

GEOTECHNICAL INVESTIGATION

FOR

CATHOLIC EDUCATION DIOCESE OF WOLLONGONG

St Paul's Catholic Primary School

18 Garrett Street, Moss Vale, New South Wales

Report No: 23/3294

Project No: 32422/8048D-G

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DRAWING NO. 23/3294 – BOREHOLE AND PENETROMETER LOCATIONS

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1. INTRODUCTION

This report presents the results of a geotechnical investigation carried out by STS Geotechnics Pty Limited (STS) for the proposed new block at St Paul's Primary School at 18 Garrett Street, Moss Vale, New South Wales.

The following documents were provided to assist in the preparation of this report:

- Architectural drawings prepared by DTA Architects, Job no. 2022.017, Revision P07, dated 15.09.2023.

Based on the drawings provided, the proposed development doesn't include excavation for the basement level, however, minor cut and fill will be required to achieve the required finished floor levels, footings, and service trenches.

The purpose of this investigation was to determine the following:

- Site conditions and regional geology,
- Subsurface conditions,
- Site Classification according to AS2870,
- Excavation conditions and vibration control during rock excavation,
- Safe batter slopes,
- Retaining wall design parameters,
- Foundation design parameters including foundation options, and
- Exposure classification/soil aggressiveness according to AS2870-2011 and AS2159-2009.

The investigation has been carried out at the request of DTA Architects in accordance with the agreed scope of works outlined in STS' proposal referenced P23-390, dated August 28, 2023.

Our scope of work did not include a contamination assessment.

2. NATURE OF THE INVESTIGATION

2.1. Fieldwork

The fieldwork consisted of the drilling of four (4) boreholes numbered BH1 to BH4 inclusive, at the locations shown on attached Drawing No. 23/3294. Boreholes were drilled using a utility mounted Christie drilling rig, owned, and operated by STS. Soil strengths were assessed by carrying out Dynamic Cone Penetrometer (DCP) tests adjacent to each borehole location.

Drilling operations were undertaken by one of STS's technical officers who also logged the subsurface conditions encountered.

Representative soil samples were collected from the boreholes for subsequent laboratory testing.

The subsurface conditions observed are recorded on the borehole logs given in Appendix A. An explanation of the terms used on the logs is also given in Appendix A. Notes relating to geotechnical reports are also attached.

2.2. Laboratory Testing

To assess the soil for its aggressiveness, a selected representative soil sample was tested to determine the following:

- pH,
- Sulphate content (SO_4),
- Chloride content (Cl) and
- Electrical Conductivity (EC).

To assist with determining the Site Classification, a representative soil sample was tested to determine the shrink/swell index.

Detailed test report is given in Appendix B.

3. GEOLOGY AND SITE CONDITIONS

The Moss Vale geological series sheet at a scale of 1:100,000 shows the site is underlain by Quaternary Age Residuum. Residual deposits of unconsolidated clayey coarse to fine grained sands to weakly consolidated sandy clay layers can be found within this formation as shown in Plate 1. The site location appears to be in proximity of the Bringelly Shale of Wianamatta Group.

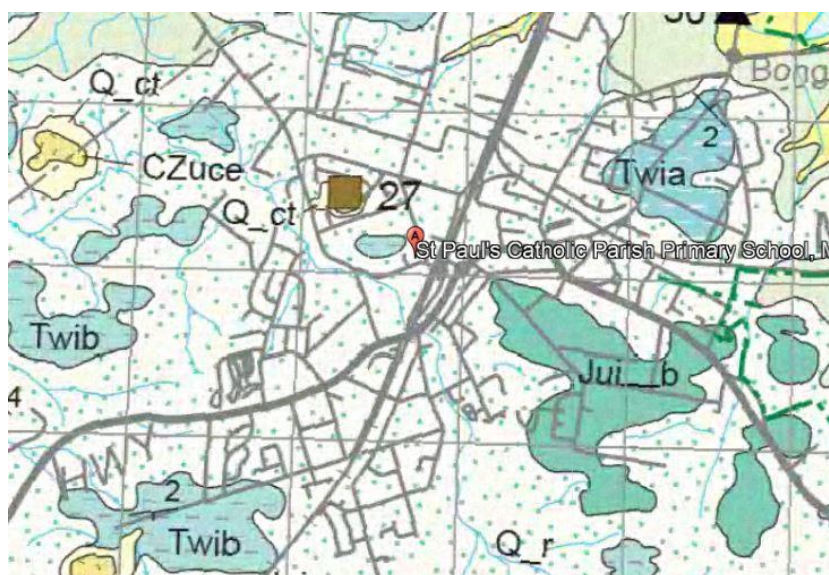


Plate 1: Excerpt of geological map showing location of site (Google Earth Pro)

At the time of the fieldwork the site was being used as a school with existing structures. Site vegetation comprises shrubs, trees, and grass. The site area is approximately 2.136 hectare. The ground surface falls approximately 8 m to south.

The site is bound by Garrett Street to the east and residential dwellings in the adjoining properties.

4. SUBSURFACE CONDITIONS

When assessing the subsurface conditions across a site from a limited number of boreholes, there is the possibility that variations may occur between test locations. The data derived from the site investigation programme are extrapolated across the site to form a geological model and an engineering opinion is rendered about overall subsurface conditions and their likely behaviour regarding the proposed development. The actual condition at the site may differ from those inferred, since no subsurface exploration programme, no matter how comprehensive, can reveal all subsurface details and anomalies, particularly on a site such as this where there has been previous development.

The subsurface conditions consist of asphaltic pavement overlying fill, natural silty clays, sandy clays and weathered shale. Pavement and fill are present from the surface to depth of 0.3 to 1.9 metres. In BH2, BH3 and BH4, firm to stiff, becoming very stiff with depth, natural soils underlie the pavement and fill materials to depths of 2.5 to 4.5 metres. In BH1 these materials were encountered to the depth of drilling, 6.0 metres. In BH2, BH3 and BH4 auger refusal on weathered shale occurred at the depths of 2.5 to 4.5 metres.

No groundwater was observed during the fieldwork.

5. GEOTECHNICAL DISCUSSION

5.1. Site Classification to AS2870-2011

The classification has been prepared in accordance with the guidelines set out in the “Residential Slabs and Footings” Code, AS2870 - 2011. Site classifications are not relevant to these types of development; however, the classification is provided in the event some high-level footings are required.

