VL Very Low

ROCK WEATHERING
F Fresh
SW Slightly Weathered
DW Distinctly Weathered
MW Moderately Weathered
HW Highly Weathered
XW Extremely Weathered

DEFECT TYPE
JT Joint
SZ Sheared zone
BP Bedding Parting
SM Seam
FL Foliation
VN Vein
CL Cleavage
CS Crushed Seam
FZ Fracture Zone
HB Handing Break
DB Drilling Break

PLANARITY
CU Curved
DIS Discontinuous
IR Irregular
PR Planar
ST Stepped
UN Undulose

ROUGHNESS
VR Very Rough
RF Rough
S Smooth
SL Slockensided
POL Polished

COATING
CN Clean
SN Stained
VNR Veneer (thin or patchy)
CT Coating (up to 1mm)

INFILL MATERIALS
X Carbonaceus
MU Unidentified minteral
MS Secondary mineral
KT Chlorite
CA Calcite
Fe Iron Oxide
Qz Quartz

Refer to explanatory notes for details of abbreviations and basis of descriptions

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CORE LOG SHEET

Client: Western Sydney Parklands Trust
Project: Geotechnical Investigation for Wallgrove Business Hub
Location: 97-123 & 125-151 Wallgrove Road, Cecil Park

Hole No: BH10

Job No: 10791E-P-710 **Sheet:** 3 of 3

Position: E300680.000 N6250167.000 56 MGA94 **Angle from Horizontal:** 90° **Surface Elevation:** 109.500 m AHD
Rig Type: Ute Mounted Drill Rig **Mounting:** 4WD Utility **Driller:**
Casing Diameter: **Bit Type:** **Bit Condition:** **Contractor:** Stratacore
Date Started: 30/6/23 **Date Completed:** 30/6/23 **Logged By:** SB **Checked By:** ZG/JH

Coring						Material Description			Defect Description		
Method	Fluid	TCR (%)	RQD (%)	RL (m AHD)	Depth (m)	Graphic Log	SOIL TYPE, plasticity or particle characteristic, colour, secondary & minor components ROCK NAME, grain size and type, colour, fabric and texture, inclusions & minor components	Weathering	Estimated Strength $Is_{(50)}$ MPa ● - Axial O - Diametral □ - Irregular Lump VL 0.1 L 0.3 M 1 H 3 VH 10 EH	Average Natural Defect Spacing (mm) 20 60 200 600 2000	Visual	Additional Data DEFECT TYPE, orientation, shape, roughness, infilling or coating, thickness, other
NMLC		100	89	104.0	5.5		SANDSTONE and Shale Interbedded: fine grained sandstone, dark grey with occasional lamina at (0-5)° *(continued)*	MW SW				5.07 m: JT, 0°, IR, RF, =2 mm 5.14 m: JT, 5°, PR, S, CN 5.15 m: JT, 5°, PR, S, CN 5.17 m: JT, 5°, IR, S, CN
							5.70m		0.1 0.64			5.54 m: JT, 0°, PR, S, CN
							SANDSTONE: fine grained, dark grey 5.84m					
				103.5	6.0		SANDSTONE and Shale Interbedded: fine grained sandstone, dark grey with occasional lamina at (0-5)°					5.88 m: JT, 5°, IR, RF
												6.25 m: BP, 0° 6.36 m: BP, 0°
				103.0	6.5				0.48			6.56 m: BP, 0° 6.63 m: BP, 0°
												6.75 m: BP, 0°
				102.5	7.0							7.01 m: BP, 0°
												7.24 m: JT, 0°, PR, S, CN
		100	92	102.0	7.5				0.61 5.04			7.39 m: BP, 5° 7.40 m: BP, 0° 7.55 m: BP, 0°
												7.91 m: JT, 15°, PR, S, CN
				101.5	8.0							8.07 m: JT, 90°, IR, S, CN, =100 mm
												8.32 m: JT, 10°, IR, S, CN 8.36 m: JT, 0 - 10°, IR, RF, =5 mm
				101.0	8.5				23.51			
							8.80m					8.67 m: BP, 0 - 5°
							TERMINATED AT 8.80 m Target depth		35.46			
				100.5	9.0							
				100.0	9.5							

DRILLING
AD/V Solid flight auger: V-Bit
AD/T Solid flight auger: TC-Bit
HFA Hollow flight auger
WB Washbore drilling
RR Rock roller
PQ Rotary core (85mm)
HQ Rotary core (63.5mm)
NMLC Rotary core (51.94mm)
DT Diatube concrete coring
PT Push tube
PS Percussion sampling
SON Sonic drilling
AH Air hammer

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Water Level on date shown
water inflow
water outflow

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RQD Rock Quality Designation (%)
TCR Total Core Recovery (%)

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BP Bedding Parting
SM Seam
FL Foliation
VN Vein
CL Cleavage
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HB Handing Break
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MS Secondary mineral
KT Chlorite
CA Calcite
Fe Iron Oxide
Qz Quartz

Refer to explanatory notes for details of abbreviations and basis of descriptions

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www.constructionsciences.net

BH No: 10

Client: Parramatta Park & W. Sydney Parkland Trust

Project: Wallgrove Business Park, Cecil Park

Location: 97-123 & 125-151 Wallgrove Road, Cecil Park, NSW 2178

Job No: 10791E/P/710

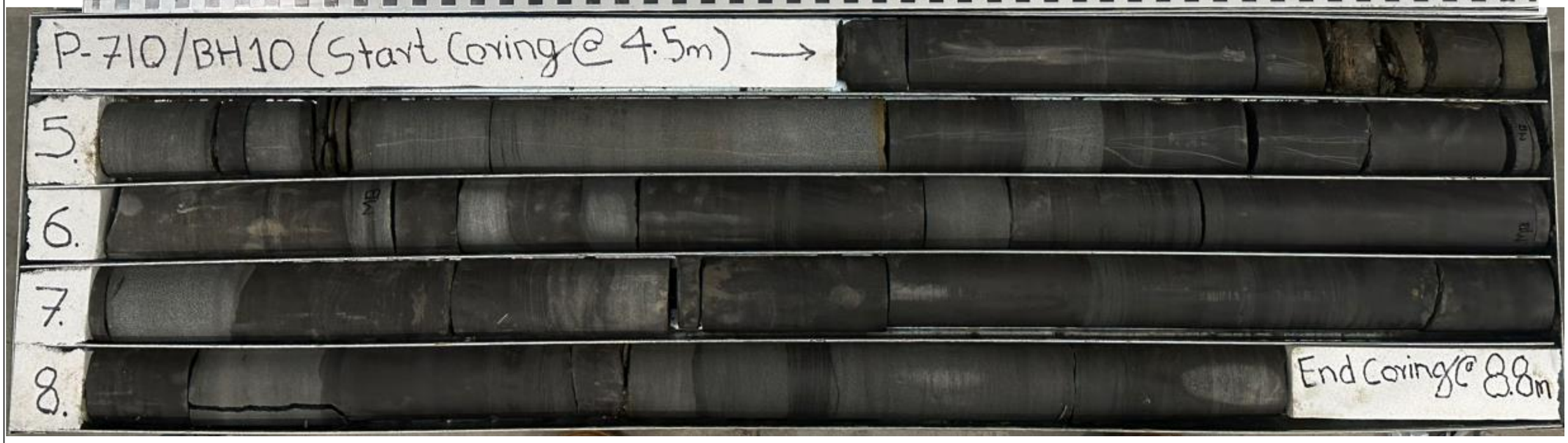
Date: 30/06/2023

Depth: 8.8m

Core Tray No: 1/1

Logged By: S.B

Driller: Strata Core



Construction Sciences 2/4 Kellogg Road ROOTY HILL NSW 2766 Tel: 1300 165 769 Web: www.constructionsciences.net	SCALE: NOT TO SCALE		CLIENT: PARRAMATTA PARK & WESTERN SYDNEY PARKLAND TRUST
	DATE: 4 AUGUST 2023		PROJECT: GEOTECHNICAL WALLGROVE BUSINESS PARK, CECIL PARK
	DRAWN: SB		LOCATION: 97-123 & 125-151 WALLGROVE ROAD, CECIL PARK, NSW 2178
	DRAWING No.: 10791E-P-710-CP2	Sheet: 1 of 1	**CORE PHOTOGRAPH**

Construction Sciences

BOREHOLE LOG SHEET

Client: Western Sydney Parklands Trust
Project: Geotechnical Investigation for Wallgrove Business Hub
Location: 97-123 & 125-151 Wallgrove Road, Cecil Park

Hole No: BH11

Job No: 10791E-P-710 **Sheet:** 1 of 1

Position: E300671.700 N6250075.000 56 MGA94 **Angle from Horizontal:** 90° **Surface Elevation:** 112.900 m AHD
Rig Type: Ute Mounted Drill Rig **Mounting:** 4WD Utility **Driller:** SM
Casing/Hole Diameter: / 100 mm **Contractor:** Geo Engineering
Date Started: 29/6/23 **Date Completed:** 29/6/23 **Logged By:** SB **Checked By:** ZG/JH

Drilling: Method	Drilling: Resistance	Drilling: Casing	Water	Sampling & Testing: Sample or Field Test	Sampling & Testing: DCP	RL (m AHD)	Depth (m)	Material Description: Graphic Log	Classification	SOIL TYPE, plasticity or particle characteristic, colour, secondary and minor components ROCK TYPE, grain size and type, colour, fabric & texture, strength, weathering, defects and structure	Moisture Condition	Consistency Relative Density	STRUCTURE & Other Observations
AD/T			Groundwater Not Encountered		1					TOPSOIL: Silty CLAY: low plasticity, brown, with roots and organics	M (>PL)		TOPSOIL
					3					0.20m			
					3				CI-CH	Silty CLAY: medium to high plasticity, brown mottled orange, with red with fine iron indurated gravel.			RESIDUAL SOIL
					2					0.30m			
					4	112.5				Silty CLAY: high plasticity, brown mottled orange, with red iron stone			
				D 0.50 - 0.60 m	2		0.5					F to St	
					3								
					2								
					1								
					1	112.0	1.0					S	
	E-F				1								
					1								
					3								
					2				CH				
					3	111.5	1.5					F to St	
				D 1.50 - 1.60 m	2						M (<PL)		
					2								
					4								
					3								
					3	111.0	2.0					St	
					4								
					2								
					3								
					3					2.30m			
					4	110.5	2.5			Silty CLAY: medium to high plasticity, red-brown, orange and grey.			
	F				6								
					5				CH				
					6							VSt	
					8								
					8	110.0	3.0			3.00m			
										SHALE: highly weathered, low strength, brown			WEATHERED ROCK
	F-H					109.5	3.5						
						109.0	4.0			4.00m			
										TERMINATED AT 4.00 m Refusal			4.00 m: TC bit refusal on SHALE, inferred low to medium strength.
						108.5	4.5						
						108.0							

METHOD
EX Excavator bucket
R Ripper
HA Hand auger
PT Push tube
SON Sonic drilling
AH Air hammer
PS Percussion sampler
AS Short spiral auger
AD/V Solid flight auger: V-Bit
AD/T Solid flight auger: TC-Bit
HFA Hollow flight auger
WB Washbore drilling
RR Rock roller

PENETRATION
VE Very Easy (No Resistance)
E Easy
F Firm
H Hard
VH Very Hard (Refusal)

WATER
Water Level on Date shown
water inflow
water outflow

FIELD TESTS
SPT - Standard Penetration Test
PP - Hand/Pocket Penetrometer
DCP - Dynamic Cone Penetrometer
PSP - Perth Sand Penetrometer
MC - Moisture Content
PLT - Plate Load Test
IMP - Borehole Impression Test
PID - Photoionisation Detector
VS - Vane Shear; P=Peak, R=Residual (uncorrected kPa)

SAMPLES
B - Bulk disturbed sample
D - Disturbed sample
ES - Environmental sample
U - Thin wall tube 'undisturbed'
SPT - Standard Penetration Test

MOISTURE
D - Dry
M - Moist
W - Wet
PL - Plastic limit
LL - Liquid limit
w - Moisture content

SOIL CONSISTENCY
VS - Very Soft
S - Soft
F - Firm
St - Stiff
VSt - Very Stiff
H - Hard

RELATIVE DENSITY
VL - Very Loose
L - Loose
MD - Medium Dense
D - Dense
VD - Very Dense

Refer to explanatory notes for details of abbreviations and basis of descriptions

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BOREHOLE LOG SHEET

Client: Western Sydney Parklands Trust
Project: Geotechnical Investigation for Wallgrove Business Hub
Location: 97-123 & 125-151 Wallgrove Road, Cecil Park

Hole No: BH12

Job No: 10791E-P-710 **Sheet:** 1 of 1

Position: E300568.000 N6250073.700 56 MGA94 **Angle from Horizontal:** 90° **Surface Elevation:** 109.300 m AHD
Rig Type: Ute Mounted Drill Rig **Mounting:** 4WD Utility **Driller:** SM
Casing/Hole Diameter: / 100 mm **Contractor:** Geo Engineering
Date Started: 15/6/23 **Date Completed:** 15/6/23 **Logged By:** SB **Checked By:** ZG/JH

Drilling: Method	Drilling: Resistance	Drilling: Casing	Drilling: Water	Sampling & Testing: Sample or Field Test	Sampling & Testing: DCP	RL (m AHD)	Depth (m)	Material Description: Graphic Log	Classification	SOIL TYPE, plasticity or particle characteristic, colour, secondary and minor components ROCK TYPE, grain size and type, colour, fabric & texture, strength, weathering, defects and structure	Moisture Condition	Consistency Relative Density	STRUCTURE & Other Observations
AD/T	E-F		Groundwater Not Encountered	ASS 0.00 - 0.10 m ES 0.00 - 0.10 m ES 0.10 - 0.30 m	7 9 12 13	109.0	0			0.10m TOPSOIL: Clayey SILT: brown, with roots and organics	M (>PL)		TOPSOIL
									CI-CH	Silty CLAY: medium to high plasticity, orange-brown	M (<PL)	H	RESIDUAL SOIL
	F				13 14 25	108.5	0.5			0.40m SILTSTONE: highly weathered to extremely weathered, very low strength, pale brown			EXTREMELY WEATHERED MATERIAL 0.70 m: DCP refusal.
	F-H					108.0	1.0 1.5			1.10m SHALE: highly weathered to moderately weathered, low to medium strength, pale grey and dark grey			WEATHERED ROCK
						107.5	2.0			2.00m TERMINATED AT 2.00 m Refusal			2.00 m: TC bit refusal on SHALE, inferred low to medium strength.
						107.0	2.5						
						106.5	3.0						
						106.0	3.5						
						105.5	4.0						
						105.0	4.5						
						104.5							

METHOD
EX Excavator bucket
R Ripper
HA Hand auger
PT Push tube
SON Sonic drilling
AH Air hammer
PS Percussion sampler
AS Short spiral auger
AD/V Solid flight auger: V-Bit
AD/T Solid flight auger: TC-Bit
HFA Hollow flight auger
WB Washbore drilling
RR Rock roller

PENETRATION
VE Very Easy (No Resistance)
E Easy
F Firm
H Hard
VH Very Hard (Refusal)

WATER
Water Level on Date shown
water inflow
water outflow

FIELD TESTS
SPT - Standard Penetration Test
PP - Hand/Pocket Penetrometer
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MC - Moisture Content
PLT - Plate Load Test
IMP - Borehole Impression Test
PID - Photoionisation Detector
VS - Vane Shear; P=Peak, R=Residual (uncorrected kPa)

SAMPLES
B - Bulk disturbed sample
D - Disturbed sample
ES - Environmental sample
U - Thin wall tube 'undisturbed'
SPT - Standard Penetration Test

MOISTURE
D - Dry
M - Moist
W - Wet
PL - Plastic limit
LL - Liquid limit
w - Moisture content

SOIL CONSISTENCY
VS - Very Soft
S - Soft
F - Firm
St - Stiff
VSt - Very Stiff
H - Hard

RELATIVE DENSITY
VL - Very Loose
L - Loose
MD - Medium Dense
D - Dense
VD - Very Dense

Refer to explanatory notes for details of abbreviations and basis of descriptions

CONSTRUCTION SCIENCES PTY LTD

Explanatory Notes

The methods of description and classification of soils and rocks used in this report are based on Australian Standard AS1726-2017 Geotechnical Site Investigations. Material descriptions are deduced from field observation or engineering examination, and may be appended or confirmed by in situ or laboratory testing. The information is dependent on the scope of investigation, the extent of sampling and testing, and the inherent variability of the conditions encountered.