The sample collected for shrink swell testing was unsuitable. Experience has shown that at times, the shrink swell index can be estimated by dividing the soil Plasticity Index (PI) by a factor of 10. The soil tested at this site has a PI of 18.0% which implies the shrink swell index is estimated as 1.8% per ΔpF .

Because there are school blocks and trees present, abnormal moisture conditions (AMC) prevail at the site (Refer to Section 1.3.3 of AS2870).

Because of the presence of AMC and over 400mm of fill, the site is classified as a *Problem Site (P)*. However, provided the recommendations given below are adopted and the fill is certified as being placed in a controlled manner, the site may be re-classified *Moderately Reactive (M)*.

Foundation design and construction consistent with this classification shall be adopted as specified in the above referenced standard and in accordance with the following design parameters provided below.

5.2. Excavation Conditions

STS notes that there is no proposed basement excavation. However, if a basement excavation is incorporated into the proposed building, it is highly likely weathered shale will be encountered. Excavators without assistance should be able to remove some of the weathered shale.

Based on our experience, medium strength shale and high strength ironstone bands may be encountered within the weathered shale. The presence of these rocks can only be confirmed by carrying out additional cored boreholes.

Excavators alone, without assistance, may not be able to remove significant amount of the weathered shale. Hydraulic breakers mounted on an excavator or jack hammers may be required to break up some of this rock before it can be removed using an excavator.

Care will be required to ensure that the structures on the subject site and buildings or other developments on adjacent properties are not damaged when excavating the rock. Excavation methods should be adopted which limit ground vibrations at the adjoining structures to not more than 5 mm/sec. Vibration monitoring may be required to verify that this is achieved.

The limits of 5 mm/sec are expected to be achievable if rock breaker equipment or other excavation methods are restricted as indicated in Table 5.1.

Use of other techniques (e.g. grinding, rock sawing), although less productive, would reduce or possibly eliminate risks of damage to property through vibration effects transmitted via the ground. Such techniques may be considered if an alternative to rock breaking is required.

If rock sawing is carried out around excavation boundaries in not less than 1-metre-deep lifts, a 900 kg rock hammer could be used at up to 100% maximum operating capacity with an assessed peak particle velocity not exceeding 5 mm/sec, subject to observation and confirmation by a geotechnical engineer at the commencement of excavation.

Table 5.1 - Recommendations for Rock Breaking Equipment

Distance from adjoining structure (m)	Maximum Peak Particle Velocity 5 mm/sec	
	Equipment	Operating Limit (% of Maximum Capacity)
1.5 to 2.5	Hand operated jackhammer only	100
2.5 to 5.0	300 kg rock hammer	50
5.0 to 10.0	300 kg rock hammer	100
	or 600 kg rock hammer	50

It should be noted that vibrations that are below threshold levels for building damage may be experienced at adjoining developments.

It would be appropriate before commencing excavation to undertake a dilapidation survey of any adjacent structures that may potentially be damaged. This will provide a reasonable basis for assessing any future claims of damage.

It is of course important that the onsite excavations are always adequately supported and do not endanger the adjacent properties.

5.3. Safe Batter Slope and Retaining Wall Design Parameters

Proposed development does not appear to have bulk deep excavations for basements. In such case, temporary dry cut slopes in clay soils should remain stable at an angle of 1(H) to 1(V). In the long-term dry cut slopes in clay soils are required, dry cut slopes formed at an angle of 2(H) to 1(V) should remain stable.

Since there are adjoining school blocks, excavations should not extend below the zone of influence of any adjacent structures, without first installing temporary support or discussing the works with a geotechnical engineer.

The parameters used to proportion retaining wall support depends on whether the walls can be permitted to deflect. For walls, which cannot be permitted to deflect, an at rest earth pressure coefficient (K_0) of 0.6 should be adopted for the clays. For walls that can be allowed to deflect, an active earth pressure coefficient (K_a) of 0.4 should be adopted for the clays. A passive earth pressure coefficient (K_p) of 2.5 may be used for the natural clays and 4.5 for the weathered shale. A bulk density of 19 kN/m³ may be used for the natural clays and 22 kN/m³ for the weathered shale/siltstone. If anchors or props are used for additional support, a rectangular pressure distribution should be used.

As with all retaining walls, the earth pressure coefficients must be adjusted for ground surface slope, presence of groundwater and surcharge loads.

5.4. Foundation Design

We do not recommend founding any structural loads in uncontrolled fill.

Pad and/or strip footings founded in fill certified as being placed as controlled engineered fill, and in stiff natural soils may be proportioned using an allowable bearing pressure of and 100 kPa. This value may be increased to 200 kPa when founding in the very stiff natural material. The minimum depth of founding must comply with the requirements of AS2870-2011.

Piers founded in very stiff soils may be proportioned using an allowable end bearing pressure of 300 kPa, provided their depth to diameter ratio exceeds a value of 4. An allowable adhesion value of 20 kPa may be adopted for the portion of the shaft below a depth of 0.5 metres.

Piers founded in weathered shale may be proportioned using an allowable end bearing pressure of 700 kPa. An allowable adhesion value of 70 kPa may be adopted for the portion of the shaft in weathered shale. When piers are founded in in weathered shale the adhesion within the overlying soils must be ignored.

To ensure the bearing values given can be achieved, care should be taken to ensure the base of the excavations is free of all loose material prior to concreting. To this end, it is recommended that all excavations be concreted as soon as possible, preferably immediately after excavating, cleaning, inspecting and approval. Pile excavations should not be left open overnight.

During foundation construction, should the subsurface conditions vary to those inferred in this report, a suitably experienced geotechnical engineer should review the design and recommendations given above to determine if any alterations are required.

5.5. Exposure Classification and Salinity

The aggressiveness or erosion potential of an environment in building materials, particularly concrete and steel is dependent on the levels of soil pH and the types of salts present, generally sulfates and chlorides. To determine the degree of aggressiveness, the test values obtained are compared to Tables 6.4.2 (C) and 6.5.2 (C) in AS2159 – 2009 Piling - Design and Installation. The test results are summarised in Table 5.2.

Table 5.2 – Soil Aggressiveness and Salinity Test Results

Sample No.	Location	Depth (m)	pH	Sulfate (mg/kg)	Chloride (mg/kg)	Electrical Conductivity (dS/m)	
						EC _{1:5}	EC _e
S1	BH2	0.2	7.0	10	<50	0.015	0.1

The soils on the site consist of low permeability soils above groundwater. Therefore, soil conditions B are considered appropriate (AS2159-2009).