Subsurface investigation may be conducted by one or a combination of the following methods.

Method	
Test Pitting: excavation/trench	
BH	Backhoe bucket
EX	Excavator bucket
R	Ripper
H	Hydraulic Hammer
X	Existing excavation
N	Natural exposure
Manual drilling: hand operated tools	
HA	Hand Auger
Continuous sample drilling	
PT	Push tube
PS	Percussion sampling
SON	Sonic drilling
Hammer drilling	
AH	Air hammer
AT	Air track
Spiral flight auger drilling	
AS	Auger screwing
AD/V	Continuous flight auger: V-bit
AD/T	Continuous spiral flight auger: TC-Bit
HFA	Continuous hollow flight auger
Rotary non-core drilling	
WB	Washbore drilling
RR	Rock roller
Rotary core drilling	
PQ	85mm core (wire line core barrel)
HQ	63.5mm core (wire line core barrel)
NMLC	51.94mm core (conventional core barrel)
NQ	47.6mm core (wire line core barrel)
DT	Diatube (concrete coring)

Sampling is conducted to facilitate further assessment of selected materials encountered.

Sampling method	
Soil sampling	
B	Bulk disturbed sample
D	Disturbed sample
C	Core sample
ES	Environmental soil sample
SPT	Standard Penetration Test sample
U	Thin wall tube ‘undisturbed’ sample
Water sampling	
WS	Environmental water sample

Field testing may be conducted as a means of assessment of the in situ conditions of materials.

Field testing	
SPT	Standard Penetration Test
HP/PP	Hand/Pocket Penetrometer
Dynamic Penetrometers (blows per noted increment)	
DCP	Dynamic Cone Penetrometer
PSP	Perth Sand Penetrometer
MC	Moisture Content
VS	Vane Shear
PBT	Plate Bearing Test
IMP	Borehole Impression Test
PID	Photo Ionization Detector

If encountered, refusal (R), virtual refusal (VR) or hammer bouncing (HB) of penetrometers may be noted.

The quality of the rock can be assessed by the degree of natural defects/fractures and the following.

Rock quality description	
TCR	Total Core Recovery (%) (length of core recovered divided by the length of core run)
RQD	Rock Quality Designation (%) (sum of axial lengths of core greater than 100mm long divided by the length of core run)

Notes on groundwater conditions encountered may include.

Groundwater	
Not Encountered	Excavation is dry in the short term
Not Observed	Water level observation not possible
Seepage	Water seeping into hole
Inflow	Water flowing/flooding into hole

Perched groundwater may result in a misleading indication of the depth to the true water table. Groundwater levels are also likely to fluctuate with variations in climatic and site conditions.

Notes on the stability of excavations may include.

Excavation conditions	
Stable	No obvious/gross short term instability noted
Spalling	Material falling into excavation (minor/major)
Unstable	Collapse of the majority, or one or more face of the excavation

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Explanatory Notes: General Soil Description

The methods of description and classification of soils used in this report are based on Australian Standard AS1726-2017 Geotechnical Site Investigations. In practice, a material is described as a soil if it can be remoulded by hand in its field condition or in water. The dominant component is shown in upper case, with secondary components in lower case. In general descriptions cover: soil type, plasticity or particle size/shape, colour, strength or density, moisture and inclusions.

In general, soil types are classified according to the dominant particle on the basis of the following particle sizes.

Soil Classification		Particle Size (mm)
CLAY		< 0.002
SILT		0.002 0.075
SAND	fine	0.075 to 0.21
	medium	0.21 to 0.6
	coarse	0.6 to 2.36
GRAVEL	fine	2.36 to 6.7
	medium	6.7 to 19
	coarse	19 to 63
COBBLES		63 to 200
BOULDERS		> 200

Soil types may be qualified by the presence of minor components on the basis of field examination methods and/or the soil grading.

Terminology	In coarse grained soils		In fine soils
	% fines	% coarse	% coarse
Trace	≤5	≤15	≤15
With	>5, ≤12	>15, ≤30	>15, ≤30

The strength of cohesive soils is classified by engineering assessment or field/lab testing as follows.

Strength	Symbol	Undrained shear strength
Very Soft	VS	≤12kPa
Soft	S	12kPa to ≤25kPa
Firm	F	25kPa to ≤50kPa
Stiff	St	50kPa to ≤100kPa
Very Stiff	VSt	100kPa to ≤200kPa
Hard	H	>200kPa

Cohesionless soils are classified on the basis of relative density as follows.

Relative Density	Symbol	Density Index
Very Loose	VL	<15%
Loose	L	15% to ≤35%
Medium Dense	MD	35% to ≤65%
Dense	D	65% to ≤85%
Very Dense	VD	>85%

The plasticity of cohesive soils is defined by the Liquid Limit (LL) as follows.

Plasticity	Silt LL	Clay LL
Low plasticity	≤ 35%	≤ 35%
Medium plasticity	N/A	> 35% ≤ 50%
High plasticity	> 50%	> 50%

The moisture condition of soil (*w*) is described by appearance and feel and may be described in relation to the Plastic Limit (PL), Liquid Limit (LL) or Optimum Moisture Content (OMC).

Moisture condition and description	
Dry	Cohesive soils: hard, friable, dry of plastic limit. Granular soils: cohesionless and free-running
Moist	Cool feel and darkened colour: Cohesive soils can be moulded. Granular soils tend to cohere
Wet	Cool feel and darkened colour: Cohesive soils usually weakened and free water forms when handling. Granular soils tend to cohere

The structure of the soil may be described as follows.

Zoning	Description
Layer	Continuous across exposure or sample
Lens	Discontinuous layer (lenticular shape)
Pocket	Irregular inclusion of different material

The structure of soil layers may include: defects such as softened zones, fissures, cracks, joints and root-holes; and coarse grained soils may be described as strongly or weakly cemented.

The soil origin may also be noted if possible to deduce.

Soil origin and description	
Fill	Anthropogenic deposits or disturbed material
Topsoil	Zone of soil affected by roots and root fibres
Peat	Significantly organic soils
Colluvial	Transported down slopes by gravity/water
Aeolian	Transported and deposited by wind
Alluvial	Deposited by rivers
Estuarine	Deposited in coastal estuaries
Lacustrine	Deposited in freshwater lakes
Marine	Deposits in marine environments
Residual soil	Soil formed by in situ weathering of rock, with no structure/fabric of parent rock evident
Extremely weathered material	Formed by in situ weathering of geological formations, with the structure/fabric of parent rock intact but with soil strength properties

The origin of the soil generally cannot be deduced solely on the appearance of the material and the inference may be supplemented by further geological evidence or other field observation. Where there is doubt, the terms ‘possibly’ or ‘probably’ may be used

Explanatory Notes: General Rock Description

The methods of description and classification of rocks used in this report are based on Australian Standard AS1726-2017 Geotechnical Site Investigations. In practice, if a material cannot be remoulded by hand in its field condition or in water, it is described as a rock. In general, descriptions cover: rock type, grain size, structure, colour, degree of weathering, strength, minor components or inclusions, and where applicable, the defect types, shape, roughness and coating/infill.

Rock types are generally described according to the predominant grain or crystal size, and in groups for each rock type as follows.

Rock type	Groups
Sedimentary	Deposited, carbonate (porous or non), volcanic ejection
Igneous	Felsic (much quartz, pale), Intermediate, or mafic (little quartz, dark)
Metamorphic	Foliated or non-foliated
Duricrust	Cementing minerology (iron oxides or hydroxides, silica, calcium carbonate, gypsum)

Reference should be made to AS1726 for details of the rock types and methods of classification.

The classification of rock weathering is described based on definitions in AS1726 and summarised as follows.

Term and symbol		Definition
Residual Soil	RS	Soil developed on rock with the mass structure and substance of the parent rock no longer evident
Extremely weathered	XW	Weathered to such an extent that the rock has 'soil-like' properties. Mass structure and substance still evident
Distinctly weathered	DW	The strength is usually changed and may be highly discoloured. Porosity may be increased by leaching, or decreased due to deposition in pores. May be distinguished into MW (Moderately Weathered) and HW (Highly Weathered).
Slightly weathered	SW	Slightly discoloured; little or no change of strength from fresh rock
Fresh Rock	FR	The rock shows no sign of decomposition or staining

The rock material strength can be defined based on the point load index as follows.

Term and symbol		Point Load Index I_s50 (MPa)
Very Low	VL	0.03 to 0.1
Low	L	0.1 to 0.3
Medium	M	0.3 to 1.0
High	H	1.0 to 3
Very High	VH	3 to 10
Extremely High	EH	> 10

It is important to note that the rock material strength as above is distinct from the rock mass strength which can be significantly weaker due to the effect of defects.

A preliminary assessment of rock strength may be made using the field guide detailed in AS1726, and this is conducted in the absence of point load testing.

The defect spacing measured normal to defects of the same set or bedding, is described as follows.

Definition	Defect Spacing (mm)
Thinly laminated	< 6
Laminated	6 to 20
Very thinly bedded	20 to 60
Thinly bedded	60 to 200
Medium bedded	200 to 600
Thickly bedded	600 to 2000
Very thickly bedded	> 2000

Terms for describing rock and defects are as follows.

Defect Terms			
Joint	JT	Sheared zone	SZ
Bedding Parting	BP	Seam	SM
Foliation	FL	Vein	VN
Cleavage	CL	Drill Lift	DL
Crushed Seam	CS	Handling Break	HB
Fracture Zone	FZ	Drilling Break	DB

The shape and roughness of defects in the rock mass are described using the following terms.

Planarity		Roughness	
Planar	PR	Very Rough	VR
Curved	CU	Rough	RF
Undulose	UN	Smooth	S
Irregular	IR	Slickensided	SL
Stepped	ST	Polished	POL
Discontinuous	DIS		

The coating or infill associated with defects in the rock mass are described as follows.

Infill and Coating		
Clean	CN	
Stained	SN	
Carbonaceous	X	
Minerals	MU	Unidentified mineral
	MS	Secondary mineral
	KT	Chlorite
	CA	Calcite
	Fe	Iron Oxide
	Qz	Quartz
Veneer	VNR	Thin or patchy coating
Coating	CT	Infill up to 1mm

Construction Sciences

Graphic Symbols Index


CLAY


Silty CLAY


Sandy CLAY


Gravelly CLAY


Silty Gravelly CLAY


Silty Sandy CLAY


Sandy Gravelly CLAY


SILT


Clayey SILT


Sandy SILT


Gravelly SILT


Clayey Sandy SILT


Clayey Gravelly SILT


Sandy Gravelly SILT


SAND


Clayey SAND


Silty SAND


Gravelly SAND


Clayey Silty SAND


Clayey Gravelly SAND


Silty Gravelly SAND


GRAVEL


Clayey GRAVEL


Silty GRAVEL


Sandy GRAVEL


Clayey Silty GRAVEL


Clayey Sandy GRAVEL


Silty Sandy GRAVEL


COBBLES & BOULDERS


PEAT, highly organic soil


TOPSOIL


FILL


FILL: Asphalt or Bituminous Seal


FILL: Ballast


FILL: Concrete


FILL: Roadbase


Sedimentary rock: fine, mostly clay (CLAYSTONE)


Sedimentary rock: fine, mostly silt (SILTSTONE)


Sedimentary rock: fine, silt and clay (MUDSTONE, SHALE, LAMINITE)


Sedimentary rock: medium (SANDSTONE, GREYWACKE)

Sedimentary rock: fine to coarse, angular (BRECCIA)

Sedimentary rock: coarse, rounded (CONGLOMERATE)

Sedimentary rock: Organic (COAL)

Sedimentary rock: Carbonate (LIMESTONE, DOLOMITE)

Sedimentary rock: Volcanic (TUFF, VOLCANIC BRECCIA, AGGLOMERATE)

Igneous rock: Felsic, fine (RHYOLITE)

Igneous rock: Felsic, coarse (GRANITE)

Igneous rock: Mafic, fine to medium (BASALT, DOLERITE)

Igneous rock: Mafic, coarse (GABBRO)

Metamorphic rock: Foliated, fine to medium (SLATE, PHYLLITE, SHIST)

Metamorphic rock: Foliated, coarse (GNEISS)

Metamorphic rock: Non-foliated (QUARTZITE, HORNFELS, MARBLE)

Appendix C
Laboratory Results

Construction Sciences

Construction Sciences Pty Ltd
ABN: 74 128 806 735

Address:
Unit 2, 4 Kellogg Road,
Glendenning NSW 2761

Laboratory: **Glendenning Laboratory**
Phone: 02 9854 1700
Fax: 02 4577 9055
Email: Sydney@constructionsciences.net

ATTERBERG LIMITS REPORT

Client:	Construction Sciences - Professional Services	Report Number:	12385/R/309755-1
Client Address:	31 Anvil Road, Seven Hills	Project Number:	12385/P/1471
Project:	Glendenning Office	Lot Number:	
Location:	2/4 Kellogg Rd	Internal Test Request:	12385/T/144466
Supplied To:	Kim McManus	Client Reference/s:	10791E- P- 710
Area Description:	Wallgrove Business Park	Report Date / Page:	21/07/2023 Page 1 of 3

Test Procedures:	AS1289.3.1.1, AS 1289.3.3.1, AS1289.3.2.1, AS1289.2.1.1		
Sample Number	12385/S/1175901	Sample Location	
Sampling Method	AS1289.1.2.1 Cl 6.4a	Borehole	BH-01
Date Sampled	6/07/2023	Depth (m)	0.5-1.0
Sampled By	Client		
Date Tested	20/07/2023		
Drying / Prep Method	Oven Dried / Dry Sieved	Material Source	In-Situ
LL Water Type	Potable	Material Type	In-situ Clay
LL Device Type	Cassagrande	Prep Mat > 53mm (%)	-
Material Description	Cllay		

Atterberg Limit	Specification Minimum	Test Result	Specification Maximum
Liquid Limit (%)		**59**	
Plastic Limit (%)		**21**	
Plasticity Index (%)		**38**	
Linear Shrinkage (%)			
Linear Shrinkage Observations:			

Remarks

Accredited for compliance with ISO/IEC 17025 – Testing

NATA

Accreditation Number: 1986
Corporate Site Number: 12385

Approved Signatory: Patrick Deasy
Form ID: W11bRep Rev 2

Construction Sciences

Construction Sciences Pty Ltd
ABN: 74 128 806 735

Address:
Unit 2, 4 Kellogg Road,
Glendenning NSW 2761

Laboratory: **Glendenning Laboratory**
Phone: 02 9854 1700
Fax: 02 4577 9055
Email: Sydney@constructionsciences.net

ATTERBERG LIMITS REPORT

Client:	Construction Sciences - Professional Services	Report Number:	12385/R/309755-1
Client Address:	31 Anvil Road, Seven Hills	Project Number:	12385/P/1471
Project:	Glendenning Office	Lot Number:	
Location:	2/4 Kellogg Rd	Internal Test Request:	12385/T/144466
Supplied To:	Kim McManus	Client Reference/s:	10791E- P- 710
Area Description:	Wallgrove Business Park	Report Date / Page:	21/07/2023 Page 2 of 3

Test Procedures:	AS1289.3.1.1, AS 1289.3.3.1, AS1289.3.2.1, AS1289.2.1.1		
Sample Number	12385/S/1175902	Sample Location	
Sampling Method	AS1289.1.2.1 Cl 6.4a	Borehole	BH-11
Date Sampled	6/07/2023	Depth (m)	0.5-1.0
Sampled By	Client		
Date Tested	20/07/2023		
Drying / Prep Method	Oven Dried / Dry Sieved	Material Source	In-Situ
LL Water Type	Potable	Material Type	In-situ Clay
LL Device Type	Cassagrande	Prep Mat > 53mm (%)	-
Material Description	Brown Clay		