In accordance with AS2159-2009 the exposure classification for the onsite soils is non-aggressive to both concrete and steel. In accordance with AS2870-2011 the soils are classified as A1.

Reference to DLWC (2002) "Site Investigations for Urban Salinity" indicates that an EC_e value of 0.1 dS/m is consistent with the presence of non-saline soil.

5.6. Site Preparation and Re-grading

Subgrade Preparation

Earthworks recommendations provided in this report should be complemented by reference to AS3798.

1. Any topsoils excavated should be stockpiled separately since these materials may not be suitable for re-use as engineered fill. Any excavations carried should be no steeper than 1 Vertical to 1 Horizontal. Any new fill required must be 'keyed-in' the sides of these batters.
2. The base of the excavation should be proof rolled with a smooth drum roller (say 12 tonne) used in static or non-vibratory mode of operation. Caution is required when proof rolling near existing infrastructures and utilities (where present). The purpose of the proof rolling is to detect any soft or heaving areas and to allow for some further improvement in strength or compaction.
3. The final pass should be undertaken in the presence of an experienced geotechnician or geotechnical engineer, to detect any unstable or soft subgrade areas, and to allow for some further improvement in strength/compaction.
4. If dry conditions prevail at the time of construction, then any exposed residual clay subgrade may become desiccated or have shrinkage cracks prior to pouring any concrete slabs. If this occurs, the subgrade must be scarified and reconditioned with watered prior recompacting.

5. Unstable subgrade detected during proof rolling should be locally excavated down to a sound base and replaced with engineered fill or further advice should be sought. Any fill placed to raise site levels should also be engineered fill, as per the specifications below.

Engineered Fill Specifications

Any fill placed for structural purposes should be engineered fill. Fill should be compacted in layers not greater than 200 mm loose thickness, to a minimum density ratio of 98% of SMDD.

The existing clayey soils excavated from cut areas may be reused as engineered fill, provided any unsuitable ('over wet' and 'oversized') and deleterious materials that may be present are removed.

Density tests should be regularly carried out on any filling required to confirm the above specifications are achieved in accordance with AS3798-2007 Table 8.1. We recommend that at least Level 1 inspection and testing, as defined in AS3798-2007, be adopted for the placement of any fill material. Level 2 testing can be carried out on the pavement layers.

We recommend that the engineered fill layers required extend a horizontal distance of at least 1m beyond the design geometry. The roller must extend over the edge of each placed layer to seal the batter surface. On completion of filling, the excess under-compacted edge fill should be trimmed back to the design geometry.

The 'tying in' of engineered fill to temporary cut batter slopes can be achieved by locally benching the cut slopes in no greater than 0.4m high steps. This can be carried out progressively as the height of engineered fill increases.

For backfilling confined excavations such as service trenches, a similar compaction to engineered fill should be adhered to, but if light compaction equipment is used then the layer thickness should be limited to 100mm loose thickness.

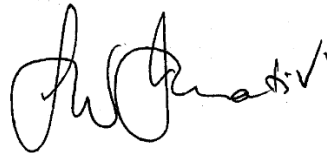
During construction of the fill, platform runoff should be enhanced by providing suitable falls to reduce ponding of water on the surface of the fill. Ponding of water may lead to softening of the fill and subsequent delays in the earthworks program. A poorly drained subgrade may become un-trafficable when wet. We recommend that if soil softening occurs, the exposed surface be over-excavated to below the affected soil, and then replaced with engineered fill as specified above.

6. FINAL COMMENTS

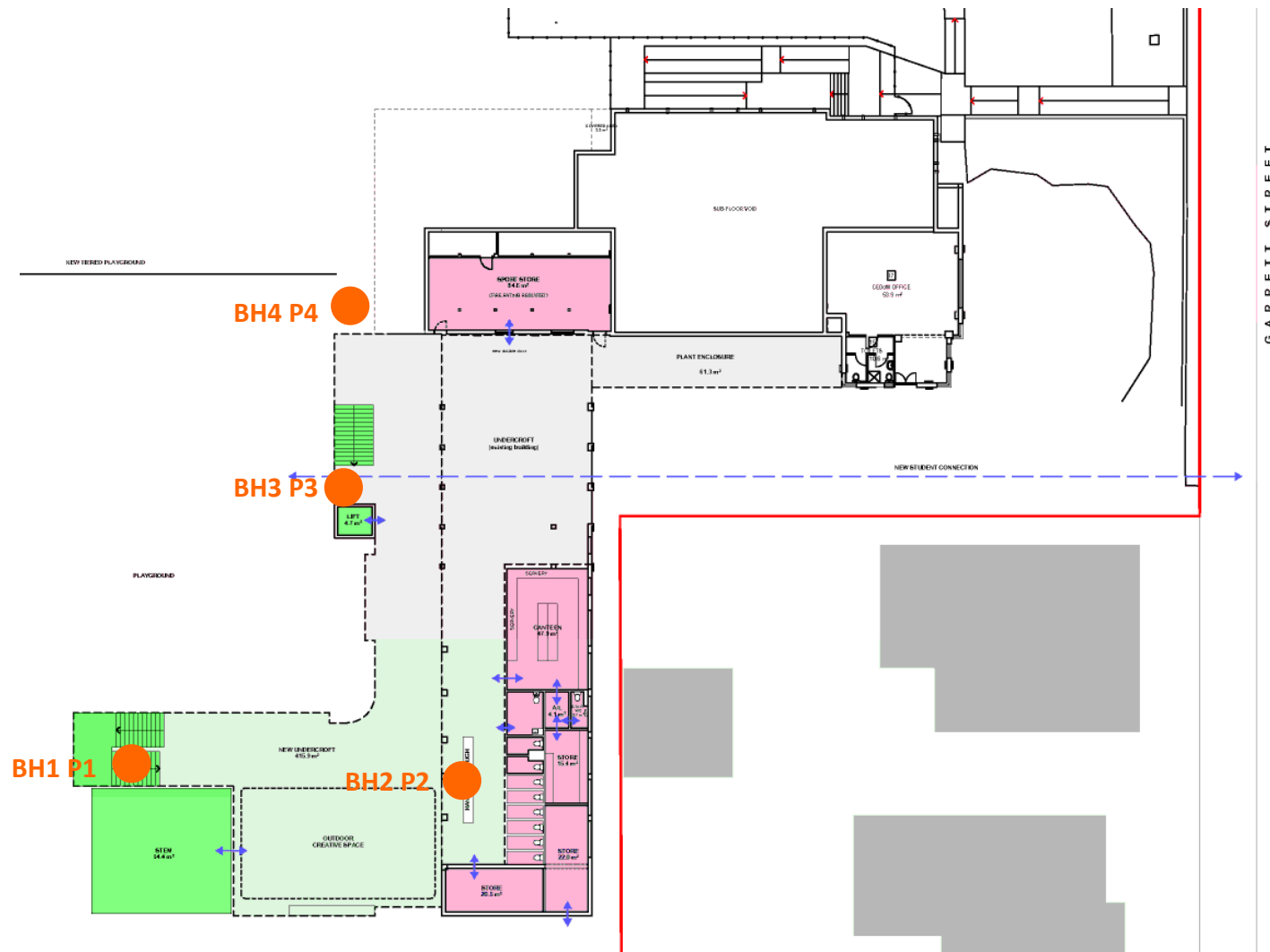
During construction, should the subsurface conditions vary from those inferred above, we would be contacted to determine if any changes should be made to our recommendations. The exposed bearing surfaces for footings should be inspected by a geotechnical engineer to ensure the allowable pressure given has been achieved.