Atterberg Limit	Specification Minimum	Test Result	Specification Maximum
Liquid Limit (%)		**59**	
Plastic Limit (%)		**20**	
Plasticity Index (%)		**39**	
Linear Shrinkage (%)			
Linear Shrinkage Observations:			

Remarks

NATA

Accredited for compliance with ISO/IEC 17025 – Testing

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Form ID: W11bRep Rev 2

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ATTERBERG LIMITS REPORT

Client:	Construction Sciences - Professional Services	Report Number:	12385/R/309755-1
Client Address:	31 Anvil Road, Seven Hills	Project Number:	12385/P/1471
Project:	Glendenning Office	Lot Number:	
Location:	2/4 Kellogg Rd	Internal Test Request:	12385/T/144466
Supplied To:	Kim McManus	Client Reference/s:	10791E- P- 710
Area Description:	Wallgrove Business Park	Report Date / Page:	21/07/2023 Page 3 of 3

Test Procedures:	AS1289.3.1.1, AS 1289.3.3.1, AS1289.3.2.1, AS1289.2.1.1		
Sample Number	12385/S/1175903	Sample Location	
Sampling Method	AS1289.1.2.1 Cl 6.4a	Borehole	BH-03
Date Sampled	6/07/2023	Depth (m)	0.1-1.0
Sampled By	Client		
Date Tested	20/07/2023		
Drying / Prep Method	Oven Dried / Dry Sieved	Material Source	In-Situ
LL Water Type	Potable	Material Type	In-situ Clay
LL Device Type	Cassagrande	Prep Mat > 53mm (%)	-
Material Description	Brown Clay		

Atterberg Limit	Specification Minimum	Test Result	Specification Maximum
Liquid Limit (%)		**69**	
Plastic Limit (%)		**22**	
Plasticity Index (%)		**47**	
Linear Shrinkage (%)			
Linear Shrinkage Observations:			

Remarks

NATA

Accredited for compliance with ISO/IEC 17025 – Testing

Accreditation Number: 1986
Corporate Site Number: 12385

Approved Signatory: Patrick Deasy
Form ID: W11bRep Rev 2

Construction Sciences

Construction Sciences Pty Ltd
ABN: 74 128 806 735

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Glendenning NSW 2761

Laboratory: **Glendenning Laboratory**
Phone: 02 9854 1700
Fax: 02 4577 9055
Email: Sydney@constructionsciences.net

EMERSON CLASS NUMBER REPORT

Client:	Construction Sciences - Professional Services	Report Number:	12385/R/309756-1
Client Address:	31 Anvil Road, Seven Hills	Project Number:	12385/P/1471
Project:	Glendenning Office	Lot Number:	
Location:	2/4 Kellogg Rd	Internal Test Request:	12385/T/144466
Supplied To:	Kim McManus	Client Reference/s:	10791E- P- 710
Area Description:	Wallgrove Business Park	Report Date / Page:	21/07/2023 Page 1 of 1

Test Procedures:	AS1289.3.8.1

Sample Number	12385/S/1175901	12385/S/1175902	12385/S/1175903	
ID / Client ID	10791E-P-710	10791E-P-710	10791E-P-710	
Lot Number	-	-	-	
Date / Time Sampled	6/07/2023	6/07/2023	6/07/2023	
Date Tested	19/07/2023	19/07/2023	20/07/2023	
Material Source	In-Situ	In-Situ	In-Situ	
Material Type	In-situ Clay	In-situ Clay	In-situ Clay	
Sampling Method	AS1289.1.2.1 Cl 6.4a	AS1289.1.2.1 Cl 6.4a	AS1289.1.2.1 Cl 6.4a	
Prep Material > 53mm (%)	-	-	-	
Water Type	Distilled	Distilled	Distilled	
Water Temperature (°C)	15	15	15	
Borehole	BH-01	BH-11	BH-03	
Depth	0.5-1.0	0.5-1.0	0.1-1.0	
Soil Description	Cllay	Brown Clay	Brown Clay	
Emerson Class Number	**4**	**4**	**4**	

Remarks

Accredited for compliance with ISO/IEC 17025 – Testing

NATA

Accreditation Number: 1986
Corporate Site Number: 12385

Approved Signatory: Patrick Deasy
Form ID: W22Rep Rev 3

Construction Sciences

Construction Sciences Pty Ltd
ABN: 74 128 806 735

Address:
Unit 2, 4 Kellogg Road,
Glendenning NSW 2761

Laboratory: **Glendenning Laboratory**
Phone: 02 9854 1700
Fax: 02 4577 9055
Email: Sydney@constructionsciences.net

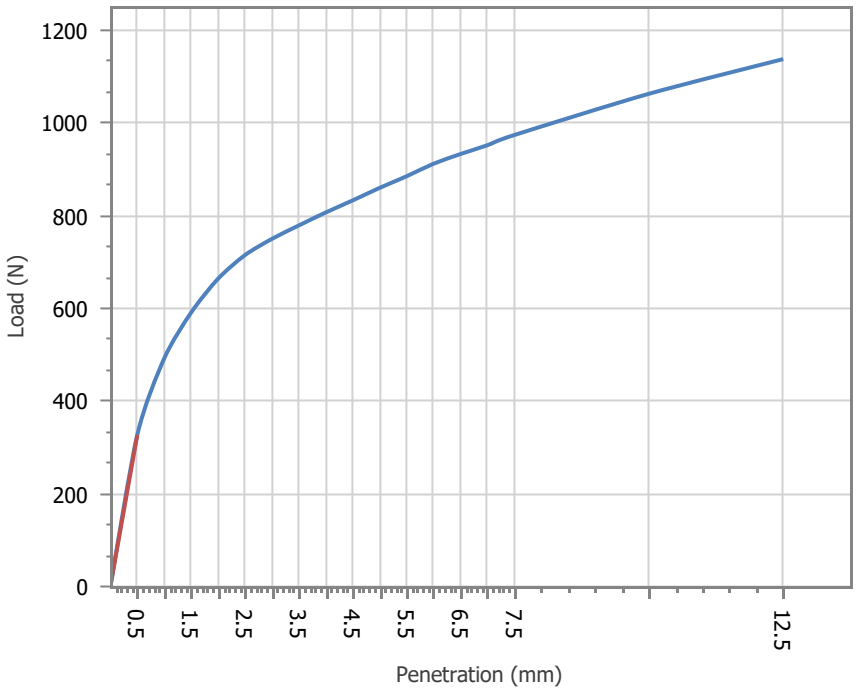
CALIFORNIA BEARING RATIO REPORT

Client:	Construction Sciences - Professional Services	Report Number:	12385/R/309757-1
Client Address:	31 Anvil Road, Seven Hills	Project Number:	12385/P/1471
Project:	Glendenning Office	Lot Number:	
Location:	2/4 Kellogg Rd	Internal Test Request:	12385/T/144466
Supplied To:	Kim McManus	Client Reference/s:	10791E- P- 710
Area Description:	Wallgrove Business Park	Report Date / Page:	21/07/2023 Page 1 of 2

Test Procedures	AS1289.6.1.1, AS1289.5.1.1, AS1289.2.1.1		
Sample Number	12385/S/1175901	Borehole	BH-01
Sampling Method	AS1289.1.2.1 Cl 6.4a	Depth (m)	0.5-1.0
Date Sampled	6/07/2023		
Sampled By	Client		
Date Tested	17/07/2023	Prep Material > 53mm (%)	-
Material Source	In-Situ	Material Limit Start	-
Material Type	In-situ Clay	Material Limit End	-
Client Reference	10791E-P-710	Compactive Effort	Standard
Material Description	Cllay		

Maximum Dry Density (t/m³):	1.56
Optimum Moisture Content (%):	24.5
Field Moisture Content (%):	26.4
Sample Percent Oversize (%)	0.0
Oversize Included / Excluded	Excluded
Target Density Ratio (%):	100
Target Moisture Ratio (%):	100
Placement Dry Density (t/m³):	1.57
Placement Dry Density Ratio (%):	100.5
Placement Moisture Content (%):	24.6
Placement Moisture Ratio (%):	100.0
Test Condition / Soaking Period:	Soaked / 4 Days
CBR Surcharge (kg)	9.0
Dry Density After Soak (t/m³):	1.56
Total Curing Time (hrs)	n/a
Liquid Limit Method	n/a
Moisture (top 30mm) After Soak (%)	27.5
Moisture (remainder) After Soak (%)	25.2
CBR Swell (%):	1.0
Minimum CBR Specification (%):	-
CBR Value @ 2.5mm (%):	**5**

CBR PENETRATION PLOT



Remarks

Accredited for compliance with ISO/IEC 17025 – Testing

NATA

Accreditation Number: 1986
Corporate Site Number: 12385

Approved Signatory: Patrick Deasy
Form ID: W2ASRep Rev 3

Construction Sciences

Construction Sciences Pty Ltd
ABN: 74 128 806 735

Address:
Unit 2, 4 Kellogg Road,
Glendenning NSW 2761

Laboratory: **Glendenning Laboratory**
Phone: 02 9854 1700
Fax: 02 4577 9055
Email: Sydney@constructionsciences.net

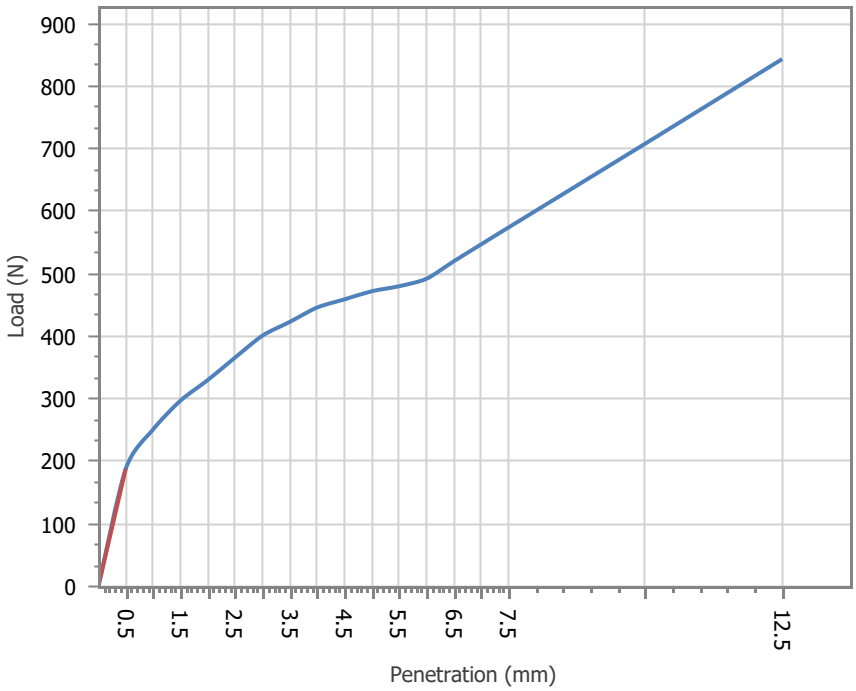
CALIFORNIA BEARING RATIO REPORT

Client:	Construction Sciences - Professional Services	Report Number:	12385/R/309757-1
Client Address:	31 Anvil Road, Seven Hills	Project Number:	12385/P/1471
Project:	Glendenning Office	Lot Number:	
Location:	2/4 Kellogg Rd	Internal Test Request:	12385/T/144466
Supplied To:	Kim McManus	Client Reference/s:	10791E- P- 710
Area Description:	Wallgrove Business Park	Report Date / Page:	21/07/2023 Page 2 of 2

Test Procedures	AS1289.6.1.1, AS1289.5.1.1, AS1289.2.1.1		
Sample Number	12385/S/1175902	Borehole	BH-11
Sampling Method	AS1289.1.2.1 Cl 6.4a	Depth (m)	0.5-1.0
Date Sampled	6/07/2023		
Sampled By	Client		
Date Tested	1/07/2023	Prep Material > 53mm (%)	-
Material Source	In-Situ	Material Limit Start	-
Material Type	In-situ Clay	Material Limit End	-
Client Reference	10791E-P-710	Compactive Effort	Standard
Material Description	Brown Clay		

Maximum Dry Density (t/m³):	1.64
Optimum Moisture Content (%):	19.0
Field Moisture Content (%):	18.0
Sample Percent Oversize (%)	0.0
Oversize Included / Excluded	Excluded
Target Density Ratio (%):	100
Target Moisture Ratio (%):	100
Placement Dry Density (t/m³):	1.65
Placement Dry Density Ratio (%):	100.0
Placement Moisture Content (%):	18.9
Placement Moisture Ratio (%):	100.5
Test Condition / Soaking Period:	Soaked / 4 Days
CBR Surcharge (kg)	9.0
Dry Density After Soak (t/m³):	1.60
Total Curing Time (hrs)	52
Liquid Limit Method	Estimation
Moisture (top 30mm) After Soak (%)	30.2
Moisture (remainder) After Soak (%)	21.2
CBR Swell (%):	3.0
Minimum CBR Specification (%):	-
CBR Value @ 2.5mm (%):	**3.0**

CBR PENETRATION PLOT



Remarks

Accredited for compliance with ISO/IEC 17025 – Testing

NATA

Accreditation Number: 1986
Corporate Site Number: 12385

Approved Signatory: Patrick Deasy
Form ID: W2ASRep Rev 3

Construction Sciences

Construction Sciences Pty Ltd
ABN: 74 128 806 735

Address:
Unit 1, 12 Callistemon Close
Warabrook NSW 2304

Laboratory: **Warabrook Laboratory**
Phone: 02 4062 0200
Fax: 02 6654 0261
Email: Newcastle@constructionsciences.net

SHRINK SWELL INDEX

Client:	Construction Sciences - Professional Services	Report Number:	16822/R/41807-1
Client Address:	31 Anvil Road, Seven Hills	Project Number:	16822/P/312
Project:	Geotechnical Services - Laboratory Testing	Lot Number:	Bole Holes
Location:	NSW	Internal Test Request:	16822/T/24772
Component:	Wallgrove Business park	Client Reference/s:	10791E-P-710
Area Description:		Report Date / Page:	1/08/2023 Page 1 of 3

Test Procedures:	AS1289.7.1.1, AS1289.2.1.1	Bore No.		BH01
Sample Number	16822/S/130872	Sample Type		Soil
Sampling Method	-	Sample Depth	m	0.3-0.45
Date Sampled	6/07/2023			
Sampled By	Client	Material Source	Existing	
Date Tested	17/07/2023	Material Type	Insitu	

Soil Description:	Clayey SILT		
Cracking / Crumbling:	Min		
Estimated Inert Inclusions (%):	0.00	Swell Pre-Soak Moisture Content (%)	16.1
Shrinkage Moisture Content (%):	17.2	Swell Post-Soak Moisture Content (%)	27.8

Shrinkage Strain (%)	3.2	Shrink / Swell Index	1.8
Swell Strain (%)	0.0		

Remarks

Accredited for compliance with ISO/IEC 17025 – Testing

NATA

Accreditation Number: 1986
Corporate Site Number: 16822

Approved Signatory: Zane Lasker
Form ID: W21Rep Rev 1

Construction Sciences

Construction Sciences Pty Ltd
ABN: 74 128 806 735

Address:
Unit 1, 12 Callistemon Close
Warabrook NSW 2304

Laboratory: **Warabrook Laboratory**
Phone: 02 4062 0200
Fax: 02 6654 0261
Email: Newcastle@constructionsciences.net

SHRINK SWELL INDEX

Client:	Construction Sciences - Professional Services	Report Number:	16822/R/41807-1
Client Address:	31 Anvil Road, Seven Hills	Project Number:	16822/P/312
Project:	Geotechnical Services - Laboratory Testing	Lot Number:	Bole Holes
Location:	NSW	Internal Test Request:	16822/T/24772
Component:	Wallgrove Business park	Client Reference/s:	10791E-P-710
Area Description:		Report Date / Page:	1/08/2023 Page 2 of 3