Manoj Shrestha
Geotechnical Engineer
STS Geotechnics Pty Limited



Laurie Ihnativ
Principal Geotechnical Engineer
STS Geotechnics Pty Limited



STS Geotechnics Pty. Ltd.

Scale: Unknown

Date: October 2023

Client: CATHOLIC EDUCATION DIOCESE OF WOLLONGONG

GEOTECHNICAL INVESTIGATION
18 GARRETT STREET, MOSS VALE
BOREHOLE AND PENETROMETER LOCATIONS

Project No.
32422/8048D-G

Drawing No: 23/3294

INTRODUCTION

These notes have been provided to outline the methodology and limitations inherent in geotechnical reporting. The issues discussed are not relevant to all reports and further advice should be sought if there are any queries regarding any advice or report. When copies of reports are made, they should be reproduced in full.

GEOTECHNICAL REPORTS

Geotechnical reports are prepared by qualified personnel on the information supplied or obtained and are based on current engineering standards of interpretation and analysis.

Information may be gained from limited subsurface testing, surface observations, previous work and is supplemented by knowledge of the local geology and experience of the range of properties that may be exhibited by the materials present. For this reason, geotechnical reports should be regarded as interpretative rather than factual documents, limited to some extent by the scope of information on which they rely.

Where the report has been prepared for a specific purpose (eg. design of a three-storey building), the information and interpretation may not be appropriate if the design is changed (eg. a twenty storey building). In such cases, the report and the sufficiency of the existing work should be reviewed by STS Geotechnics Pty Limited in the light of the new proposal.

Every care is taken with the report content, however, it is not always possible to anticipate or assume responsibility for the following conditions:

- Unexpected variations in ground conditions. The potential for this depends on the amount of investigative work undertaken.
- Changes in policy or interpretation by statutory authorities.
- The actions of contractors responding to commercial pressures.

If these occur, STS Geotechnics Pty Limited would be pleased to resolve the matter through further investigation, analysis or advice.

UNFORSEEN CONDITIONS

Should conditions encountered on site differ markedly from those anticipated from the information contained in the report, STS Geotechnics Pty Limited should be notified immediately. Early identification of site anomalies generally results in any problems being more readily resolved and allows re-interpretation and assessment of the implications for future work.

SUBSURFACE CONDITIONS

Logs of a borehole, recovered core, test pit, excavated face or cone penetration test are an engineering and/or geological interpretation of the subsurface conditions. The reliability of the logged information depends on the drilling/testing method, sampling and/or observation spacings and the ground conditions. It is not always possible or economic to obtain continuous high quality data. It should also be recognised that the volume or material observed or tested is only a fraction of the total subsurface profile.

Interpretation of subsurface information and application to design and construction must take into consideration the spacing of the test locations, the frequency of observations and testing, and the possibility that geological boundaries may vary between observation points.

Groundwater observations and measurements outside of specially designed and constructed piezometers should be treated with care for the following reasons:

- In low permeability soils groundwater may not seep into an excavation or bore in the short time it is left open.
- A localised perched water table may not represent the true water table.
- Groundwater levels vary according to rainfall events or season.
- Some drilling and testing procedures mask or prevent groundwater inflow.

The installation of piezometers and long term monitoring of groundwater levels may be required to adequately identify groundwater conditions.

SUPPLY OF GEOTECHNICAL INFORMATION OR TENDERING PURPOSES

It is recommended tenderers are provided with as much geological and geotechnical information that is available and that where there are uncertainties regarding the ground conditions, prospective tenders should be provided with comments discussing the range of likely conditions in addition to the investigation data.

APPENDIX A – BOREHOLE LOGS AND EXPLANATION SHEETS

Client: Catholic Education Diocese of Wollongong		Project: 32422/8048D-G		BOREHOLE NO.: BH 1		
Project: St Pauls Catholic Primary School, 18 Garrett Street, Moss Vale		Date: September 26, 2023				
Location: Refer to Drawing No. 23/3294		Logged: PS Checked By: MT		Sheet 1 of 1		
W A T T A E B R L E	S A M P L E S	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT Soil Name, grain size /plasticity, colour; secondary constituents (Inc. Description) , minor constituents including other remarks	S Y M B O L	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	M O I S T U R E
			ASPHALTIC CONCRETE: (40 mm thick)			
			FILL: SANDY CLAY: low plasticity, brown, some gravel	CL	APPEARS COMPACTED	M
		1.0	FILL: GRAVELLY SAND: fine to medium to coarse grained, grey black	SP		M
		2.0	SILTY CLAY: medium plasticity, brown	CI	Very Stiff	≤PL
		3.0	SANDY CLAY: low to medium plasticity, brown	CL/CI		≤PL
		4.0				
		5.0				
			BOREHOLE DISCONTINUED AT TARGET DEPTH 6.0 M			
D - disturbed sample U - undisturbed tube sample B - bulk sample WT - level of water table or free water N - Standard Penetration Test (SPT) S - jar sample				Contractor: STS Equipment: Christie Hole Diameter (mm): 100 Angle from Vertical (°): 0 Drill Bit: Spiral		
NOTES: See explanation sheets for meaning of all descriptive terms and symbols						