Test Procedures:	AS1289.7.1.1, AS1289.2.1.1	Bore No.		BH03
Sample Number	16822/S/130873	Sample Type		Soil
Sampling Method	-	Sample Depth	m	0.25-0.8
Date Sampled	6/07/2023			
Sampled By	Client	Material Source	Existing	
Date Tested	17/07/2023	Material Type	Insitu	

Soil Description:	Silty CLAY		
Cracking / Crumbling:	Min		
Estimated Inert Inclusions (%):	0.00	Swell Pre-Soak Moisture Content (%)	21.3
Shrinkage Moisture Content (%):	24.5	Swell Post-Soak Moisture Content (%)	22.1

Shrinkage Strain (%)	4.2	Shrink / Swell Index	2.4
Swell Strain (%)	0.2		

Remarks

NATA

Accredited for compliance with ISO/IEC 17025 – Testing

Accreditation Number: 1986
Corporate Site Number: 16822

Approved Signatory: Zane Lasker
Form ID: W21Rep Rev 1

Construction Sciences

Construction Sciences Pty Ltd
ABN: 74 128 806 735

Address:
Unit 1, 12 Callistemon Close
Warabrook NSW 2304

Laboratory: **Warabrook Laboratory**
Phone: 02 4062 0200
Fax: 02 6654 0261
Email: Newcastle@constructionsciences.net

SHRINK SWELL INDEX

Client:	Construction Sciences - Professional Services	Report Number:	16822/R/41807-1
Client Address:	31 Anvil Road, Seven Hills	Project Number:	16822/P/312
Project:	Geotechnical Services - Laboratory Testing	Lot Number:	Bole Holes
Location:	NSW	Internal Test Request:	16822/T/24772
Component:	Wallgrove Business park	Client Reference/s:	10791E-P-710
Area Description:		Report Date / Page:	1/08/2023 Page 3 of 3

Test Procedures:	AS1289.7.1.1, AS1289.2.1.1	Bore No.		BH11
Sample Number	16822/S/130874	Sample Type		Soil
Sampling Method	-	Sample Depth	m	0.25-0.9
Date Sampled	6/07/2023			
Sampled By	Client	Material Source	Existing	
Date Tested	17/07/2023	Material Type	Insitu	

Soil Description:	Silty CLAY		
Cracking / Crumbling:	Min		
Estimated Inert Inclusions (%):	0.00	Swell Pre-Soak Moisture Content (%)	21.3
Shrinkage Moisture Content (%):	20.2	Swell Post-Soak Moisture Content (%)	26.9

Shrinkage Strain (%)	5.0	Shrink / Swell Index	3.5
Swell Strain (%)	2.4		

Remarks

NATA

Accredited for compliance with ISO/IEC 17025 – Testing

Accreditation Number: 1986
Corporate Site Number: 16822

Approved Signatory: Zane Lasker
Form ID: W21Rep Rev 1

ANALYTICAL REPORT

Accreditation No. 2562

CLIENT DETAILS

Contact	Subash Baral
Client	CONSTRUCTION SCIENCES PTY LTD
Address	2/4 KELLOGG RD ROOTY HILL NSW 2766
Telephone	61 2 86462000
Facsimile	61 7 33208599
Email	subash.baral@constructionsciences.net
Project	**P710 Wallgrove Business Park**
Order Number	**P710**
Samples	15

LABORATORY DETAILS

Manager	Huong Crawford
Laboratory	SGS Alexandria Environmental
Address	Unit 16, 33 Maddox St Alexandria NSW 2015
Telephone	+61 2 8594 0400
Facsimile	+61 2 8594 0499
Email	au.environmental.sydney@sgs.com
SGS Reference	**SE250222 R0**
Date Received	4/7/2023
Date Reported	11/7/2023

COMMENTS

Accredited for compliance with ISO/IEC 17025 - Testing. NATA accredited laboratory 2562(4354).

SIGNATORIES

Dong LIANG
Metals/Inorganics Team Leader

Shane MCDERMOTT
Inorganic/Metals Chemist

Soluble Anions in Soil from 1:2 DI Extract by Ion Chromatography [AN245] Tested: 10/7/2023

PARAMETER	UOM	LOR	BH01 /0.5m SOIL - 30/6/2023 SE250222.001	BH01 /1.5m SOIL - 30/6/2023 SE250222.002	BH01 /2.5m SOIL - 30/6/2023 SE250222.003	BH03 /3.5m SOIL - 30/6/2023 SE250222.004	BH03 /4.5m SOIL - 30/6/2023 SE250222.005
Chloride	mg/kg	0.25	37	54	25	120	95
Sulfate	mg/kg	0.5	180	150	57	45	55

PARAMETER	UOM	LOR	BH05 /0.5m SOIL - 30/6/2023 SE250222.006	BH05 /1.5m SOIL - 30/6/2023 SE250222.007	BH05 /2.5m SOIL - 30/6/2023 SE250222.008	BH05 /3.5m SOIL - 30/6/2023 SE250222.009	BH08 /0.5m SOIL - 28/6/2023 SE250222.010
Chloride	mg/kg	0.25	90	220	390	360	8.5
Sulfate	mg/kg	0.5	65	64	54	39	40

PARAMETER	UOM	LOR	BH08 /1.2m SOIL - 28/6/2023 SE250222.011	BH10 /0.5m SOIL - 28/6/2023 SE250222.012	8H10 /1.5m SOIL - 28/6/2023 SE250222.013	BH11 /0.5m SOIL - 28/6/2023 SE250222.014	BH11 /1.5m SOIL - 28/6/2023 SE250222.015
Chloride	mg/kg	0.25	180	200	86	590	600
Sulfate	mg/kg	0.5	130	63	29	320	350

pH in soil (1:2) [AN101] Tested: 10/7/2023

PARAMETER	UOM	LOR	BH01 /0.5m SOIL - 30/6/2023 SE250222.001	BH01 /1.5m SOIL - 30/6/2023 SE250222.002	BH01 /2.5m SOIL - 30/6/2023 SE250222.003	BH03 /3.5m SOIL - 30/6/2023 SE250222.004	BH03 /4.5m SOIL - 30/6/2023 SE250222.005
pH (1:2)	pH Units	-	5.5	5.8	6.6	8.1	8.2

PARAMETER	UOM	LOR	BH05 /0.5m SOIL - 30/6/2023 SE250222.006	BH05 /1.5m SOIL - 30/6/2023 SE250222.007	BH05 /2.5m SOIL - 30/6/2023 SE250222.008	BH05 /3.5m SOIL - 30/6/2023 SE250222.009	BH08 /0.5m SOIL - 28/6/2023 SE250222.010
pH (1:2)	pH Units	-	4.9	5.2	8.1	8.4	5.3

PARAMETER	UOM	LOR	BH08 /1.2m SOIL - 28/6/2023 SE250222.011	BH10 /0.5m SOIL - 28/6/2023 SE250222.012	8H10 /1.5m SOIL - 28/6/2023 SE250222.013	BH11 /0.5m SOIL - 28/6/2023 SE250222.014	BH11 /1.5m SOIL - 28/6/2023 SE250222.015
pH (1:2)	pH Units	-	5.8	5.1	5.8	4.5	4.5

Conductivity (1:2) in soil [AN106] Tested: 10/7/2023

PARAMETER	UOM	LOR	BH01 /0.5m SOIL - 30/6/2023 SE250222.001	BH01 /1.5m SOIL - 30/6/2023 SE250222.002	BH01 /2.5m SOIL - 30/6/2023 SE250222.003	BH03 /3.5m SOIL - 30/6/2023 SE250222.004	BH03 /4.5m SOIL - 30/6/2023 SE250222.005
Conductivity (1:2) @25 C*	µS/cm	1	250	300	180	460	440
Resistivity (1:2)*	ohm cm	-	4100	3300	5600	2200	2300