Client: Catholic Education Diocese of Wollongong		Project: 32422/8048D-G		BOREHOLE NO.: BH 2		
Project: St Pauls Catholic Primary School, 18 Garrett Street, Moss Vale		Date: September 26, 2023		Sheet 1 of 1		
Location: Refer to Drawing No. 23/3294		Logged: PS Checked By: MT				
W A T T A B E R L E	S A M P L E S	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT Soil Name, grain size /plasticity, colour; secondary constituents (Inc. Description) , minor constituents including other remarks	S Y M B O L	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	M O I S T U R E
	S1 @ 0.2 m		ASPHALTIC CONCRETE: (40 mm thick)			
			FILL: SANDY CLAY: low plasticity, brown, some gravel	CL	APPEARS COMPACTED	M
			FILL: GRAVELSAND: fine to medium grained, grey black	SP		M
			SILTY CLAY: medium plasticity, brown	CI/CH	FIRM TO STIFF VERY STIFF	≤PL
			SANDY CLAY: low to medium plasticity, yellow brown grey	CL/CI		<PL
			AUGER REFUSAL AT 4.5 M ON WEATHERED SHALE			>PL
D - disturbed sample U - undisturbed tube sample B - bulk sample WT - level of water table or free water N - Standard Penetration Test (SPT) S - jar sample				Contractor: STS Equipment: Christie Hole Diameter (mm): 100 Angle from Vertical (°): 0 Drill Bit: Spiral		
NOTES: See explanation sheets for meaning of all descriptive terms and symbols						

Client: Catholic Education Diocese of Wollongong			Project: 32422/8048D-G			BOREHOLE NO.:		BH 3	
Project: St Pauls Catholic Primary School, 18 Garrett Street, Moss Vale			Date : September 26, 2023						
Location: Refer to Drawing No. 23/3294			Logged: PS Checked By: MT			Sheet 1 of 1			
W A T T A B E R L E	S A M P L E S	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT			S Y M B O L	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)		M O I S T U R E
		1.0	ASPHALTIC CONCRETE: (40 mm thick)				APPEARS COMPACTED		M
			FILL: SANDY CLAY: low to medium plasticity, brown			CL/CI			M
			FILL: SANDY GRAVEL: fine to medium grained, black			GP			M
		2.0	SILTY CLAY: low to medium plasticity, grey brown			CL/CI	VERY STIFF		≤PL
		3.0	SANDY CLAY: low plasticity, brown, fine to medium grained sand			CL			<PL
		4.0	AUGER REFUSAL AT 3.5 M ON WEATHERED SHALE						
		5.0							

D - disturbed sample			U - undisturbed tube sample			B - bulk sample			Contractor: STS		
WT - level of water table or free water						N - Standard Penetration Test (SPT)			Equipment: Christie		
S - jar sample									Hole Diameter (mm): 100		
NOTES: See explanation sheets for meaning of all descriptive terms and symbols						Angle from Vertical (°): 0					
						Drill Bit: Spiral					

Client: Catholic Education Diocese of Wollongong		Project: 32422/8048D-G		BOREHOLE NO.: BH 4		
Project: St Pauls Catholic Primary School, 18 Garrett Street, Moss Vale		Date : September 26, 2023		Sheet 1 of 1		
Location: Refer to Drawing No. 23/3294		Logged: PS Checked By: MT				
W A T E R L E V E L	S A M P L E S	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT Soil Name, grain size /plasticity, colour; secondary constituents (Inc. Description) , minor constituents including other remarks	S Y M B O L	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	M O I S T U R E
			ASPHALTIC CONCRETE: (40 mm thick)			
			FILL: SANDY CLAY: low to medium plasticity, brow, fine to medium grained sand	CL/CI	APPEARS COMPACTED	<PL
			SILTY CLAY: medium plasticity, brown	CI	STIFF TO VERY STIFF	<PL
	U50	1.0	SANDY CLAY: low plasticity, dark brown, trace gravel	CL		<PL
		2.0				
		3.0	Auger Refusal at 2.5 m on weathered shale			
		4.0				
		5.0				
D - disturbed sample U - undisturbed tube sample B - bulk sample WT - level of water table or free water N - Standard Penetration Test (SPT) S - jar sample				Contractor: STS Equipment: Christie Hole Diameter (mm): 100 Angle from Vertical (°): 0 Drill Bit: Spiral		
NOTES: See explanation sheets for meaning of all descriptive terms and symbols						

Dynamic Cone Penetrometer Test Report

Project: ST PAULS PRIMARY SCHOOL, 18 GARRETT STREET, MOSS VALE

Project No.: 32422/8048D

Client: CATHOLIC EDUCATION DIOCESE OF WOLLONGONG

Report No.: 23/3293

Address: 86-88 Market Street, Wollongong

Report Date: October 5, 2023

Test Method: AS 1289.6.3.2

Page: 1 of 1

Site No.	P1	P2	P3	P4		
Location	Refer to Drawing No. 23/3294	Refer to Drawing No. 23/3294	Refer to Drawing No. 23/3294	Refer to Drawing No. 23/3294		
Date Tested	26/9/2023	26/9/2023	26/9/2023	26/9/2023		
Starting Level	Surface Level	Surface Level	Surface Level	Surface Level		
Depth (m)	Penetration Resistance (blows / 150mm)					
0.00 - 0.15	*	*	*	*		
0.15 - 0.30	4	9	7	5		
0.30 - 0.45	7	5	13	4		
0.45 - 0.60	10	4	11	5		
0.60 - 0.75	6	4	7	5		
0.75 - 0.90	7	2	4	4		
0.90 - 1.05	6	6	4	5		
1.05 - 1.20	7	3	2	7		
1.20 - 1.35	5	3	7	19		
1.35 - 1.50	7	5	6	Refusal		
1.50 - 1.65	5	10	7			
1.65 - 1.80	2	5	11			
1.80 - 1.95	8	2	14			
1.95 - 2.10	7	4	20			
2.10 - 2.25	10	4	Discontinued			
2.25 - 2.40	20	7				
2.40 - 2.55	23	10				
2.55 - 2.70	Discontinued	15				
2.70 - 2.85		23				
2.85 - 3.00		Discontinued				
3.00 - 3.15						
3.15 - 3.30						
3.30 - 3.45						
3.45 - 3.60						
3.60 - 3.75						

Remarks: * Pre drilled prior to testing

Technician: PS

Approved Signatory.....

Orlando Mendoza - Laboratory Manager

EXPLANATION OF NOTES, ABBREVIATIONS & TERMS USED ON BOREHOLE AND TEST PIT LOGS

DRILLING/EXCAVATION METHOD

HA	Hand Auger	ADH	Hollow Auger	NQ	Diamond Core - 47 mm
DT	Diatube Coring	RT	Rotary Tricone bit	NMLC	Diamond Core - 52 mm
NDD	Non-destructive digging	RAB	Rotary Air Blast	HQ	Diamond Core - 63 mm
AD*	Auger Drilling	RC	Reverse Circulation	HMLC	Diamond Core - 63 mm
*V	V-Bit	PT	Push Tube	EX	Tracked Hydraulic Excavator
*T	TC-Bit, e.g. AD/T	WB	Washbore	HAND	Excavated by Hand Methods

PENETRATION RESISTANCE

L	Low Resistance	Rapid penetration/ excavation possible with little effort from equipment used.
M	Medium Resistance	Penetration/ excavation possible at an acceptable rate with moderate effort from equipment used.
H	High Resistance	Penetration/ excavation is possible but at a slow rate and requires significant effort from equipment used.
R	Refusal/Practical Refusal	No further progress possible without risk of damage or unacceptable wear to equipment used.

These assessments are subjective and are dependent on many factors, including equipment power and weight, condition of excavation or drilling tools and experience of the operator.

WATER

	 Standing Water Level	 Partial water loss
	 Water Seepage	 Complete Water Loss
GWNO	GROUNDWATER NOT OBSERVED - Observation of groundwater, whether present or not, was not possible due to drilling water, surface seepage or cave-in of the borehole/ test pit.	
GWNE	GROUNDWATER NOT ENCOUNTERED - Borehole/ test pit was dry soon after excavation. However, groundwater could be present in less permeable strata. Inflow may have been observed had the borehole/ test pit been left open for a longer period.	

SAMPLING AND TESTING

SPT	Standard Penetration Testing to AS1289.6.3.3 2004
4,7,11 N=18	4,7,11 = Blows per 150mm. N = Blows per 300mm penetration following a 150mm seating drive
30/80mm	Where practical refusal occurs, the blows and penetration for that interval are reported, N is not reported
RW	Penetration occurred under the rod weight only, N<1
HW	Penetration occurred under the hammer and rod weight only, N<1
HB	Hammer double bouncing on anvil, N is not reported
Sampling	
S1	Jar sample – number indicates sample number
D	Disturbed Sample
B	Bulk disturbed Sample
U50	Thin walled tube sample - number indicates nominal sample diameter in millimetres
Testing	
PP	Pocket Penetrometer test expressed as instrument reading in kPa
DCP	Dynamic Cone Penetrometer (AS1289.6.3.1 1997)
PSP	Perth Sand Penetrometer (AS1289.6.3.2 1997)

GEOLOGICAL BOUNDARIES

————— = Observed Boundary (Position known)	- - - - - = Observed Boundary (Position approximate)	- - ? - - ? - - ? - - = Boundary (Interpreted or inferred)
---	---	---

ROCK CORE RECOVERY

TCR = Total Core Recovery (%)

$$= \frac{\text{Length of core recovered}}{\text{Length of core run}} \times 100$$

RQD = Rock Quality Designation (%)

$$= \frac{\sum \text{Axial lengths of core} > 100\text{mm}}{\text{Length of core run}} \times 100$$

METHOD OF SOIL DESCRIPTION USED ON BOREHOLE AND TEST PIT LOGS



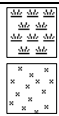
FILL



COUBLES or
BOULDERS



GRAVEL (GP or GW)



ORGANIC SOILS
(OL, OH or Pt)



SILT (ML or MH)

Combinations of these basic symbols may be used to indicate mixed materials such as sandy clay



CLAY (CL, CI or CH)



SAND (SP or SW)

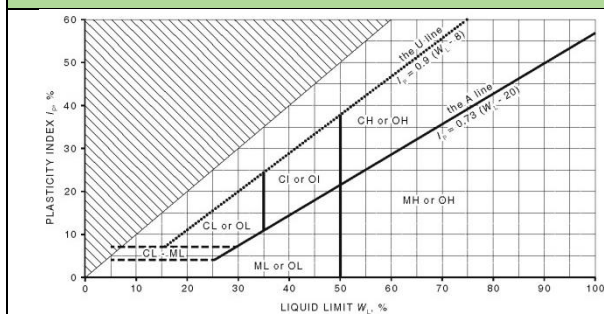
CLASSIFICATION AND INFERRED STRATIGRAPHY

Soil is broadly classified and described in Borehole and Test Pit Logs using the preferred method given in AS 1726:2017, Section 6.1 – Soil description and classification.

PARTICLE SIZE CHARACTERISTICS

Fraction	Components	Sub Division	Size mm
Oversize	BOULDERS		>200
	COBBLES		63 to 200
Coarse grained soil	GRAVEL	Coarse	19 to 63
		Medium	6.7 to 19
		Fine	2.36 to 6.7
	SAND	Coarse	0.6 to 2.36
		Medium	0.21 to 0.6
		Fine	0.075 to 0.21
Fine grained soil	SILT		0.002 to 0.075
	CLAY		<0.002

PLASTICITY PROPERTIES



GROUP SYMBOLS

Major Divisions	Symbol	Description
COARSE GRAINED SOILS More than 65% of soil excluding oversize fraction is greater than 0.075mm	GRAVEL More than 50% of coarse fraction is >2.36mm	GW Well graded gravel and gravel-sand mixtures, little or no fines, no dry strength.
		GP Poorly graded gravel and gravel-sand mixtures, little or no fines, no dry strength.
		GM Silty gravel, gravel-sand-silt mixtures, zero to medium dry strength.
		GC Clayey gravel, gravel-sand-clay mixtures, medium to high dry strength.
	SAND More than 50% of coarse fraction is <2.36 mm	SW Well graded sand and gravelly sand, little or no fines, no dry strength.
		SP Poorly graded sand and gravelly sand, little or no fines, no dry strength.
		SM Silty sand, sand-silt mixtures, zero to medium dry strength.
		SC Clayey sand, sandy-clay mixtures, medium to high dry strength.
FINE GRAINED SOILS More than 35% of soil excluding oversized fraction is less than 0.075mm	Liquid Limit less < 50%	ML Inorganic silts of low plasticity, very fine sands, rock flour, silty or clayey fine sands, zero to medium dry strength.
		CL, CI Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, medium to high dry strength.
		OL Organic silts and organic silty clays of low plasticity, low to medium dry strength.
	Liquid Limit > 50%	MH Inorganic silts of high plasticity, high to very high dry strength.
		CH Inorganic clays of high plasticity, high to very high dry strength.
		OH Organic clays of medium to high plasticity, medium to high dry strength.
Highly Organic soil	PT	Peat muck and other highly organic soils.