PARAMETER	UOM	LOR	BH05 /0.5m SOIL - 30/6/2023 SE250222.006	BH05 /1.5m SOIL - 30/6/2023 SE250222.007	BH05 /2.5m SOIL - 30/6/2023 SE250222.008	BH05 /3.5m SOIL - 30/6/2023 SE250222.009	BH08 /0.5m SOIL - 28/6/2023 SE250222.010
Conductivity (1:2) @25 C*	µS/cm	1	230	390	880	810	89
Resistivity (1:2)*	ohm cm	-	4400	2600	1100	1200	11000

PARAMETER	UOM	LOR	BH08 /1.2m SOIL - 28/6/2023 SE250222.011	BH10 /0.5m SOIL - 28/6/2023 SE250222.012	8H10 /1.5m SOIL - 28/6/2023 SE250222.013	BH11 /0.5m SOIL - 28/6/2023 SE250222.014	BH11 /1.5m SOIL - 28/6/2023 SE250222.015
Conductivity (1:2) @25 C*	µS/cm	1	450	340	210	1200	1200
Resistivity (1:2)*	ohm cm	-	2200	2900	4700	870	860

Conductivity and TDS by Calculation - Soil [AN106] Tested: 10/7/2023

PARAMETER	UOM	LOR	BH01 /0.5m SOIL - 30/6/2023 SE250222.001	BH01 /1.5m SOIL - 30/6/2023 SE250222.002	BH01 /2.5m SOIL - 30/6/2023 SE250222.003	BH03 /3.5m SOIL - 30/6/2023 SE250222.004	BH03 /4.5m SOIL - 30/6/2023 SE250222.005
Conductivity of Extract (1:5 as received)	µS/cm	1	140	140	85	260	260
Resistivity of extract (1:5 as received)*	ohm m	0.1	73	70	120	38	39

PARAMETER	UOM	LOR	BH05 /0.5m SOIL - 30/6/2023 SE250222.006	BH05 /1.5m SOIL - 30/6/2023 SE250222.007	BH05 /2.5m SOIL - 30/6/2023 SE250222.008	BH05 /3.5m SOIL - 30/6/2023 SE250222.009	BH08 /0.5m SOIL - 28/6/2023 SE250222.010
Conductivity of Extract (1:5 as received)	µS/cm	1	94	190	500	470	47
Resistivity of extract (1:5 as received)*	ohm m	0.1	110	53	20	21	210

PARAMETER	UOM	LOR	BH08 /1.2m SOIL - 28/6/2023 SE250222.011	BH10 /0.5m SOIL - 28/6/2023 SE250222.012	8H10 /1.5m SOIL - 28/6/2023 SE250222.013	BH11 /0.5m SOIL - 28/6/2023 SE250222.014	BH11 /1.5m SOIL - 28/6/2023 SE250222.015
Conductivity of Extract (1:5 as received)	µS/cm	1	210	170	82	630	590
Resistivity of extract (1:5 as received)*	ohm m	0.1	47	58	120	16	17

Moisture Content [AN002] Tested: 7/7/2023

PARAMETER	UOM	LOR	BH01 /0.5m SOIL - 30/6/2023 SE250222.001	BH01 /1.5m SOIL - 30/6/2023 SE250222.002	BH01 /2.5m SOIL - 30/6/2023 SE250222.003	BH03 /3.5m SOIL - 30/6/2023 SE250222.004	BH03 /4.5m SOIL - 30/6/2023 SE250222.005
% Moisture	%w/w	1	15.2	9.9	7.6	8.8	6.3

PARAMETER	UOM	LOR	BH05 /0.5m SOIL - 30/6/2023 SE250222.006	BH05 /1.5m SOIL - 30/6/2023 SE250222.007	BH05 /2.5m SOIL - 30/6/2023 SE250222.008	BH05 /3.5m SOIL - 30/6/2023 SE250222.009	BH08 /0.5m SOIL - 28/6/2023 SE250222.010
% Moisture	%w/w	1	9.8	10.1	7.5	7.4	15.9

PARAMETER	UOM	LOR	BH08 /1.2m SOIL - 28/6/2023 SE250222.011	BH10 /0.5m SOIL - 28/6/2023 SE250222.012	8H10 /1.5m SOIL - 28/6/2023 SE250222.013	BH11 /0.5m SOIL - 28/6/2023 SE250222.014	BH11 /1.5m SOIL - 28/6/2023 SE250222.015
% Moisture	%w/w	1	6.5	12.2	5.0	8.7	10.1

METHOD	METHODOLOGY SUMMARY
AN002	The test is carried out by drying (at either 40°C or 105°C) a known mass of sample in a weighed evaporating basin. After fully dry the sample is re-weighed. Samples such as sludge and sediment having high percentages of moisture will take some time in a drying oven for complete removal of water.
AN101	pH in Soil Sludge Sediment and Water: pH is measured electrometrically using a combination electrode and is calibrated against 3 buffers purchased commercially. For soils, an extract with water is made at a ratio of 1:2 and the pH determined and reported on the extract after 1 hour extraction (pH 1:2) or after 1 hour extraction and overnight aging (pH (1:2) aged). Reference APHA 4500-H+.
AN106	Conductivity and TDS by Calculation: Conductivity is measured by meter with temperature compensation and is calibrated against a standard solution of potassium chloride. Conductivity is generally reported as µmhos /cm or µS/cm @ 25°C. For soils, an extract of as received sample with water is made at a ratio of 1:5 and the EC determined and reported on the extract, or calculated back to the as-received sample. Salinity can be estimated from conductivity using a conversion factor, which for natural waters, is in the range 0.55 to 0.75. Reference APHA 2510 B.
AN106	Resistivity of the extract is reported on the extract basis and is the reciprocal of conductivity. Salinity and TDS can be calculated from the extract conductivity and is reported back to the soil basis.
AN245	Anions by Ion Chromatography: A water sample or extract is injected into an eluent stream that passes through the ion chromatographic system where the anions of interest ie Br, Cl, NO2, NO3 and SO4 are separated on their relative affinities for the active sites on the column packing material. Changes to the conductivity and the UV-visible absorbance of the eluent enable identification and quantitation of the anions based on their retention time and peak height or area. APHA 4110 B

FOOTNOTES

*	NATA accreditation does not cover the performance of this service.	-	Not analysed.	UOM	Unit of Measure.
		NVL	Not validated.	LOR	Limit of Reporting.
**	Indicative data, theoretical holding time exceeded.	IS	Insufficient sample for analysis.	↑↓	Raised/lowered Limit of Reporting.
		LNR	Sample listed, but not received.		
***	Indicates that both * and ** apply.				

Unless it is reported that sampling has been performed by SGS, the samples have been analysed as received.
Solid samples expressed on a dry weight basis.

Where "Total" analyte groups are reported (for example, Total PAHs, Total OC Pesticides) the total will be calculated as the sum of the individual analytes, with those analytes that are reported as <LOR being assumed to be zero. The summed (Total) limit of reporting is calculated by summing the individual analyte LORs and dividing by two. For example, where 16 individual analytes are being summed and each has an LOR of 0.1 mg/kg, the "Totals" LOR will be 1.6 / 2 (0.8 mg/kg). Where only 2 analytes are being summed, the " Total" LOR will be the sum of those two LORs.

Some totals may not appear to add up because the total is rounded after adding up the raw values.

If reported, measurement uncertainty follow the ± sign after the analytical result and is expressed as the expanded uncertainty calculated using a coverage factor of 2, providing a level of confidence of approximately 95%, unless stated otherwise in the comments section of this report.

Results reported for samples tested under test methods with codes starting with ARS-SOP, radionuclide or gross radioactivity concentrations are expressed in becquerel (Bq) per unit of mass or volume or per wipe as stated on the report. Becquerel is the SI unit for activity and equals one nuclear transformation per second.
Note that in terms of units of radioactivity:

a. 1 Bq is equivalent to 27 pCi
b. 37 MBq is equivalent to 1 mCi

For results reported for samples tested under test methods with codes starting with ARS-SOP, less than (<) values indicate the detection limit for each radionuclide or parameter for the measurement system used. The respective detection limits have been calculated in accordance with ISO 11929.

The QC and MU criteria are subject to internal review according to the SGS QAQC plan and may be provided on request or alternatively can be found here: www.sgs.com.au/en-gb/environment-health-and-safety.

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