MOISTURE CONDITION

Symbol	Term	Description
D	Dry	Non- cohesive and free running.
M	Moist	Soils feel cool, darkened in colour. Soil tends to stick together.
W	Wet	Soils feel cool, darkened in colour. Soil tends to stick together, free water forms when handling.

Moisture content of cohesive soils shall be described in relation to plastic limit (PL) or liquid limit (LL) for soils with higher moisture content as follows: Moist, dry of plastic limit ($w < PL$); Moist, near plastic limit ($w \approx PL$); Moist, wet of plastic limit ($w > PL$); Wet, near liquid limit ($w \approx LL$); Wet, wet of liquid limit ($w > LL$).

CONSISTENCY

Symbol	Term	Undrained Shear Strength (kPa)	SPT "N" #
VS	Very Soft	≤ 12	≤ 2
S	Soft	>12 to ≤ 25	>2 to ≤ 4
F	Firm	>25 to ≤ 50	>4 to ≤ 8
St	Stiff	>50 to ≤ 100	>8 to ≤ 15
VSt	Very Stiff	>100 to ≤ 200	>15 to ≤ 30
H	Hard	>200	>30
Fr	Friable	-	-

DENSITY

Symbol	Term	Density Index %	SPT "N" #
VL	Very Loose	≤ 15	0 to 4
L	Loose	>15 to ≤ 35	4 to 10
MD	Medium Dense	>35 to ≤ 65	10 to 30
D	Dense	>65 to ≤ 85	30 to 50
VD	Very Dense	>85	Above 50

In the absence of test results, consistency and density may be assessed from correlations with the observed behaviour of the material.

SPT correlations are not stated in AS1726:2017, and may be subject to corrections for overburden pressure, moisture content of the soil, and equipment type.

MINOR COMPONENTS

Term	Assessment Guide	Proportion by Mass
Add 'Trace'	Presence just detectable by feel or eye but soil properties little or no different to general properties of primary component	Coarse grained soils: $\leq 5\%$ Fine grained soil: $\leq 15\%$
Add 'With'	Presence easily detectable by feel or eye but soil properties little or no different to general properties of primary component	Coarse grained soils: 5 - 12% Fine grained soil: 15 - 30%
Prefix soil name	Presence easily detectable by feel or eye in conjunction with the general properties of primary component	Coarse grained soils: $>12\%$ Fine grained soil: $>30\%$

CLASSIFICATION AND INFERRED STRATIGRAPHY

Rock is broadly classified and described in Borehole and Test Pit Logs using the preferred method given in AS1726 – 2017, Section 6.2 – Rock identification, description and classification.

ROCK MATERIAL STRENGTH CLASSIFICATION

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

Rock Strength Test Results



Point Load Strength Index, $IS_{(50)}$, Axial test (MPa)



Point Load Strength Index, $IS_{(50)}$, Diametral test (MPa)

Relationship between rock strength test result ($IS_{(50)}$) and unconfined compressive strength (UCS) will vary with rock type and strength, and should be determined on a site-specific basis. However UCS is typically $20 \times IS_{(50)}$.

ROCK MATERIAL WEATHERING CLASSIFICATION

Symbol	Term	Field Guide
RS	Residual Soil	Soil developed on extremely weathered rock; the mass structure and substance fabric are no longer evident; there is a large change in volume but the soil has not been significantly transported.
XW	Extremely Weathered	Rock is weathered to such an extent that it has soil properties - i.e. it either disintegrates or can be remoulded, in water.
DW	HW	Rock strength usually changed by weathering. The rock may be highly discoloured, usually by iron staining. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores. In some environments it is convenient to subdivide into Highly Weathered and Moderately Weathered, with the degree of alteration typically less for MW.
	MW	
SW	Slightly Weathered	Rock slightly discoloured but shows little or no change of strength relative to fresh rock.
FR	Fresh	Rock shows no sign of decomposition or staining.

ABBREVIATIONS AND DESCRIPTIONS FOR ROCK MATERIAL AND DEFECTS

CLASSIFICATION AND INFERRED STRATIGRAPHY

Rock is broadly classified and described in Borehole and Test Pit Logs using the preferred method given in AS1726 – 2017, Section 6.2 – Rock identification, description and classification.

DETAILED ROCK DEFECT SPACING

Defect Spacing			Bedding Thickness (Stratification)	
Spacing/width (mm)	Descriptor	Symbol	Term	Spacing (mm)
<20	Extremely Close	EC	Thinly laminated	<6
20-60	Very Close	VC	Laminated	6 – 20
60-200	Close	C	Very thinly bedded	20 – 60
200-600	Medium	M	Thinly bedded	60 – 200
600-2000	Wide	W	Medium bedded	200 – 600
2000-6000	Very Wide	VW	Thickly bedded	600 – 2,000
			Very thickly bedded	> 2,000

ABBREVIATIONS AND DESCRIPTIONS FOR DEFECT TYPES

Defect Type	Abbr.	Description
Joint	JT	Surface of a fracture or parting, formed without displacement, across which the rock has little or no tensile strength. May be closed or filled by air, water or soil or rock substance, which acts as cement.
Bedding Parting	BP	Surface of fracture or parting, across which the rock has little or no tensile strength, parallel or sub-parallel to layering/ bedding. Bedding refers to the layering or stratification of a rock, indicating orientation during deposition, resulting in planar anisotropy in the rock material.
Contact	CO	The surface between two types or ages of rock.
Sheared Surface	SSU	A near planar, curved or undulating surface which is usually smooth, polished or slickensided.
Sheared Seam/ Zone (Fault)	SS/SZ	Seam or zone with roughly parallel almost planar boundaries of rock substance cut by closely spaced (often <50 mm) parallel and usually smooth or slickensided joints or cleavage planes.
Crushed Seam/ Zone (Fault)	CS/CZ	Seam or zone composed of disoriented usually angular fragments of the host rock substance, with roughly parallel near-planar boundaries. The brecciated fragments may be of clay, silt, sand or gravel sizes or mixtures of these.
Extremely Weathered Seam/ Zone	XWS/XWZ	Seam of soil substance, often with gradational boundaries, formed by weathering of the rock material in places.
Infilled Seam	IS	Seam of soil substance, usually clay or clayey, with very distinct roughly parallel boundaries, formed by soil migrating into joint or open cavity.
Vein	VN	Distinct sheet-like body of minerals crystallised within rock through typically open-space filling or crack-seal growth.

NOTE: Defects size of <100mm SS, CS and XWS. Defects size of >100mm SZ, CZ and XWZ.

ABBREVIATIONS AND DESCRIPTIONS FOR DEFECT SHAPE AND ROUGHNESS

Shape	Abbr.	Description	Roughness	Abbr.	Description
Planar	PR	Consistent orientation	Polished	POL	Shiny smooth surface
Curved	CU	Gradual change in orientation	Slickensided	SL	Grooved or striated surface, usually polished
Undulating	UN	Wavy surface	Smooth	SM	Smooth to touch. Few or no surface irregularities
Stepped	ST	One or more well defined steps	Rough	RO	Many small surface irregularities (amplitude generally <1mm). Feels like fine to coarse sandpaper
Irregular	IR	Many sharp changes in orientation	Very Rough	VR	Many large surface irregularities, amplitude generally >1mm. Feels like very coarse sandpaper

Orientation:

Vertical Boreholes – The dip (inclination from horizontal) of the defect.

Inclined Boreholes – The inclination is measured as the acute angle to the core axis.

ABBREVIATIONS AND DESCRIPTIONS FOR DEFECT COATING

Coating	Abbr.	Description	Aperture	Abbr.	Description
Clean	CN	No visible coating or infilling	Closed	CL	Closed.
Stain	SN	No visible coating but surfaces are discoloured by staining, often limonite (orange-brown)	Open	OP	Without any infill material.
Veneer	VNR	A visible coating of soil or mineral substance, usually too thin to measure (< 1 mm); may be patchy	Infilled	-	Soil or rock i.e. clay, silt, talc, pyrite, quartz, etc.

APPENDIX B – LABORATORY TEST RESULTS

Atterberg Limits and Linear Shrinkage Report

Project: 18 GARRETT STREET, MOSS VALE

Project No.: 32422

Client: CATHOLIC EDUCATION DIOCESE OF WOLLONGONG

Report No.: 23/3510

Address: 86-88 Market Street, Wollongong

Report Date: 19/10/2023

Test Method: AS1289.3.1.2,3.2.1,3.4.1,2.1.1

Page: 1 OF 1

Sampling Procedure: AS 1289.1.2.1 Clause 6.5.3 - Power Auger Drilling (Not covered under NATA Scope of Accreditation)

STS / Sample No.	8048D-L/1					
Sample Location	Borehole 4 Refer to Drawing No.23/3294					
Material Description	Sandy Clay, dark brown, trace of gravel					
Depth (m)	0.7 - 1.1					
Sample Date	26/09/2023					
Sample History	Air Dried					
Method of Preparation	Dry Seived					
Liquid Limit (%)	38					
Plastic Limit (%)	20					
Plasticity Index	18					
Linear Shrinkage (%)	11.0					
Mould Size (mm)	127					
Crumbing	N					
Curling	N					

Remarks:

Approved Signatory.....

Technician: AW

Orlando Mendoza - Laboratory Manager



CERTIFICATE OF ANALYSIS

Work Order	: ES2333149	Page	: 1 of 4
Client	: STS Geotechnics	Laboratory	: Environmental Division Sydney
Contact	: ENQUIRES STS	Contact	: Customer Services ES
Address	: Unit 14/1 Cowpasture Place Wetherill Park 2164	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: ----	Telephone	: +61-2-8784 8555
Project	: 30055/30060/32422	Date Samples Received	: 27-Sep-2023 15:20
Order number	: 2023-348	Date Analysis Commenced	: 03-Oct-2023
C-O-C number	: ----	Issue Date	: 04-Oct-2023 17:01
Sampler	: MB, PS		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 6		
No. of samples analysed	: 6		



Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	Position	Accreditation Category
Ankit Joshi	Senior Chemist - Inorganics	Sydney Inorganics, Smithfield, NSW
Edwandy Fadjar	Organic Coordinator	Sydney Inorganics, Smithfield, NSW



General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contract for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.

LOR = Limit of reporting

^ = This result is computed from individual analyte detections at or above the level of reporting

ø = ALS is not NATA accredited for these tests.

~ = Indicates an estimated value.

- ED045G: LOR raised for Chloride on sample 6 due to sample matrix.
- ED045G: The presence of Thiocyanate, Thiosulfate and Sulfite can positively contribute to the chloride result, thereby may bias results higher than expected. Results should be scrutinised accordingly.



Analytical Results

Sub-Matrix: SOIL
 (Matrix: SOIL)

Sample ID

				30055/9171	30055/9172	30055/9178	30060/1852	30060/1853
Sampling date / time				26-Sep-2023 00:00	26-Sep-2023 00:00	26-Sep-2023 00:00	26-Sep-2023 00:00	26-Sep-2023 00:00
Compound	CAS Number	LOR	Unit	ES2333149-001	ES2333149-002	ES2333149-003	ES2333149-004	ES2333149-005
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	6.3	6.6	5.8	7.9	6.6
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	412	12	19	431	17
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	16.2	8.9	3.8	12.5	9.8
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	80	<10	<10	410	<10



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Sample ID	32422/S1	----	----	----	----
				Sampling date / time	26-Sep-2023 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit	ES2333149-006	-----	-----	-----	-----	-----
				Result	----	----	----	----	----
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit	7.0	----	----	----	----	----
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm	15	----	----	----	----	----
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	0.1	%	8.2	----	----	----	----	----
ED040S : Soluble Sulfate by ICPAES									
Sulfate as SO4 2-	14808-79-8	10	mg/kg	10	----	----	----	----	----
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	10	mg/kg	<50	----	----	----	----	----